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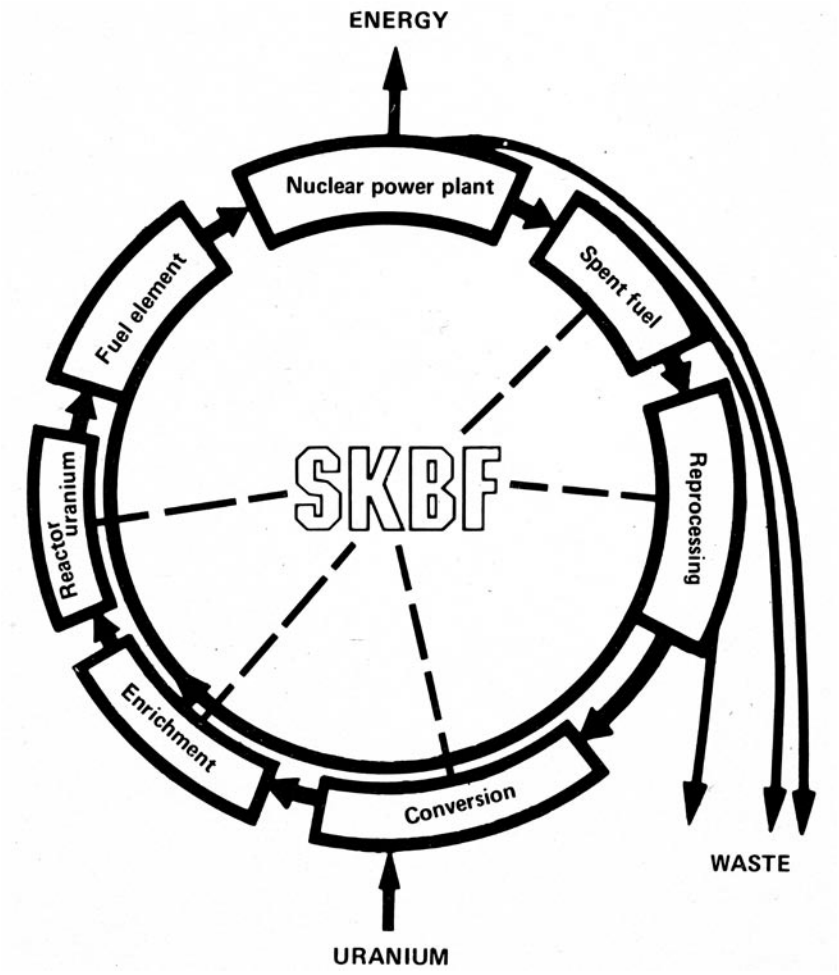
Report to the Swedish Ministry of Industry, November 1981



SKBF
SVENSK KÄRNBRÄNSLEFÖRSÖRJNING AB
SWEDISH NUCLEAR FUEL SUPPLY COMPANY

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REPORT ON THE CURRENT SITUATION WITH REGARD TO NUCLEAR FUEL AND THE OPERATIONS OF SVENSK KÄRNBRÄNSLEFÖRSÖRJNING AB (SWEDISH NUCLEAR FUEL SUPPLY COMPANY) DURING THE PERIOD OCTOBER 1980 – OCTOBER 1981

SUMMARY

Plans and measures to supply the Swedish nuclear power system with fuel and to manage and dispose of its residues are affected primarily by three factors: the decisions taken since the national nuclear referendum in March of 1980, requirements set forth in legislation and the conditions for international trade. The planning principles are illustrated by a diagram on page 5 of this report.

It should be possible for Sweden to meet its needs for natural uranium, conversion and enrichment services satisfactorily during the 1980s. An attempt is made to get supply from different geographical areas. In addition, SKBF has built up a reserve stockpile of low-enriched uranium within the country for its owners.

Particulars on needs and signed agreements are provided in the report.

The large but low-grade Swedish uranium shale deposits have been investigated during several years in the past. SKBF pays for prospecting for other kinds of domestic deposits. SKBF has made a decision concerning the Pleutajokk project, for which the Swedish mining company LKAB has the exploration licence. It is our opinion that the known quantities of recoverable ore are too small to provide a basis for a viable industrial enterprise. SKBF has therefore withdrawn its support of the project.

A number of uranium-bearing boulder formations and mineralizations have been found in Norrland County in Northern Sweden and are gradually being explored. It is still too early to draw any conclusions as to whether any of them represents an exploitable orebody.

Current work on the back end of the nuclear fuel cycle concerns transport systems, plants, foreign contracts for reprocessing, research and development as well as financial projections.

A sea transportation system for all types of radioactive products is under development. The special-purpose ship is expected to be delivered in the summer of 1982. Work on harbours has proceeded, along with the procurement of terminal equipment. It is estimated that a sea transportation plan will be submitted to the National Swedish Administration of Shipping and Navigation in November of 1981.

Shipments of spent fuel to Great Britain under the terms of an older reprocessing agreement between OKG and British Nuclear Fuels Ltd. (BNFL) have continued and are expected to be concluded in 1982.

The erection of the new reprocessing plant, UP3, in France has proceeded to the point that the receiving section has been put into operation. Swedish shipments under existing agreements will not begin until the end of 1982 when the afore-mentioned transportation system has been completed.

The construction of Clab, the central temporary storage facility for spent fuel, on the Simpevarp peninsula is proceeding according to schedule.

Site investigations and project work have been conducted during the report period on a central final repository for reactor waste, i.e. waste types whose "toxicity" is limited to a period of a few hundred years. The facility (SFR) is planned to be located at Forsmark, a site for three nuclear power reactors. The necessary applications are planned to be summitted in early 1982. According to the plans, the facility should be ready to be put into operation in 1988. It can later be expanded so that it can also accept radioactive waste components from dismantled nuclear power plants.

The principles for the final storage of long-lived waste that can also be high-level are location in a deep rock formation, measures to limit temperature increase and multiple barriers against the escape and transfer of toxic products to man.

As a basis for the design of such repositories, SKBF is conducting extensive research and development work within the fields of geology, materials science, chemistry and engineering.

In addition to discussing this research work, the report provides an account of the practical demonstration and research project at Stripa, where organizations from Canada, Finland, France, Japan, Switzerland and the United States are participating under the auspices of the OECD.

The report also provides an account of ongoing site-specific geological field studies. The long-range plan calls for such studies to be conducted at 10-20 sites during the 1980s and then concentrated to a few sites in the 1990s. It is expected that the final site choice will not be made until around the year 2000.

As of 1 July 1981, new forms have been introduced for the organization and financing of the work on the back end of the nuclear fuel cycle.

Responsibility for the development work and facilities design rests with the licensed operators of the nuclear power stations, who have decided that SKBF shall perform this function. SKBF's ownership structure and the consortium agreement have been adjusted accordingly. The present owners are:

- Swedish State Power Board 36 %
- Forsmarks Kraftgrupp AB 30 %
- OKG Aktiebolag 22 %
- Sydsvenska Värmekraft AB 12 %

The licensed operators are responsible for the costs for the above. In order to ensure that funds will be available as needed, the operators shall pay a quarterly charge to the state in proportion to the amount of nuclear energy they produce.

The "National Board for Spent Nuclear Fuel" was established on 1 July 1981. This Board examines SKBF's annual plans for activities within the Board's sphere of interest and submits a recommendation to the Government for the size of the charge. The Board also makes a recommendation on loans to the power utilities from the fund created by the surplus left over after the relevant costs of SKBF's activities have been subtracted from the accumulated charges paid by the utilities.

INTRODUCTION

Plans and measures to supply the Swedish nuclear power system with material and services within the nuclear fuel cycle - including waste handling - are affected primarily by three factors: requirements set forth in legislation, conditions for international trade and decisions taken since the national nuclear referendum in March of 1980, according to which decisions the reactors are to be decommissioned by the year 2010.

The preceding report provided an overall picture of the availability of goods and services. No essential changes have occurred in this respect, and the present report is mainly concerned with developments and activities during the stated period.

