OVERVIEW OF WASTE DISPOSAL PROJECTS IN SWITZERLAND

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INTRODUCTION

In the area of nuclear waste disposal, the relative importance attached to technical, economic and societal issues is often very different from many other technological programmes, and this has a direct effect on the determination of a national waste management strategy. The widely accepted technological option for nuclear waste disposal involves burying in geologic media. National strategies within this option, and the specific items to which most effort, time and money are dedicated, are directly dependent on a range of internal and external constraints. In this paper we attempt to identify some of these constraints and to describe their influence on the programme of research, development and implementation of disposal projects in Switzerland. Within the framework thus erected, we summarise the main aspects of the organizational, legal and technical positions with respect to nuclear waste management in this country.

ISSUES INFLUENCING DISPOSAL STRATEGY

The principal aim of nuclear waste management is to ensure that no undue radiation exposures to individuals should arise through handling of wastes or through any return to man's environment from a final repository. This aim is common to programmes in all countries and obviously has a dominating influence on choice of disposal strategies. Many issues, however, can also vary from country to country leading to different emphases in programmes. Examples are:

- types and quantities of radioactive wastes produced
- political/legal requirements
- the pallet of nuclear services available within the country or on offer from outside
- the technical and the economic level
- national natural resources or raw materials
- geography and geology
- organization of waste management programmes.

We briefly discuss these points and their relevance in the Swiss case.

Radioactive Waste Production

Basic differences obviously exist amongst those countries with weapon programmes, those with nuclear power programmes and those where radioactive wastes are produced only from isotope applications in medicine, research and industry. Switzerland has a small nuclear power programme (5 units with approx. 3 GW(e) in 1983). This brings little simplification in HLW disposal compared to countries with larger capacities since the technology depends on the characteristics rather than the relatively small volumes of these wastes. In plans for L/ILW disposal, site selection is influenced by the fact that for these few power plants (or even for the projected 6 GW(e)) only one site need be identified and developed. The obvious advantage of this can be counterbalanced - especially in a federal system with a strong anti-nuclear minority - by the fact that the perceived burden of hosting a waste facility is concentrated upon a single community.

Nuclear Services Available

A small nuclear programme like that in Switzerland has ruled out to the present the feasibility of closing the fuel cycle by having national reprocessing facilities. The scarcity of such facilities and the constantly rising costs may lead to reawakened interest in multinational efforts, but currently small nations which believe in the advantages of reprocessing over direct disposal of spent fuel are restricted to the rôle of customer. Original contracts had the inherent advantage of freeing customer states from the onus of organizing disposal of high level wastes; newer agreements imply that all primary and secondary wastes may be shipped to the customer and furthermore can compromise his freedom in the choice of conditioning methods for the diverse wastes.

In Switzerland, national waste disposal projects are being planned for all wastes produced. International solutions would be welcomed but, for planning purposes, even those options, such as sea disposal of LLW and ILW, which are currently in operation are assumed to be discontinued.

In the organization of disposal projects smaller countries are often dependent upon services, contacts and capabilities not nationally available. A constant objective is, by judicious choice of technical options and by continuing cooperation with other countries, to crystallize out a limited number of research areas in which high-standard, easily-exchangeable results can be achieved.

Technical and Economic Level

In Switzerland the technological level is advanced and the economy is relatively healthy so that challenging and important issues can be tackled. There are, however, limitations. For example, competition for technical expertise is high so that the search for highly qualified - and available - earth scientists, technologists and engineers can be long and difficult. Furthermore even a healthy economy, when small, implies that there are absolute limits on available finance and effort and these make imperative a restricted choice of options in waste disposal technology. An illustration here is the restriction of work to one HLW matrix, namely the borosilicate glasses which Switzerland will receive from French and British reprocessors. Even then participation in expensive experimental work with active materials was considered justifiable only as part of a recently started joint project with Sweden and Japan.

National Resources and Raw Materials

Switzerland has no fossil fuel reserves and a hydroelectric power capacity which is commonly judged to be incapable of significant expansion without conflicting with the protection of the environment. Thus nuclear energy, although objected to by many, is currently of great importance for the country and projects for disposal of resulting wastes are essential. For the implementation of geologic disposal projects the scarcity of raw materials has two principal effects. Scenarios which include disruption of repositories by inadvertent human intrusion are rendered less likely; but the scarcity of experience in mining technology means that more organization may be required to form a framework for tackling the diversity of problems involved in projecting the short- and long-term behaviour of disposal systems in deep mined cavities. For facilities nearer the surface, on the other hand, extensive experience is available because of the numerous existing tunnels, hydro-schemes etc.

