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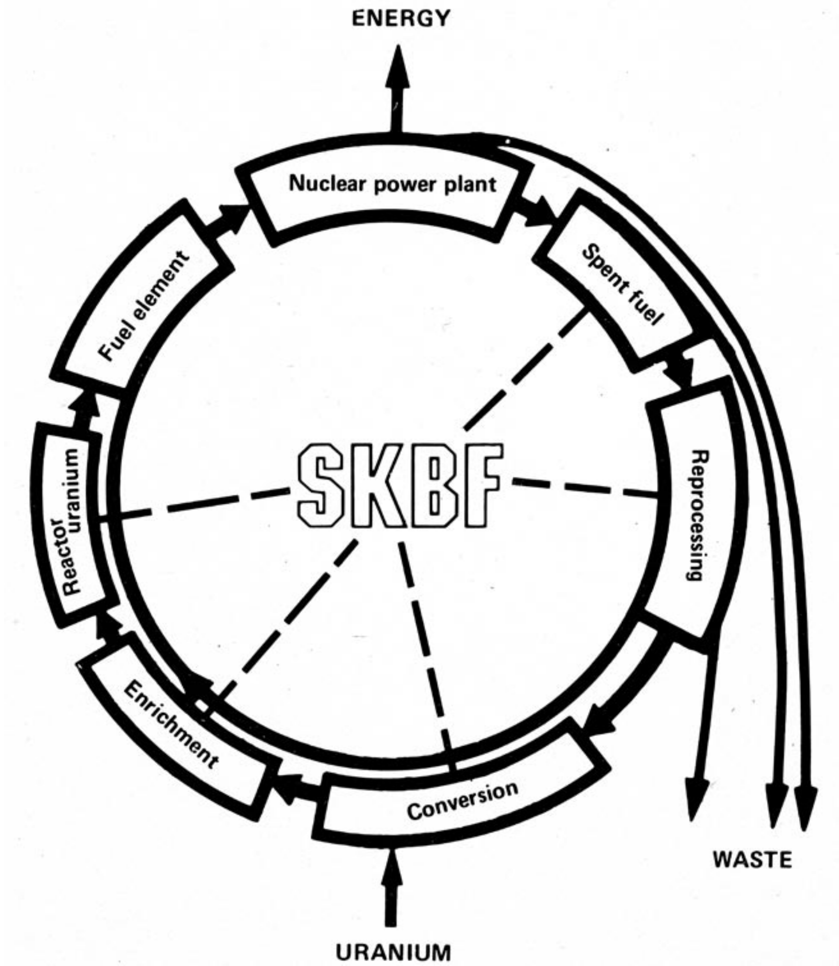
Report to the Swedish Ministry of Industry, November 1979



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 KÄRNBRÄNSLE-FÖRSÖRJNING AB (SWEDISH NUCLEAR FUEL SUPPLY COMPANY) DURING 1978 AND 1979 UP TO THE MONTH OF SEPTEMBER

SUMMARY

In 1978, nuclear reactors produced more than 25% of Sweden's electric power. Nuclear energy now plays a vital role in the supply of electric power in many industrial countries, both in the East and in the West. Nuclear power is a hotly debated subject in the West, and its future is difficult to predict. If current nuclear construction programmes in these countries are carried to completion, capacity in the year 1985 may be twice what it is now.

The western world's natural uranium market is in balance. Extensive hearings and administrative procedures have been held in Australia and Canada concerning the consequences of the exploitation of new uranium deposits. The results are that considerable new deposits can now be exploited. Estimated reserves of uranium have increased in the past few years.

During this period, only small quantities of natural uranium have been purchased by Sweden.

SKBF has financed LKAB's studies of the uranium deposit in Pleutajokk. Studies of technology, environmental impact and economy for a relatively small-scale exploitation have been begun. The company is also financing uranium prospecting by the Geological Survey of Sweden in southern Norrland. A couple of promising deposits have been found. If continued prospecting should result in an expanded ore base and studies of technology, environmental impact and economy have a positive outcome, small-scale uranium mining could be started at several locations in Norrland.

Ranstad Skiffer AB is continuing its investigations and studies of the feasibility of the industrial exploitation of the uranium-bearing aluminous shale in the Billingen area. A three-year programme was initiated on 7 January 1978 with government financing in the form of loans and grants.

The annual consumption of natural uranium by the operation of 12 nuclear reactors in Sweden will be about 1400 metric tons. In SKBF's judgement, reliable long-term contracts can be signed for this quantity.