The planning principles are illustrated in broad terms by the diagram below.

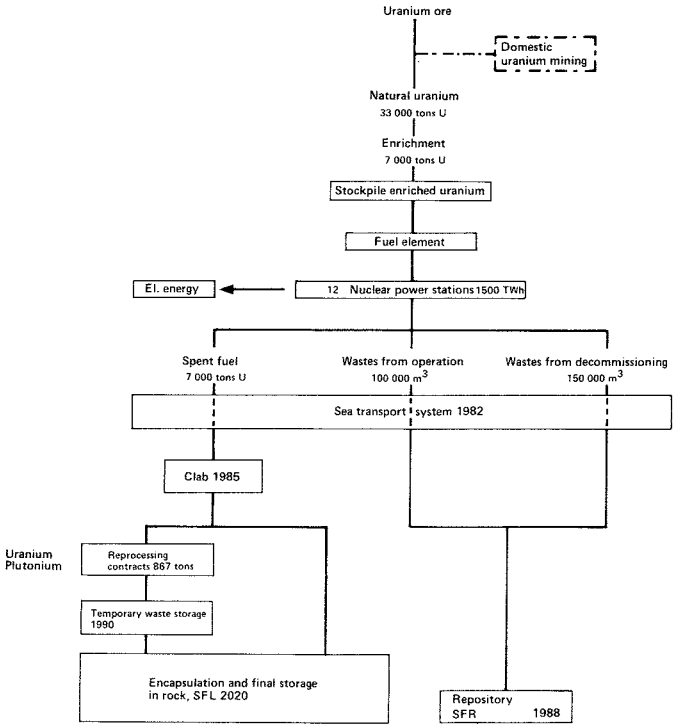

Figure 1. The Swedish nuclear power programme

1 SUPPLIES OF NUCLEAR FUEL

1.1 NATURAL URANIUM

1.1.1 The international situation

In September of 1981, the Uranium Institute published a study of nuclear plant construction and uranium requirements in the world (except for the Eastern bloc countries) for the period up to 1995. Three cases were dealt with:

- plants in operation (250 units), under production and on order (more than 200)
- probable case (certain new orders for nuclear power plants)
- high growth.

The table shows the uranium requirements for the three cases (in thousands of tons of uranium per year)*

	1980	1985	1990	1995
Plants in operation, under construction and on order	29	43	48	48
Probable case	29	46	60	70
High growth	29	50	71	99

* 0.25 % U-235 in depleted uranium

The so-called "probable case" involves a doubling of the uranium requirement from 1980 to 1990. Plants that are under construction and on order alone entail an increase of uranium needs. The "high growth" case presumes such factors as economic growth,

political backing and new orders in the United States. Events to date have not made such "high growth" probable.

The figures shed light on the possible long-term uranium need. In the short term, however, the uranium need is determined by existing enrichment contracts. As an example of this, the study points out that the real need in 1981 was 30 000 tons, but that 41 000 tons were actually demanded under the terms of existing enrichment contracts.

Considerable reserve stocks - on the average about three times current annual consumption - have been established. Policies with regard to the size of reserve stocks in different countries will be of essential importance in any assessment of the future supply and demand picture.

The most important producer countries in 1980 were:

USA	16 809	tons	of	uranium
Canada	7 050	"	"	"
South Africa	6 100	"	"	"
Niger	4 505	"	"	"
Namibia	4 038	"	"	"
France	2 600	"	"	"
Australia	1 560	"	"	"
Gabon	1 000	"	"	"
Other countries	600	"	"	"
	44 262	tons	of	uranium

Reduced production is forecast for 1981 in the United States owing to the low price for spot purchases. With some increase in Canada and Australia, total production in 1981 will probably be 42 000 - 43 000 tons of uranium.

Overcapacity and overproduction prevailed during 1980. The price for spot purchases declined. This price, which is quoted monthly by NUKEM, was about US$ 31.50 per lb U_3O_8 in September of 1980, and declined to about US$ 24.50 per lb U_3O_8 in September of 1981.

At an exchange rate of US$ 1 = SEK 5:60, the price as of September 1981 was SEK 357 per kg uranium content.

A better balance between production and demand has been achieved in 1981. The situation at the close of the 1980s is difficult to predict today. Additional mines will have to be opened in all three of the above cases. Known ore reserves exist for this. Whether or not uranium production will be expanded and balance will exist between production capacity and demand during the period will depend upon the price trend and the uranium industry's projections for the future as well as on political circumstances, licensing etc.

The spot market represents only 5-10% of the uranium market. Most uranium purchases are based on long-term contracts between mining industries and power utilities. Prices for uranium deliveries during 1981 under long-term contracts vary considerably depending upon the time and terms of the contracts, with an average level of just over US$ 30 per lb U_3O_8. This level is higher than the present-day price level on the spot market.

This is partially due to high production during the 1980s, but also to the high level of interest rates in the United States, which has induced American power utilities to sell parts of their stocks of uranium on the spot market.

1.1.2 Domestic uranium resources

1.1.2.1 Ranstad

Ranstad in Västergötland county is surrounded by an area containing alum shale, the most uranium-rich portion of which contains about 300 g of uranium per ton of shale. The reserves of uranium contained in a homogeneous ore are large, but the concentrations are low. A method has been developed and demonstrated on an industrial scale for uranium recovery from this special type of uranium ore.

The shale also contains other substances such as molybdenum, vanadium, aluminium, potassium and kerogen, but in relatively low concentrations.

For three years now, Ranstad Skiffer AB (RSA) has been conducting a development project to evaluate the recoverability of different products from the shale. RSA has applied to the Government for additional funds for this purpose, but the application was denied. In the spring of 1981, however, the Parliament decided that the remaining funds - about SEK 20 million - may be used for continued development work during the next few years. As a result of this decision, research on the extraction of valuable products from the shale is continuing on a limited scale.

The work on the recultivation of reclaimed strip-mined areas is continuing.

1.1.2.2 Pleutajokk

LKAB, the holder of the exploration licence, submitted an application to the Government in December of 1980 pursuant to Section 136a of the

Building Act for permission to locate a mine and uranium mill at Pleutajokk in the municipality of Arjeplog. The application has been reviewed by a number of agencies and organizations. The municipality has decided not to exercise its veto against the project.

In early September 1981, LKAB announced that it was withdrawing from the Pleutajokk project. SKBF, which had given financial support to the investigations, was offered the opportunity to take over the project.

SKBF declined this offer, stating its reasons as follows:

"After the investigations performed by LKAB and by outside experts, SKBF is forced to conclude that the mineralization in Pleutajokk is complex. Assuming realistic alternatives for mining, the proven quantities of recoverable ore are too small to provide a basis for a viable industrial enterprise. SKBF is therefore discontinuing its support of future investigations in Pleutajokk".

SKBF has contributed a total of SEK 10 million to the Pleutajokk project since 1978.

1.1.2.3 Prospecting

Domestic prospecting for uranium has heretofore been financed by the state and by SKBF. In its Budget Bill, the Government declared that as from July 1981, prospecting for uranium ore should be paid for by the power utilities. Measurements of the natural radioactivity in the country will continue to be paid for by state funds. SKBF has thereafter applied for permission to take over 20 exploration licences and applications for such licences from the state.

These exploration licences and applications apply to areas located within the municipalities of Arjeplog, Arvidsjaur, Berg, Boden and Sorsele. SKBF has also applied for two new exploration licences in Arjeplog.

SKBF has an agreement with the Geological Survey of Sweden concerning prospecting within an area corresponding to approximately 50 map-sheets in the southern part of Norrland County. Regional studies in the form of aerial surveys and geochemical evaluations are being performed within the framework of this agreement, along with local geological and geophysical investigations, radon measurements and test drillings.

SKBF has a cooperation agreement with the Swedish Board for Government Mining Properties, as a consequence of which all uranium prospecting efforts will also be of value in connection with other prospecting. A similar agreement was reached during the year with the Norrland Fund with respect to certain areas in Jämtland County.