Geography and Geology

Clearly both these subjects profoundly affect disposal plans for waste repositories. Large countries like the USA can sometimes afford to dispose of low toxicity wastes in a simplified manner which takes credit for the isolation achievable by choice of remote locations. Large countries can also sometimes afford to formulate siting criteria in which the large distances proposed to nearest populations reflect, not an assesment of likely contaminant transport, but rather the availability of large remote areas! In Switzerland distances from repository entrances to nearest inhabitants will of necessity be relatively small but we do not believe that this must compromise the safety of the disposal system. A real effect of the dense population is, however, that many more people can be directly affected by site investigation and development programmes, and this has led to practical problems and delays in Switzerland.

The disposal concept is directly affected by geography and geology. Unavailable to land-locked countries are the attractive possibilities for locating underground repositories near coastal areas where any water flow is towards a large dilution reservoir. The geological structure determines the host rocks available. Switzerland has a variety which may be useful for L/ILW (marl, clay, anhydrite, granite) but for HLW attention is currently centred upon the granitic crystalline basement underlying the country. As is apparent from Fig. 1 this basement which is on the surface in the extreme north, dips rapidly to the south achieving a maximum overburden of around 8000 m before rising again in the more recent alpine massif. The facts that this rock is reachable only in a limited area which is overburdened by hundreds of meters of sedimentary rocks, and that very little research has been done to date on its structure, have direct consequences on technical waste disposal work in Switzerland. The region for site investigation is fixed; large-scale hydrogeologic modelling of complex layered structures is needed; great emphasis must be placed on remote non-destructive geophysical techniques for characterisation of the potential host rock formation; geologic field work becomes very time consuming and expensive.

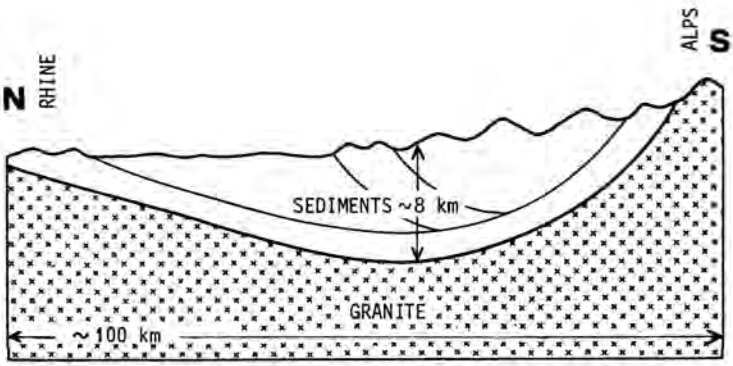

Fig. 1. Simplified geological profile through northern and middle Switzerland

Legal/Political Situations

These directly affect the organization of waste management, the priorities, the timescales and the constraints. In Switzerland responsiblity for disposal lies directly with the producers of wastes, although the government reserves the right to dispose at the cost of the producers. In 1979 an important change was introduced in a revised atomic law which made the granting of permits for new reactors dependent upon the existence of accepted projects for long-term, safe disposal of nuclear wastes. The 1985 deadline for such projects was imposed also for reactors already in existence by the appropriate government office which regards this step as necessary to justify the continued use of nuclear power in Switzerland.

Interpretation of the contents of the required safety "guarantee" is, of course, open to discussion. Guidance given in the intervening period has indicated that engineering projects for all waste types must be carried out, along with site investigations and appropriate safety assessments of the concepts proposed. The breadth and the depth of the work required is not clear and is still under discussion. Concrete proposals as to the criteria against which safety will be assessed are given in government guidelines presented at this conference last year[1]. Questions still arise, however, in the interpretation of these guidelines, in particular with regard to treatment of low probability nuclide release scenarios.