Facilities for the isotope enrichment of uranium are being built abroad. Their capacity can be expected to cover demand through the 1980s.

Enrichment services have been secured through foreign contracts up to the mid-1990s for all commissioned and planned Swedish nuclear power reactors.

Reserve stocks of enriched uranium for the Swedish nuclear power system have begun to be built up during 1979.

SKBF has signed a contract with the French company Cogema for the reprocessing of 620 metric tons (counted as enriched uranium) of spent nuclear fuel discharged during the 1980s. According to a decision of the Swedish Government, the contract complies with the requirements of the Stipulations Act.

With reference to this contract, continued operating permission has been granted for Barsebäck 2.

The Nuclear Fuel Safety Project (Projekt Kärnbränslesäkerhet, KBS) issued a report in December of 1977 concerning a system for the final storage of vitrified high-level radioactive waste from reprocessing. On the basis of this report and the reprocessing contract, the Swedish State Power Board and the Forsmark Company have submitted applications in accordance with the terms of the Stipulations Act for permission to charge the Ringhals 3 and Forsmark 1 reactors with fuel. The work of the KBS project has been examined by some 40-odd domestic and foreign bodies. After supplementary test drillings, approval has now been granted in accordance with the Stipulations Act. According to a special act, adopted as a consequence of the national referendum on nuclear power in March 1980, the units may not be charged with fuel before 1 July 1980, or an earlier date determined by the Government.

In October of 1978, another KBS report was submitted to the Ministry of Industry. This report dealt with the handling and final storage of unreprocessed spent nuclear fuel. This material is now being examined by a number of domestic and foreign bodies.

As from January of 1979, the programme has been expanded to include the development of systems for the handling of low- and medium-level radioactive waste obtained from nuclear reactor operation and from reprocessing. The work is aimed at the commissioning of a final repository at the end of the 1980s.

During the period, in situ studies of the effects of heat on the rock mass enclosing a simulated final repository etc. at a depth of 350 m in a granite massif in the Stripa mine have been carried out in cooperation with the US Department of Energy (DOE).

On 23 August 1978, SKBF was granted permission in accordance with the Atomic Energy Act to build a central storage facility for intermediate storing of spent nuclear fuel, which facility is currently in the design stages. The construction work may not begin until 1 April 1980. Design work is also underway on a special ship for the transport of spent fuel and other types of radioactive products.

The total cost of nuclear energy is currently estimated at SKr 0.031 - 0.040 per kWh. The costs of handling and final storage will not fall due until long after the time of the corresponding electric power production. Consequently, the producers are currently making allocations for this purpose. In 1978, the National Tax Board allowed allocations for fiscal purposes of max. SKr 0.008 per kWh. As a result, this future cost is being paid by current production. This is taken into account in rate-setting.

Thanks to the build-up of reserve stocks of enriched uranium on the supply side, and the construction of a central storage facility for spent fuel and a transport system on the disposal side, the Swedish power industry has gained, via nuclear energy, a self-sufficiency of several years in the event of blockades or other difficulties in obtaining products or services from abroad. Particularly the realization of the project involving the "back end" of the nuclear fuel cycle (handling and final storage of spent nuclear fuel) will provide greater freedom of action and a high degree of independence from foreign industrial and political developments.