At the present time, SKBF has 17 exploration licences and applications for such licences in southern Norrland County. The licence areas are located within the municipalities of Bräcke, Härjedalen, Krokom, Ljusdal, Ovanåker, Ragunda, Ånge, Åre and Östersund.

Drilling is continuing at Lilljuthatten in the municipality of Krokom. A study of groundwater conditions was begun in the area during the year. Krokom municipality has appointed a joint consultation group to follow the investigations.

At Sågtjärn in the municipality of Ånge, test drilling has revealed a limited uranium mineralization.

It is still too early to draw any conclusions as to whether any of the uranium mineralizations found in the northern part of the country are sufficient for exploitation.

1.1.3 Supplies of natural uranium

Plans are aimed at meeting the needs of 12 nuclear power reactors with a combined production of 1 500 TWh.

The total remaining requirement is thereby estimated at 26 000 - 39 000 tons of uranium.

The natural uranium requirement can vary within relatively wide limits with a number of different factors. It is therefore important that supply planning be rolling and flexible.

The Swedish nuclear power utilities have contracts with suppliers of uranium from Australia, Canada, France (uranium from Niger and Gabon), and the United States. These contracts provide for a total of 6 150 tons of natural uranium for the period 1981-1990. The total need for the same period is 12 340 tons of uranium. The intention is to sign contracts within the next few years for a substantial portion of the need not yet covered for the period in question.

Contracts have been signed for the period 1991-2000 for 900 tons of uranium, while the total need for this period can be estimated to be 10 000 - 14 000 tons of uranium.

Considerable uncertainty exists with regard to the uranium requirement for the period 2001-2010. In the event of a phase-out of nuclear power in Sweden, the reserve stockpile will be used.

The above contracts include one which OKG has signed with Energy Resources of Australia for 2 400 tons of uranium for delivery during the period 1982-1996. The uranium is intended for the Oskarshamn power station.

Also included is a contract signed by SKBF with Gulf Minerals Canada Ltd. for 348 tons of uranium. This uranium is intended for build-up of the reserve stockpile and for use at the Barsebäck power station.

1.2 CONVERSION

Conversion entails the transformation of uranium concentrate to uranium hexafluoride.

Total conversion capacity in the West in 1980 (at five enterprises) corresponds to the conversion of about 40 000 - 45 000 tons of uranium. An expansion of capacity at present-day plants by an additional 20 000 tons is planned for 1984. Conversion services can also be purchased from the Soviet Union under the terms of enrichment contracts. According to current assessments, conversion capacity will catch up with demand during the 1980s, and there will be no obstacle to further capacity expansion if required.

In 1981, SKBF signed a contract with Eldorado Nuclear in Canada for conversion of the abovementioned uranium concentrate containing 348 tons of uranium.

1.3 ENRICHMENT

1.3.1 Suppliers to Sweden

As has been described in further detail in a preceding report to the Ministry of Industry, the power utilities have signed "requirement contracts" with the US Department of Energy (DOE) for Oskarshamn units 1 and 2, Ringhals units 1 and 2 and Barsebäck units 1 and 2. SKBF is the Swedish party to additional contracts of a later type with DOE - providing for more fixed commitments (quantity contract) - that have been concluded for Ringhals units 3 and 4 and Forsmark units 1, 2 and 3.

The price of enrichment under the terms of the requirement contracts was $119 per separative work unit (SWU) during 1981, but will be raised as of

November 2 1981 to an indexed ceiling price estimated in November of 1981 at $125.41.

The price of enrichment under the terms of long-term fixed commitment contracts was $110 per SWU during 1981, but was raised as of 1 October 1981 to $130.75 per SWU.

A separate work unit is equivalent to a given weight of enriched uranium at a given level of enrichment; this amount increases at lower enrichment levels and decreases at higher enrichment levels.

The 1970 Swedish-Soviet nuclear cooperation agreement provides for isotope enrichment for Swedish needs in the Soviet Union. In 1974, SKBF signed a contract with Techsnabexport for 300 000 separative work units with delivery in 1979. In 1975, SKBF concluded an agreement with Techsnabexport concerning the exercise of options. These options permitted the purchase of an annual enrichment quantity for the period 1981-2000 corresponding to one reactor unit plus an additional 300 000 separative work unit for delivery in 1982-83.

The enriched uranium delivered in 1979-82 is being set aside as a reserve stockpile for the Swedish nuclear power plants. Enriched uranium delivered from 1983 will mainly be used for the operation of Oskarshamn 3.

1.3.2 Other suppliers

Eurodif in France is now completing the construction of a plant utilizing the gas diffusion method. Shipments of enriched uranium from the plant began in early 1979. The full capacity of the plant - 10.8 million separative working units per year - is expected to be available in 1982.

Urenco has plants utilizing the gas centrifuge method in the Netherlands and Great Britain. To date, limited quantities of enriched uranium have been delivered. Urenco's current capacity in the two countries amounts to a total of 460 000 SWU per year. Plants for capacity expansion include a new plant in Gronau, West Germany.

Prototype plants for isotope enrichment exist in Japan (gas centrifuges) and South Africa (helicon process).

In 1978, France presented a new method for isotope enrichment based on chemical exchange. It is said that this method cannot be used in practice to produce highly enriched uranium, which means it cannot

contribute to the risk of nuclear weapons proliferation.

The total enrichment capacity currently existing and under construction is expected to be sufficient for international nuclear power programmes during the 1980s. Additional expansion is deemed quite feasible in the event of a rise in demand.

The price of enrichment in the United States has risen more rapidly than inflation in the past few years. In combination with changing currency exchange rates, this means that the United States no longer has lower prices than Eurodif or Urenco.

1.4 RESERVE STOCKPILE

The reserve stockpile of enriched uranium administered by SKBF increased during 1981. Natural uranium produced in Ranstad and converted to uranium hexafluoride at Comurhex in France and then isotope-enriched by Techsnabexport in the Soviet Union has been added to the stockpile, which now contains about 23 TWhe.

A continued build-up of the stockpile is planned for next year, so that it will contain about 36 TWhe at the end of 1982.

The 1980 Oil Stockpiling Committee has proposed that the nuclear power utilities should maintain an emergency stockpile of nuclear fuel equivalent to 35 TWhe. With the nuclear fuel in reactors, fuel bundles at the nuclear power plants and fuel under fabrication within the country, this provides a reserve capacity that will enable the Swedish reactors to hold out for 22-23 months with the normal operation of 12 units. In other words, the Committee is proposing a stockpile that is roughly in line with the plans of the nuclear power utilities through 1982. The proposal is currently under official review.

2 MANAGEMENT OF RESIDUE PRODUCTS

2.1 CENTRAL TEMPORARY STORAGE FACILITY FOR SPENT FUEL (CLAB)

The process planning and engineering work is now in the detailed design and procurement phase. Technical solutions for several of the systems are still being worked out.

As far as the underground work is concerned, the transport tunnel has been blasted to a length of 473 m. Of a total of 90 000 m^3 in the storage building underground there still remains in October 30 000 m^3 of rock to be taken out. The blasting and reinforcement work is expected to be completed by 1 February 1982.