A further point in the revised atomic law which has greatly affected waste management planning is that all preparatory field work related to waste disposal requires direct permission from the Federal Council of government ministers. Although originally intended to smooth investigations (without prejudicing repository siting choice), subsequent decisions that normal local permits are also required, and underestimation of the legal complications involved, have led to delays in implementation of geologic field work. A decision from the Federal Council on the permits for deep drillings applied for in June 1980 may be reached in February 1982.

Organization of Waste Management

The need for an efficient organization with minimum duplication of effort rises when resources are limited and time is short. It is important to separate and define the rôles of government, waste producers, and regulatory authorities. The principle of "producer responsibility" mentioned in the above section primarily determines overall organization in Switzerland.

Accordingly, utilities with nuclear power interests together with the Federal Office of Public Health (which is responsible for industrial, medicinal and research wastes) have formed Nagra (National Cooperative for the Storage of Radioactive Waste) to perform the necessary project work. An overview of the total organization is given in Fig. 2. It is important to note that conflicts of interest are avoided by separating government implementation and regulatory interests into different political departments and by use of different consulting offices by Nagra and by the regulatory authorities. Complete duplication of technical methodology is, on the other hand, not sought; for example common safety analysis models may be employed. The Federal Reactor Research Institute (EIR) has a special rôle in that it acts as contractor to Nagra, has an independent waste programme and may also be asked by the regulatory bodies to perform specific technical tasks.

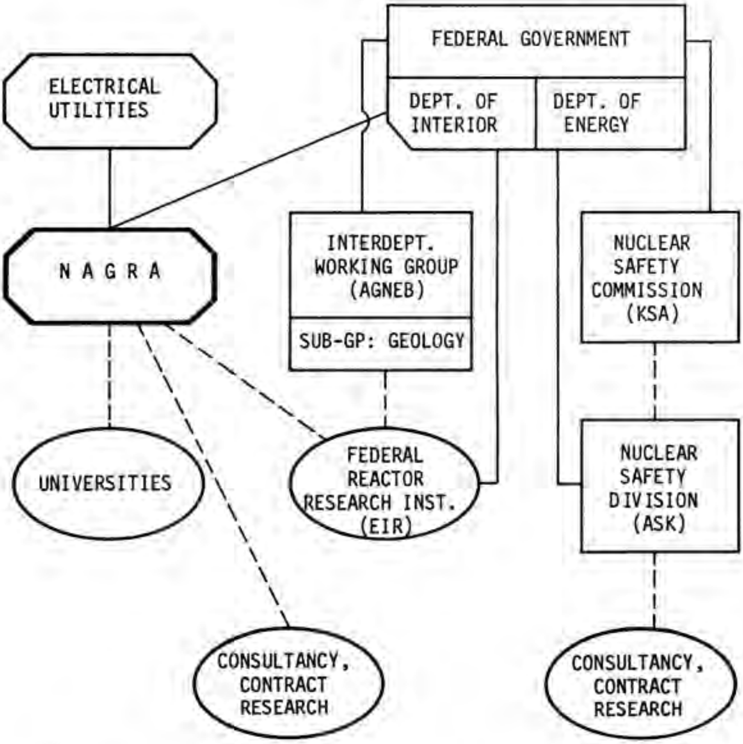

Fig. 2. Organization of nuclear waste disposal work in Switzerland

NAGRA WASTE DISPOSAL PROGRAMME

Organization

Within Nagra the work areas and the allocation of effort and funding are determined by the technical aims and by externally imposed programme and time constraints. The technical departments concentrate upon each of the topics which were mentioned above as being requirements for the "safety guarantee" projects expected in 1985. The departments of Waste Technology and Safety Analysis, Repository Engineering and Earth Sciences are complemented by a Legal Department, which for example must devote large efforts to handling objections to applications for site work, and a Public Relations Department. The activities of the last-mentioned range through press work, organization of technical exhibitions, contact with local populations and publication of regular news magazines.

The permanent staff positions at Nagra number only approx. 30, the objective being to provide a project management structure capable of allocating available resources in the best possible way. For the period 1980-85 these resources are broadly assessed at approx. 200 million SFr. The 1982 budget allocation is 40 million SFr.

Technical Programme

The project work at Nagra must include disposal facilities for all types of active wastes. The concepts for repository types have been described previously[2] and are briefly summarized in Table I.