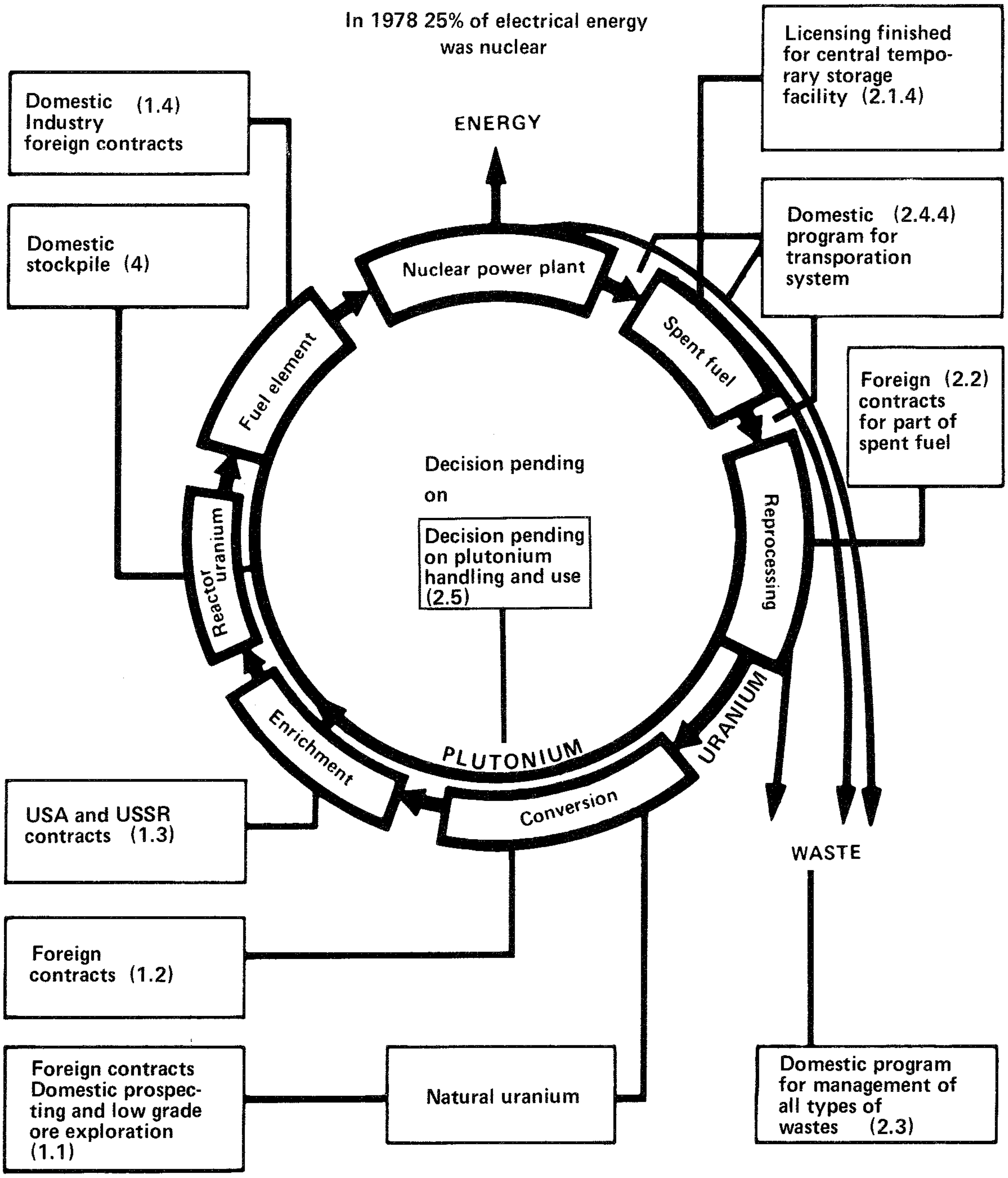
The conditions surrounding the nuclear fuel cycle are matters of international urgency. This applies to practical measures taken to prevent unacceptable radioactivity levels resulting from releases etc. from the various activities, including the final storage of waste. It also applies to measures taken to prevent products and facilities being used to produce nuclear weapons or warheads, despite the fact that raw materials for nuclear weapons can be produced more efficiently in separate plants. This latter possibility imposes special demands on international trade with nuclear fuel. SKBF has been involved in numerous international efforts in this connection. SKBF emphasizes the urgency of continued Swedish efforts in this area.

SKBF's activities span a number of disciplines. In order to maintain flexibility and competence in its efforts, the company has only a small staff of its own and instead draws heavily upon the resources of its owners, outside organizations, researchers etc.

SKBF is owned

- to 50% by Statens Vattenfallsverk (Swedish State Power Board)
- to 25% by Sydkraft AB, and
- to 25% by Oskarshamnsverkets Kraftgrupp AB (OKG).

The Chairman of the Board of Directors is appointed by the Swedish Government.



The figures in brackets relate to those in the table of contents

Figure 1. The nuclear fuel cycle - Swedish activities

1 SUPPLY OF NUCLEAR FUEL

1.1 PROCUREMENT OF NATURAL URANIUM

1.1.1 The International Situation

The supply of and demand for uranium has been investigated by International Nuclear Fuel Cycle Evaluation (INFCE), Working Group 1. The Eastern bloc countries have not furnished information, so the following applies only to the rest of the world.