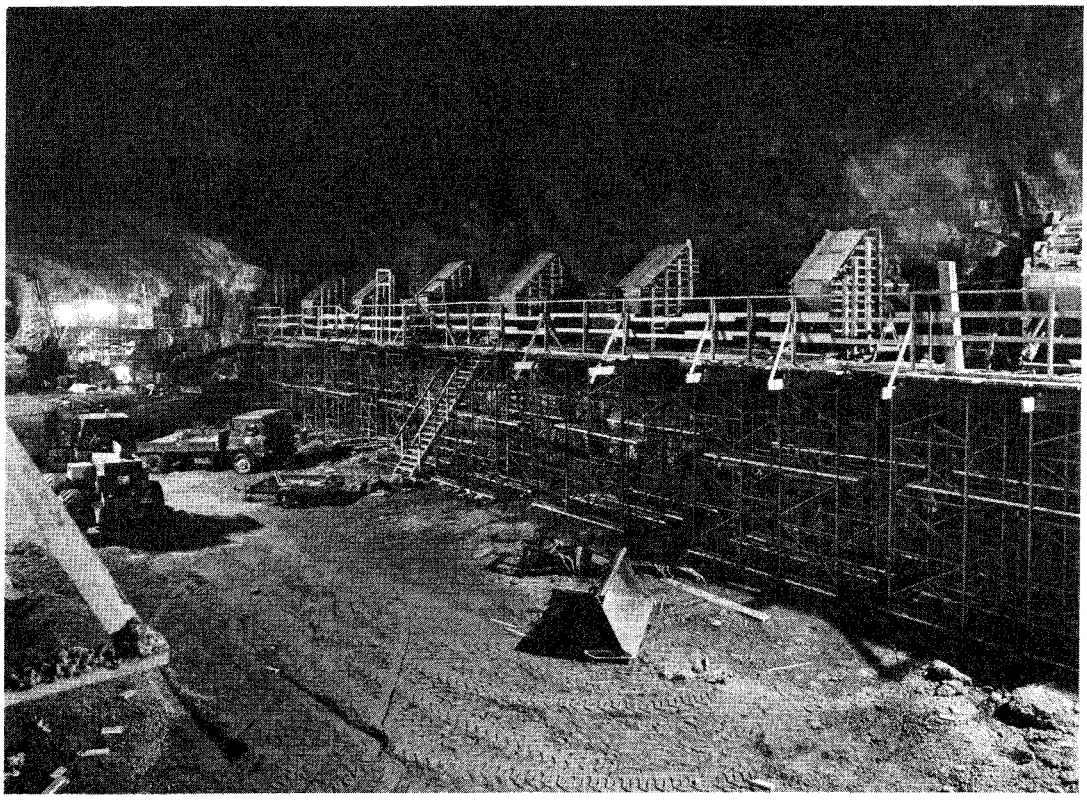

Figure 2. Blasting for storage area

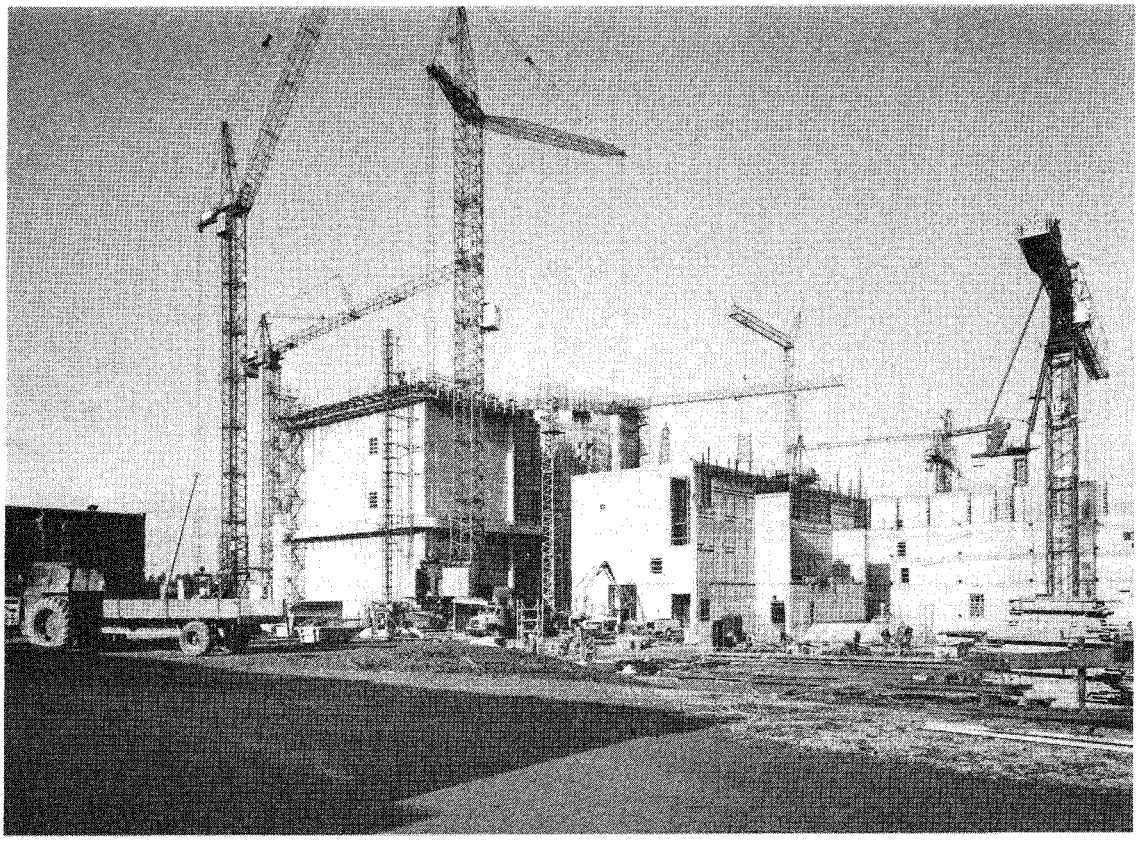

Figure 3. Construction work on the surface.

Above ground extensive construction work has been going on in the receiving building and the auxiliary systems building in the form of form work, reinforcement, support for pool lining and concrete casting. The connecting shaft between the surface and the storage area has also been casted.

The service tunnel between OKG's facilities and Clab has been completed and the piping and cabling work has commenced.

Concrete casting has been completed corresponding to 1/3 of the surface buildings.

The labour force of the building consortium "Byggkonsortiet Oskarshamnsarbetena" (BOA) and its subcontractors has been progressively increased during the period and amounted to about 410 persons in October 1981.

According to an agreement with SKBF, procurement and inspection of the building works for Clab is handled through OKG. OKG's site organisation will also be in charge of the operation of the facility.

The Clab facility is scheduled to be finished by 1985. The cost of construction in 1981 price level is estimated at SEK 1 200 million.

2.2 TRANSPORTATION SYSTEM

All the necessary shipments of radioactive products deriving from the nuclear power generation are planned to be carried out in solid form by means of a sea transportation system.

2.2.1 Ship

A contract was signed on 9 December 1980 with the French shipyard Ateliers et Chantiers du Havre (ACH) in Le Havre, Normandy, for the delivery of a roll-on/ /roll-off ship designed by Salén Technologies AB in Stockholm.

Laying of the keel began in July of 1981. Launching is planned for January of 1982 and delivery for July of 1982.

2.2.2 Equipment

A special-purpose transport vehicle for spent fuel casks has been purchased. The equipment will be delivered during March-April of 1982, whereupon its function together with the ship will be tested.

The manufacture of four transport casks is in progress at Uddcomb in Karlskrona. Owing to delays at the manufacturer, the delivery date for the first transport cask has been postponed four months.

Barring additional delays, it should be possible to keep the planned transport schedule to La Hague. The French Ministry of Transportation has issued an IAEA type B (U) licence. It is at present being examined by the concerned Swedish authorities.

2.2.3 Safety report

The preliminary safety report has been examined by the concerned Swedish authorities (the National Swedish Administration of Shipping and Navigation, The Swedish Nuclear Power Inspection Board and the National Institute of Radiation Protection). In France, a special commission was appointed to examine the preliminary safety report. The commission consisted of representatives of Commissariat à l'Energie Atomique, Comité Interministériel de la Securité Nucléaire, Technicatome and Bureau Veritas. Preliminary approval was obtained from the concerned Swedish authorities in July of 1980 and from the French commission in December of 1980.

A sea transportation plan has been prepared in accordance with directives from the National Swedish Administration of Shipping and Navigation. The report will be submitted to the Administration in November of 1981.