An abbreviated overview of the Nagra technical programme is given in Table II. All of the considerations discussed in the previous section have contributed to the balance of effort reflected in the programme. Most time and money is devoted to geological, geophysical and hydrological field work. The extensive geophysics regional programme is performed in conjuction with the Swiss Geophysics Commission (SGPK). Gravimetric, aeromagnetic and magnetotelluric measurements as well as some refraction seismic have already been carried out. In 1982 around 200 km of vibroseismic profile measurements will link up a series of proposed drilling sites. If permission is granted, the first of these deep drillings, each penetrating 1000 m into the crystalline basement, will begin in summer 1982. A large programme on characterisation of mineral waters of special interest is underway. In Fig. 3 an overview is given of the earth sciences programme in northern Switzerland, where the feasibility of HLW disposal is being studied. A further programme, aimed at identifying potential L/ILW repository sites involves regions spread throughout the country.

Table I

Waste Category	Repository Type	Possible Geologic Formations
Short-lived or low active	A Near-surface cavern	numerous (isolation by technical barriers)
Intermediate level	B Rock caverns 100-600 m	Anhydrite, Clay, Marl, Crystalline, Formations above water-table
High-level and actinide	C Rock cavern or deep boreholes 600 - 2500 m	Crystalline, Clay

Table II

Nagra Programme Overview

Project	Activities
Waste Technology	
Nuclide-specific waste characterisation	Analysis of literature, complementary lab-work, calculations
Characteristics of L/ILW	Literature; liaison with power plants; lab-work; large scale experiments
Characteristics of HLW (Glasses)	International project lab-work
Evaluation of container concepts (HLW and spent fuel)	Literature; complementary lab-work
Repository Planning	
Design work for repositories Typ A, B, C	Engineering design; calculation
Evaluation of buffer materials	Joint studies; international project; complementary lab-work
In-situ experiments	Stripa participation; Grimsel rock laboratory
Earth Sciences	
Regional programme for investigation of granitic basement in North Switzerland:	
- local and regional geology	Literature study and analysis; Geophysics (reflection and refraction seismic, gravimetry, aeromagnetic survey, magnetotellurism); 12 deep drillings (1200-2500 m)
- local and regional hydrology	characterisation of mineral waters; isotope age determinations
- tectonic studies	study of neotectonics; possible geodesic field programme

Project	Activities
Site selection for L/ILW repository	Literature evaluation, selection of 3-6 sites for field work
Host rock characterisation (rock mechanics, geochemistry, sorption)	Literature analysis; lab-work on sorption; in-situ experiments in anhydrite and in granite
Methodology for water age determination	Development and application of ^{39}Ar, ^{14}C, ^{36}Cl, ^{81}Kr menthods; investigation of sampling techniques
Safety analysis	
Determination of criteria for allocation of wastes to appropriate repository type	Improved characterisation of waste; categorization of waste; simplified safety analyses
Mathematical modelling:	
- hydrogeology	Model development; calibration; calculation
- leaching	model development; calibration; calculation;
- chemical speciation, solubility	model adaption; data extention
- geosphere transport in porous and fissured media	model development; intercomparison
- biosphere transport	model adaption; collection of local data
Safety assessment methodology	Literature analysis; international contact; adaption to local requirements
Diverse	
Disposal of LLW at sea	International cooperation; experimental monitoring programme
Sea-bed disposal	International cooperation