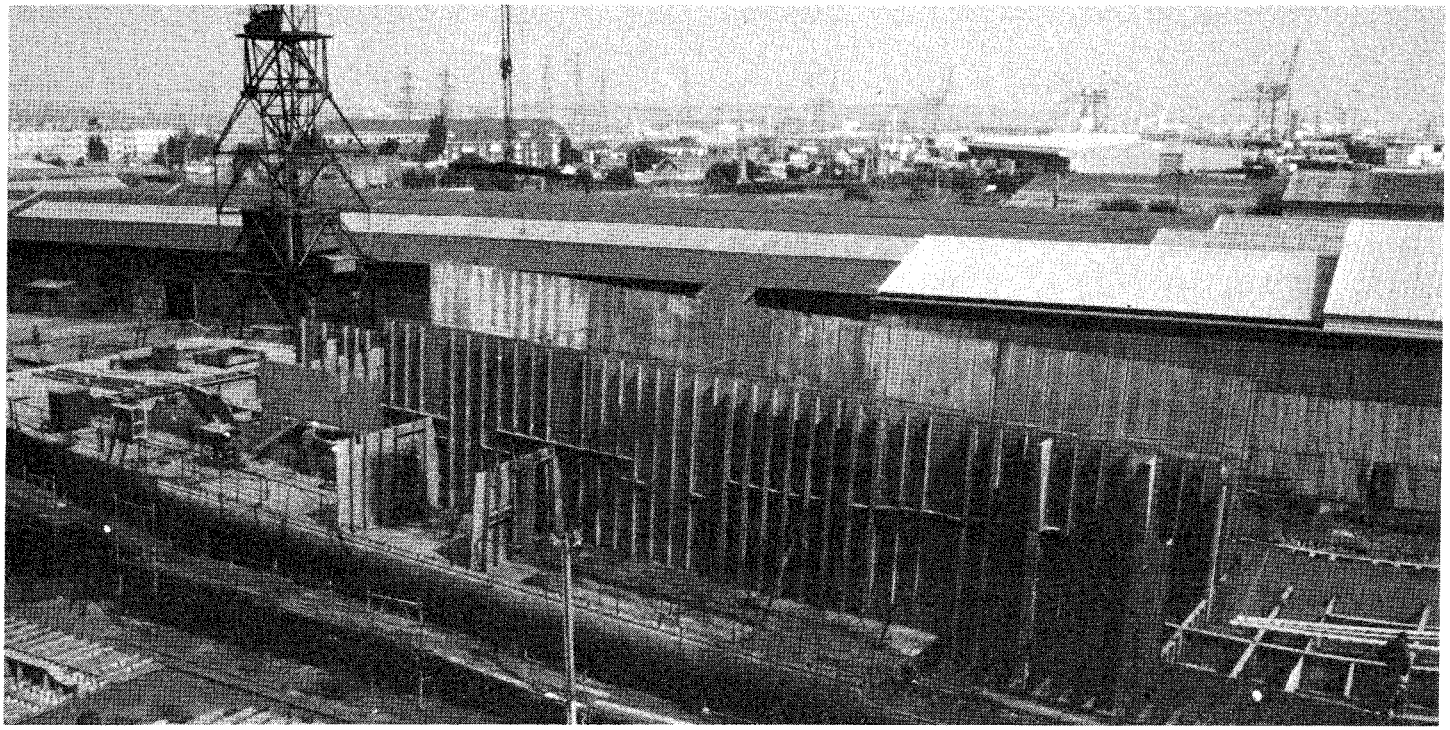

Figure 4. The ship under construction

The final safety report is currently being prepared and should be submitted to the Swedish and French authorities during the first quarter of 1982.

2.3 REPROCESSING

An agreement exists between OKG and British Nuclear Fuels Ltd (BNFL) providing for the reprocessing of 140 tons (counted as enriched uranium) of fuel from the OKG reactors. The final shipment to Great Britain within the framework of this contract is planned to go in 1982. BNFL is responsible for the transports.

Contracts - as required by the Swedish Stipulations Act - exist between SKBF and the French company of Cogema for the reprocessing of 727 tons of fuel

(counted as uranium) from the reactors in Barsebäck, Ringhals and Forsmark. The first shipments of such fuel are scheduled for the autumn of 1982 and will be handled by a Swedish-French company, Sofrasam, with a Swedish majority ownership (SKBF). The sea transportation system described in the preceding chapter will be used for the transports. Under the terms of these contracts, waste corresponding to the Swedish fuel can later (after 1990) be returned to Sweden.

Project work is proceeding on the UP3 processing plant under construction at La Hague in France for the fulfillment of Swedish and other foreign contracts. The first storage pool was put into use in early 1981, and shipments of spent fuel to the plant have begun. Through June of 1981, 125 tons of spent nuclear fuel have been received at the plant. As mentioned above, there have as yet not been any shipments from Sweden.

Cogema estimates that the rest of the plant, including a plant for the vitrification of waste, will be completed in 1987.

The official permit required under French law for UP3 has been obtained. Thus, the "décret d'utilisation publique" (May 1980) mentioned in the preceding report has been followed by "décret autorisant Cogéma à créer..." (May 1981) and "permit de construire" (June 1981).

344 tons of spent nuclear fuel from light water reactors have been reprocessed through June of 1981 in the existing UP2 reprocessing plant. During the second half of 1981, primarily magnox fuel will be processed, with a return to oxide fuel at the beginning of 1982. Only a small portion of the Swedish contracts provide for reprocessing in UP2.

The French commitment to reprocess and fulfill its foreign reprocessing contracts has been confirmed following a parliamentary debate on the 6th and 7th of October, 1981.

The French vitrification method (AVM), for which there is a small plant in Marcoule, has been chosen by BNFL for the reprocessing plant at Windscale, now Sellafield, in Great Britain.

BNFL has officially postponed its Thorp reprocessing plant for oxide fuel approximately three years, and it is now expected to be completed around 1990. This postponement is attributed primarily to a lack of resources in relation to the very large programme for Sellafield and a continuous heavy need for the re-processing of domestic magnox fuel. BNFL states that

the postponement should not be taken as an indication of a change in attitude towards the reprocessing of oxide fuel.

2.4 FINAL REPOSITORY FOR REACTOR WASTE (SFR)

Planning and engineering work has proceeded during the year on a common final repository for reactor waste from the Swedish reactor stations. SKBF expects to submit applications in early 1982 for permission to build such a final repository at Forsmark, where site investigations have been carried out during the year. It is proposed that the repository be built in a rock cavern. The waste products in question, mainly filter medium and ion exchange resin, have a "toxic" life of some hundred years.

The facility is planned for later expansion so that it can also accommodate waste from the dismantling of nuclear power plants. This expansion is not included in the permit applications mentioned above.

Provided that the necessary approvals are obtained, the construction work can commence in 1983 and the first phase can be completed by 1988.

2.5 RESEARCH AND DEVELOPMENT

2.5.1 Background

A separate department within SKBF is responsible for the research and development work that constitutes the basis for the design of the processing and terminal storage facilities for all of the different types of radioactive waste products that can be expected to arise in connection with the operation of nuclear power plants, including radioactive parts from the later dismantling of plants. The department is an outgrowth of the power industry's former KBS (Nuclear Fuel Safety) project, which was organized in 1976/77 in response to the "Stipulation Act".

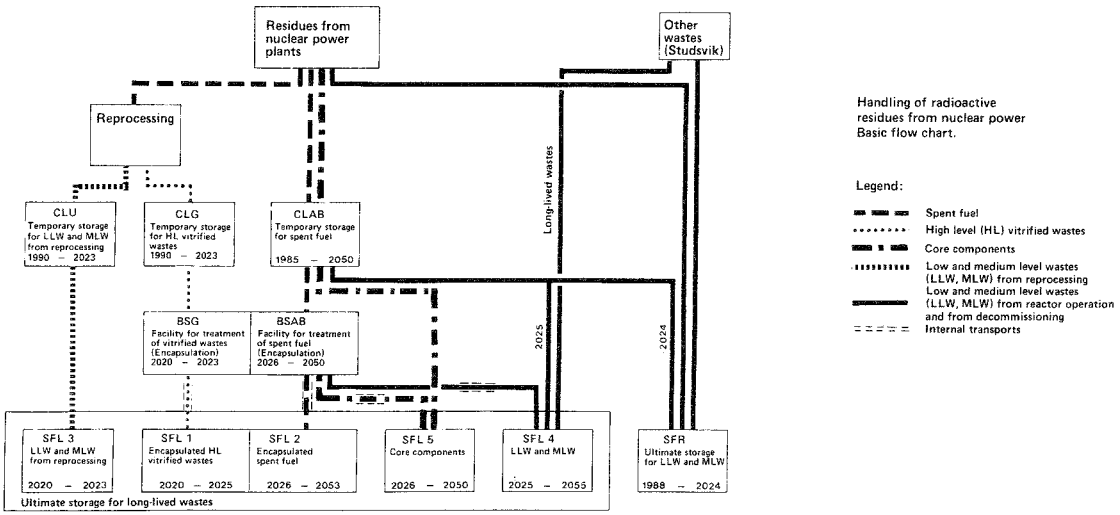

Figure 5. Waste products and plant types being studied.

Up to 1 July, 1981, the research and development work has been divided between the National Council for Radioactive Waste (Prav) and KBS. Prav has mainly been in charge of geological site investigations for a final repository for long-lived radioactive waste, chemical questions and the development of methods for the processing of reactor waste. SKBF's investigations have been concentrated to the fields of hydrology, waste characterization, encapsulation technology, design questions (including rock technology and packing materials) and safety analysis. Other special tasks performed by SKBF have included preliminary engineering of the final repository for reactor waste (SFR) described above and management of the international research project at Stripa.

When the Financing Act(SFS 1981:669) entered into force on 1 July, 1981, Prav ceased to exist and its R&D functions were taken over for the most part by SKBF.

Up to now, the final repository studies have been concentrated to fields of importance for the long-term safety of the final repository. Less work has been done on the design of handling equipment and the detailed design of the facilities.

2.5.2 General studies

By "general studies" is meant here such studies whose results are more or less applicable regardless of which site is chosen for a final repository. Such studies can be contrasted to site-specific studies, whose purpose is to shed light on the special conditions prevailing within a certain area which is being considered as a site for a final repository.

The general studies are based on certain principles for how the final repository for radioactive waste products is to be designed. The principles that have won increasing international acceptance include storage in rock formations, measures to reduce the temperature increase and the establishment of a series of barriers (multi-barrier system) against the escape and transfer of the products to man before their toxicity has declined sufficiently.

The following is a brief summary of the studies conducted during the report period within the different fields.

2.5.2.1 Hydrology

The work done within the field of hydrology during the past year has mainly been concerned with the development of methods and instruments:

- an improved calculation model for studies of groundwater movements in fractured rock has been developed
- improved instruments for measuring the hydrological characteristics of the bedrock in deep boreholes have been developed and tested
- instruments for recording the chemical properties of the groundwater in fractured rock have been developed.

A large quantity of hydrological and chemical data from a study area at Finnsjö Lake in northern Uppland County has been compiled and is currently under evaluation. The same area has also been used for testing new instruments.

2.5.2.2 Chemistry

A new calculation model for studies of the dispersal of different substances in a fractured rock mass has been developed. Collection of the necessary background data for the model is underway both in laboratories

and in the field.

Studies have been initiated concerning the chemistry of the so-called "nearfield" area, i.e. the chemical reactions that determine the conditions in the zone immediately surrounding the encapsulated waste deposited in a final repository.

Studies have been conducted concerning the diffusion of different substances in clay materials.

2.5.2.3 Materials

Studies have been conducted on the solubility and corrosion of simulated waste glass. Similar studies on actual radioactive waste glass are planned for 1982-84.

Trials are being conducted of different welding methods for welding the lid on a copper canister intended to be used to surround the unreprocessed spent fuel in final storage. Other closure methods for the canister are also being tested.

Continued studies of the mechanisms of dissolution of spent fuel in the final repository environment are planned.

Studies of the long-range durability of concrete in contact with clay and groundwater are being conducted.

SKBF is participating in the discussions between the reprocessing company of Cogema and its customers concerning the treatment and properties of different types of reprocessing waste. SKBF has also carried out its own tests on certain waste types.

Investigations concerning the treatment and properties of the operating waste from reactors have been carried out in order to obtain the background data required for designing a final repository for such waste.

2.5.2.4 Rock and soil mechanics

A multi-year research programme has been commenced with the aim of obtaining a clear understanding of what actually happens during Swedish earthquakes and how they can be related to geological structures.

Studies of the properties and long-range durability of different clay materials, intended to be used to surround the waste in the final repository, are

being conducted.

Trials of methods for borehole plugging and sealing of tunnels and shafts have been initiated.

2.5.2.5 Safety analysis

The calculation model has been improved. Studies are being conducted of processes in nature that are similar to those that are expected to take place if the long-lived radioactive elements in a final repository escape into the rock surrounding the repository.

2.5.3 Site-specific studies

The long-range general schedule for the site studies is presented in Figure 6.

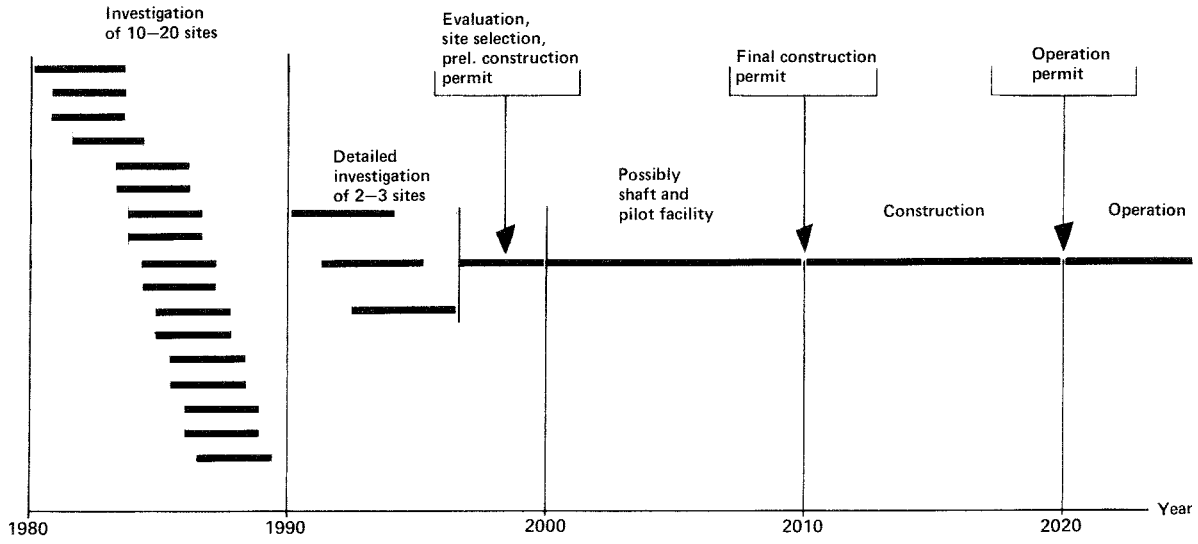

Figure 6. Final repository for high-level waste. General schedule.

Deep core boreholes are being drilled at four sites: Fjällveden in the municipality of Nyköping, Svartboberget in the municipality of Ovanåker, Gideå in the municipality of Örnsköldsvik and Kamlungskölen in the municipality of Kalix. Hydrological studies in the boreholes will be commenced at the end of the year.

2.6 NEW LEGISLATION CONCERNING NUCLEAR POWER RESIDUE PRODUCTS

The report of the commission of inquiry mentioned in the preceding annual report concerning the radioactive wastes from nuclear power: organization and financing matters, SOU 1980:14, has been subjected to official review and has given rise to some new legislation:

- SFS 1981:669: Law concerning the financing of future expenses for spent nuclear fuel etc (known as the Financing Act)
- SFS 1981:670: Law concerning amendment of the Municipal Tax Act
- SFS 1981:671: Ordinance concerning the financing of future expenses for spent nuclear fuel etc
- SFS 1981:672: Ordinance with instructions for the Board for the Management of Spent Nuclear Fuel.