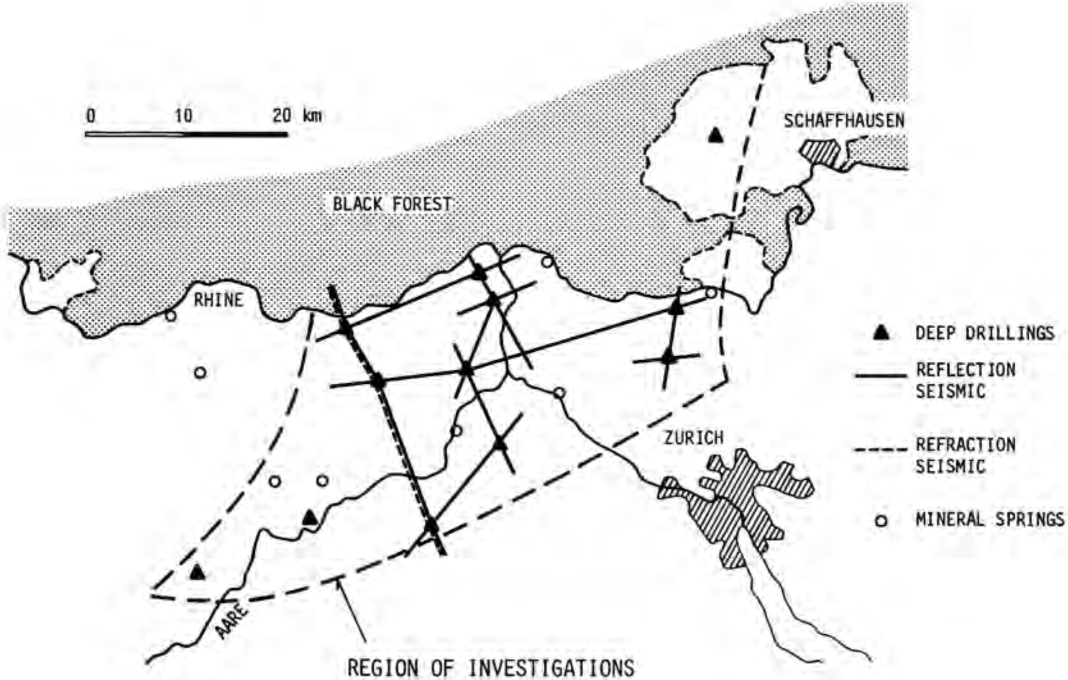

Fig. 3. Regional programme of geologic, hydrogeologic and geophysical investigations in northern Switzerland

In the Civil Engineering Department comprehensive design studies have been produced for all 3 types of repositories A, B and C[3, 4, 5]. These studies are currently being revised and refined in specific areas to provide the basis for final design proposals. This department also manages planning work for an underground rock laboratory to be horizontally accessed from an existing tunnel system in the Swiss Alps thus providing a granite test facility with an overburden of $\sim$500 m. Following a detailed reconnaissance campaign based on 6 100 m pilot holes[6], application for permission to construct the laboratory was submitted in December 1981.

In the Waste Technology and Safety Assessment Department attention is focussed upon characterisation of wastes arising at power plants, at foreign reprocessors and during decommissioning work. Contact with the various waste producers is supplemented by literature analysis, calculation and laboratory testing. One objective is to characterise wastes sufficiently well that they can be grouped into categories which are not so detailed as to be unmanageable but still sufficiently fine for optimal allocation of wastes to appropriate repository types. This allocation is currently being attempted by comparing the results of simplified safety analyses with the dose guidelines provided by the authorities.

Final safety assessment of complete repository systems will, of course, require more detailed safety analysis modelling. Extensive work on deterministic modelling of phenomena affecting nuclide release rates is in progress, much of it in collaboration with the Federal Reactor Research Institute. The problematic issues of determining and quantifying possible scenarios leading to nuclide release are also being examined. For projects in 1985 a full "risk approach" in the safety assessments will not be employed. Analyses will be based upon detailed examination of specific scenarios with much importance being attached to the uncertainties and incompleteness of models and data.

Timescales

The most pressing deadline in Switzerland is obviously the artificially set date of 1985. Planning work for this demonstration project can sometimes bring conflicts with implementation time-scales for actual facilities needed soon thereafter. As in many countries most urgent real needs are for disposal methods for L/ILW from reactor operation and for intermediate storage for HLW and other reprocessing wastes. Table III gives a broad picture of the range of facilities foreseen for Switzerland and the time-scales for implementation. Adherance to these timescales will be dependent upon good organization of projects, high level of technical work, smoother handling of legal issues and fruitful contact with scientists and engineers from other countries engaged in parallel projects.

Table III

Time Schedule

1985	"Projekt Gewähr" Submission of project which can be accepted as evidence that long-term safe disposal of all Swiss wastes is possible
1985-95	Implementation of projects for: - Extention of intermediate storage capacity for L/ILW - Final repository for L/ILW (Type B) - Long-term intermediate AFR storage for HLW and actinide wastes from reprocessing - Long-term intermediate AFR storage for spent fuel
from 2000	Repository for LLW from maintainance and decommissioning (Type A)
from 2020	Repository for HLW (in Switzerland or abroad)

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