The law enters into effect on 1 July 1981. Payments under the law shall not be due until after 1 January 1982, however.

It should be noted that the law does not cover all radioactive waste from nuclear power, being limited to waste from spent nuclear fuel and the dismantling of nuclear power stations. The handling and storage of low- and medium-level wastes from the operation of power reactors does not fall under the Financing Act and is to be dealt with in the same manner as heretofore. This latter waste is of minor consequence in terms of cost compared to the rest of the waste.

2.6.1 Organization

Responsibility for the handling and storage of spent nuclear fuel and its radioactive waste products, including the dismantling of nuclear power stations, rests with the owners of the stations, the licensed operators, as does responsibility for the necessary research and development work for this purpose. It has been deemed suitable that activities towards these ends be managed by a company owned jointly by the nuclear power utilities. The utilities have decided that SKBF is to be this company. The consequentially necessary changes in consortium agreements etc have been made and have passed Parliament.

The Financing Act provides that certain supervisory and economic functions be assigned to an agency determined by the Government. This agency is the National Board for Spent Nuclear Fuel, formed in accordance with SFS 1981:672.

SKBF shall submit a plan for its activities to the Board by June of every year.

2.6.2 Financing

The Financing Act stipulates that a reactor owner is responsible for ensuring that

- spent nuclear fuel and radioactive waste from such fuel is handled and terminally stored in a safe manner
- the reactor facility is decommissioned and dismantled in a safe manner
- the necessary research and development work is conducted and other necessary measures are adopted.

This also entails liability for associated costs. This cost liability has been extended to include the costs incurred by the state for supplementary research and development activities, trial of cases falling under the Financing Act and monitoring and surveillance of final repositories.

In order to ensure that funds are available, the reactor owner shall pay a quarterly charge to the state in proportion to the amount of energy delivered. This charge shall be determined annually by the Government upon the recommendation of the Board.

The Board shall administer the charges, which shall be deposited in an interest-bearing account with the National Bank of Sweden. Reactor owners can re-borrow, against security, up to 75% of monies paid in and not utilized during the loan period.

On the basis of the aforementioned annual plan for activities, the Board also consents to the use of the paid-in fees for their intended purpose.

3 INTERNATIONAL COOPERATION

3.1 THE STRIPA PROJECT

An international joint research project is under way in the abandoned mine at Stripa, where the function of a large-scale model of a final repository is being studied along with hydrological and geochemical conditions. The project is an independent OECD/NEA project in which the following countries are participating: Canada, Finland, France, Japan, Sweden, Switzerland and the United States. SKBF has been given responsibility for the management of the project, which will continue until 1984. An extension of the project with a second phase is being discussed.

3.2 OTHER COOPERATION

Besides cooperation in the Stripa Project, there is an extensive exchange of information bilaterally and multinationally with corresponding organizations in other countries. Thus, annual program reviews are conducted within the framework of formal cooperation agreements with the US Department of Energy, the Canadian AECL and the Swiss NAGRA. Informal meetings and exchanges of experiences have taken place with the French CEA and with the EEC's special group for radioactive waste management.

SKBF is participating in and supporting an international information system initiated by the OECD/NEA concerned with data of importance for the dispersal of various substances in rock fissures.

Discussions concerning cooperation with the NAGRA in Switzerland and the CRIEPI in Japan in a joint study of the corrosion and solubility of waste glass are in their final phase.

SKBF is also a member of the Atomic Industrial Forum in Washington and the Uranium Institute in London. In the latter organization in particular, personnel from SKBF have participated in studies of the con-

ditions of trade on the nuclear fuel market.

In the wake of the reprocessing contracts with Cogema, joint consultation groups have been organized between Cogema and its customers in which personnel from SKBF are participating.

Employees from SKBF are participating in the inter-governmental work being conducted in the nuclear energy field within the IAEA and the OECD.

4 THE SKBF ORGANIZATION

In keeping with the rules of responsibility and the guidelines for the handling and storage of spent nuclear nuclear fuel and radioactive waste products mentioned on page 25, SKBF is owned as of the 1 July of 1981 directly by the licensed operators of the reactor facilities in proportion to their licensed outputs:

-	Swedish State Power Board	36 %
-	Forsmarks Kraftgrupp AB	30 %
-	OKG Aktiebolag	22 %
-	Sydsvenska Värmekraft AB	12 %

A number of factors have led to progressively increasing demands on SKBF. The organization's own staff has been kept within limited bounds, however. This has been made possible by the fact that SKBF consistently attempts to tap the expertise and resources of its part-owners, consulting firms, universities, colleges, technical institutes, research organizations etc. in Sweden and abroad for research, computations, project engineering, construction of facilities, industrial operation etc. Financial accounting is handled by Kraftindustrins Redovisnings AB, of which SKBF is a part-owner.

Formally, the staff of the Nuclear Safety Board of the Swedish Utilities (RKS), 7 persons, are in the employ of SKBF. The Board has a separate budget and a separate programme.

The number of employees in SKBF - not including RKS - was 25 as of 31 October, 1981.

SKBF operating costs are paid by its part-owners and will, in the future, also be paid out of the fund that will be accumulated from charges paid by the part-owners, as described on page 26.

5 INFORMATION ACTIVITIES AND PUBLICATIONS

5.1 INTERNATIONAL WORKING GROUPS

SKBF har participated in the work of the following groups:

- IAEA expert group on international spent fuel management.
- Deutsche Gesellschaft für Wiederaufarbeitung von Kernbrennstoffen. Working group on high active waste storage and transportation.
- Advisory group meeting on the application of safety analyses for repositories for solid high-level and alpha-bearing wastes in deep, continental geologic formations; IAEA, Wien, 17-21 November 1980.
- Consultants meeting on a guide for design and construction of repositories for solid low- and intermediate-level wastes in rock cavities; IAEA, Wien, 11-15 May 1981.
- Advisory group meeting on the site investigations for repositories for low- and intermediate-level radioactive solid wastes in rock cavities; IAEA, Otaniemi, 22-26 June 1981.
- Siting of radioactive waste repositories in geological formations; OECD workshops, Paris, May 1981.
- Near field phenomena in geologic repositories for radioactive waste; OECD workshops, Seattle, August 1981.
- Uranium Institute, London, Committee on International Trade in Uranium:

Prior-consent and security of supply in international nuclear trade; October 1980.

Bilateral agreements and the evolution of the international safeguards system; September 1981.

5.2 INFORMATION ACTIVITIES IN SWEDEN

Once a year, SKBF submits a report to the Ministry of Industry on the situation in the nuclear fuel field and on the company's activities.

A conventional annual report is also published.

In accordance with the guidelines laid down by Parliament in 1981, SKBF's programme with respect to important parts of the back end of the nuclear fuel cycle is reviewed by the National Board for Spent Nuclear Fuel. A proposed programme and a report on these activities will be submitted to the Board on the first of July every year, starting in 1982.

Important parts of SKBF's activities are tied to specific geographic areas within the country. Such activities include the siting of facilities and field surveys in connection with prospecting activities and site investigations for a final repository. At a relatively early stage, representatives from SKBF get in touch with local officials - i.e. the elected authorities in the local municipality and country administration - and furnish them with essential information. It has been left to the discernment of these authorities to invite representatives of the local populace and mass media to be present.

5.2.1 Uranium prospecting in Sweden

Information meetings with municipal representatives:

80-10-10	Krokom	municipality	81-08-12	Boden	municipality
81-02-10	Ljusdal	"	81-08-17	Arjeplog	"
81-02-17	Härjedalen	"	81-08-18	Arvidsjaur	"
81-08-05	Berg	"	81-10-19	Krokom municipality, joint consultation group	
81-08-10	Sorsele	"			

81-03-04 County Administration in Jämtland County and municipalities - Östersund
I Lindholm (SKBF): Uranium prospecting in Jämtland; and
E Svenke (SKBF): Supplying the Swedish nuclear program.

81-10-28 Information meeting in Stugun with landowners from Näverån and Högremmen.

81-11-11 Department of Mining and Minerals, University of Luleå
I Lindholm (SKBF): Lilljuthatten - prospecting, technology, environment.

SKBF and the Swedish Federation for the Promotion of Studies have arranged five lectures during October - November 1980 in Rörvattnet and Jänsmässholmen as follows:

- Sven Löfveberg, SSI: Radiation and the environment
- Hans Edvall, SSI: Radon in the air and water
- Gunnar Walinder, FOA: The biological effects of radiation on man
- Ingemar Lindholm, SKBF: Uranium mining
- Elis Holm, Department of Radiophysics, Lund: Radioecology.

5.2.2 Final repository for reactor waste (SFR)

Information on the project was provided at a seminar in Kungälv, September 1981, arranged by the Nordic Contact Agency for Atomic Energy Matters (NKA) and SKBF. Information was also given to the press and attending representatives of the nuclear power municipalities.

Representatives of Östhammar municipality were given information on the subject on 80-11-07 and 81-06-04.

The municipal council and persons invited by the municipality received an oral presentation on 81-09-22. Copies were also distributed of the publication

"Final repository for reactor waste, SFR"
SKBF/KBS Information 10, August 1981.

5.2.3 Geological field studies for final repository for long-lived waste (SFL)

Information meetings were held for the municipalities as follows:

81-05-25 Örnsköldsvik, Själevad
81-06-16 Nyköping
81-06-30 Kalix
81-10-07 Nyköping, Lid (invitation by municipality)

The following material was distributed in connection with the presentations:

"The bedrock and the high-level waste"
SKBF/KBS Information 09, February 1980.

"Bedrock investigations; field studies of the geological conditions for the final storage of high-level waste", Prav, March 1981.

5.3 LECTURES AND PUBLICATIONS

Interim storage. Sweden goes for central temporary storage facility.
B Gustafsson (SKBF)
Nuclear Engineering International, October, 1980.

The Swedish approach to spent fuel management as regards intermediate storage and reprocessing
B Gustafsson (SKBF)
7th annual meeting and international conference on nuclear energy. Munich, October 1980.

The investigations for final disposal of high level waste in Sweden.
A Hult (SKBF)
Symposium at "Schweizerische Vereinigung für Atom-energie", October 1980.

Sea transport of spent fuel
B Gustafsson (SKBF) and T Milchert (Salén Technologies AB)
PATRAM 1980. 6th international symposium. Packaging and transportation of radioactive materials.
November 10-14 1980. Berlin (West).

Final disposal of unreprocessed spent fuel
F Karlsson (SKBF)
Symposium at Haus der Technik, Essen, Fed. Rep. of Germany, November 1980.

Treatment of cladding hulls by the HIPOW process
H Larker and R Tegman (ASEA Robertsfors)
MRS seminar 1980, Boston, 16-21 November 1980.

Some difficulties in interpreting in-situ tracer tests.
I Neretnieks (The Royal Institute of Technology, Stockholm)
MRS seminar 1980, Boston, 16-21 November 1980.

Highly compacted bentonite - a self-healing substance for nuclear waste isolation
R Pusch (University of Luleå), A Bergström (SKBF)
MRS seminar 1980, Boston, 16-21 November 1980.

An ESCA investigation of molybdenum containing silicate glasses.
R Nyholm (University of Uppsala), L Werme (SKBF)
MRS seminar 1980, 16-21 November 1980.

Modeling of rock mass deformation for radioactive waste repositories in hard rock.
O Stephansson, P Johansson (University of Luleå) and T Groth (The Royal Institute of Technology, Stockholm)
MRS seminar 1980, Boston, 16-21 November 1980.

Diffusion in the rock matrix: An important factor in radionuclide retardation?
I Neretnieks (The Royal Institute of Technology, Stockholm)
Journal of Geophysical Research 85, B8 (1980) 4379.

Exact solution of a model for diffusion in particles and longitudinal dispersion in packed beds.
A Rasmuson and I Neretnieks (The Royal Institute of Technology, Stockholm)
American Journal of Chemical Engineering 26 (1980)

Sweden's reactor program and supplies of uranium (in Swedish)
I Lindholm (SKBF)
Hearing of the environment protection drafting committee 81-03-02
Published in "Svensk uranbrytning?". Liber Förlag.

Bentonite shielding of rock-deposited radioactive wastes
R Pusch (University of Luleå)
National Bureau of Standards, workshop on research and development needs relating to backfill for underground nuclear waste management. Maryland.
13 April 1981.

Solidification of radioactive waste forms and waste containments by the HIPOW process.
H Larker (ASEA Robertsfors)
International seminar on chemistry and process engineering for high-level liquid waste solidification.
Jülich, 1-5 June 1981.

Canister materials proposed for final disposal of spent nuclear fuel: A review with respect to the corrosion resistance.
E Mattsson (Swedish Corrosion Institute)
International seminar on chemistry and process engineering for high-level liquid waste solidification.
Jülich, 1-5 June 1981.

Environmental effects of barrier systems presented by KBS
T Papp (SKBF)
CNS annual meeting, Ottawa, June 1981.

Conditions for increased independence in the nuclear fuel cycle
E Svenke (SKBF)
Nuclear energy symposium, Mexico City, June 15-17, 1981.

Prediction of radionuclide migration in the geosphere - Is the porous media flow adequate?
I Neretnieks (The Royal Institute of Technology, Stockholm)
IAEA/CEC/OECD-NEA international symposium on migration in the terrestrial environment of long-lived radionuclides from the nuclear fuel cycle. Knoxville, 27-31 July 1981.

Actinide species in ground water systems.
I Grenthe and D Ferri (The Royal Institute of Technology, Stockholm)
OECD-NEA workshop on near-field phenomena in geologic repositories for radioactive waste. Seattle.
31 August - 3 September 1981.

Minerals and precipitates in fractures and their effects on the retention of radionuclides in crystalline rocks.
B Allard, M Karlsson, K Andersson and B Torstenfelt (Chalmers University of Technology), S Å Larsson and E L Tullborg (Geological Survey of Sweden)
OECD-NEA workshop on near-field phenomena in geologic repositories for radioactive waste. Seattle.
31 August - 3 September 1981.

Swedish policy for the back end of the nuclear fuel cycle.
E Svenke (SKBF)
The Uranium Institute, 6th annual symposium, London, 2-4 September 1981.

The paths and rate of flow of water through highly compacted bentonite
R Pusch (University of Luleå)
AIPEA 7th international clay conference. Bologna.
6-12 September 1981.

Waste from reactor operation - experiences from the nuclear power plants in the Nordic countries (in Swedish)
H Forsström (SKBF)
Nordic symposium 1981: Reactor waste. Kungälv, 14-16 September 1981.

Final repository for reactor waste in Sweden (in Swedish)
G Lange (SKBF)
Nordic symposium 1981: Reactor waste. Kungälv, 14-16 September 1981.

Transports to a central facility for the final storage of reactor waste
B Gustafsson (SKBF)
Nordic symposium, Kungälv, 14-16 September 1981.

Information on central storage facility for spent fuel (in Swedish)
B Gustafsson (SKBF)
Stockholm, September 1981.

Information on sea transportation system for radioactive material (in Swedish)
B Gustafsson (SKBF)
Stockholm, September 1981.

Mineral/water interactions and their influence on the physical behaviour of highly compacted Na-bentonite.
R Pusch (University of Luleå)
Canadian Geotechnical Society, 34th conference, New Brunswick, 29-30 September 1981.

Management of radioactive waste at Swedish nuclear power plants.
H Forsström (SKBF), S Gustafsson (The State Power Board), B Persson (Oskarshamnsverkets Kraftgrupp AB), J Ransmark (Sydkraft AB), C Thegerström (Studsvik Energiteknik AB) and G Wickström (The State Power Board)
IAEA, Karlsruhe, 5-9 October 1981.

A central repository for final disposal of the Swedish low- and intermediate-level reactor wastes
G Lange (SKBF)
IAEA, Karlsruhe, 5-9 October 1981.