Reasonably assured and estimated additional uranium resources in this part of the world amounted to a total of 5.0 million metric tons of uranium in 1979. This uranium can be recovered at a cost of less than SKr 550 per kg uranium. Beyond this amount, an international geological inquiry estimates that there are 6.6 - 14.8 million tons of uranium in so-called "speculative resources", i.e. deposits that have not yet been found. In addition, certain quantities of uranium can be produced from phosphate rock in connection with phosphoric acid manufacture.

If an international agreement could be reached on nuclear disarmament, considerable quantities of civilian nuclear fuel could be obtained from these weapons.

Uranium prospecting has been pursued on a large scale over the past years. Total investments in such prospecting have been an estimated SKr 2 000 million per year in recent years. The increase in reasonably assured and estimated additional uranium resources between 1977 and 1979 is about 700 000 metric tons of uranium, which is about 10 times more than the uranium production during the same period of time. This means that known resources of uranium have increased over the past few years.

A considerable portion of these uranium prospecting activities are being financed by the power companies in the industrial countries or via the national budgets of these countries. Such prospecting is being pursued in, for example, Canada and Australia and in a number of developing countries. When uranium prospecting is financed in this manner, it is normally stipulated that the option on any future uranium production will be reserved for the power company or country that financed the prospecting. Through this procedure, a certain portion of future uranium production will be "earmarked" and not available to the market.

Important producer countries during the 1980s will probably be Australia, Canada, France, Gabon, Namibia, Niger, South Africa and the United States.

World production in 1978 was about 33 500 metric tons of uranium. It is believed that production from known ores and as by-product to phosphoric acid could rise to more than 100 000 tons of uranium per year during the 1990s.

A number of hearings and inquiries have been held in recent years in different countries in order to determine whether uranium production is acceptable from various viewpoints, including environmental. The governments of Australia and the province of Saskatchewan in Canada have granted their consent for the exploitation of considerable new deposits. In the province of Ontario in Canada, already operating uranium mines have received permission to increase their production.

Even if the supply of uranium now appears to be good, political and economical factors can limit the <u>availability</u> of uranium. Both Canada and Australia have imposed export controls on uranium with restrictions in the form of price controls and special bilateral terms as well as, in the case of Canada, special consideration for domestic supply. Niger and Gabon have state-controlled prices. In addition to this, other demands on land use may put restrictions on uranium production in some countries.

The consumption of uranium is dependent primarily on the future use of nuclear power and what types of reactors that are used. In its lower forecast based on information furnished by participating nations, INFCE has estimated that the output of operational nuclear power plants will increase from 122 GW in 1979 to 257 GW in 1985 and to 830 GW in 2000. For the period thereafter, an increase to 1800 GW by 2025 is expected. The increase by 1985 is based on reactor units under construction.

For the period up to 2000, we know with relative certainty what types of reactors that will be used and thus the consumption of uranium. But there is a great deal of uncertainty concerning the period after 2000, when uranium consumption will depend on whether uranium is used in light water reactors without recycling, in light water reactors with recycling of uranium and plutonium or whether breeder reactors will be used.

INFCE has estimated uranium consumption for several different scenarios as shown by the following table (INFCE's lower forecast; the figures refer to thousands of metric tons of uranium):

Case	Year	1980	1985	1990	2000	2010	2025
	GW	144	257	432	830	1300	1800
Light water without recycling	Uranium/year	29	44	66	136	194	260
	Cumulative	100	289	570	1590	3290	6780
Lightwater with recycling	Uranium/year	29	42	56	94	138	184
	Cumulative	98	279	521	1300	2500	4970
Breeder reactor from year 2000	Uranium/year	28	42	56	100	94	69
	Cumulative	97	275	516	1340	2340	3660

The table shows that even in the event of a considerable expansion of nuclear power facilities, currently reasonably assured and estimated additional uranium recources will last until the year 2025 if uranium and plutonium are recycled.

Continued prospecting and uranium extraction from phosphoric acid is expected to provide additional quantities of uranium and therefore permit continued nuclear power production even if breeder reactors are not introduced on a large scale.

At the present time, there is a balance between uranium production and consumption, and no drastic price changes are expected in the next few years. However, difficult-to-predict political and economic factors could affect both the availability of uranium and the pace of expansion of nuclear power, and thereby consumption.

1.1.2 Supplying Sweden with Natural Uranium

The three power companies which own SKBF as well as SKBF itself have uranium supply contracts with companies in France, the United States and Canada. The most important companies are Uranex and Cogema (uranium from Niger and Gabon), Westinghouse and Agnew Lake Mines Ltd.

In September of 1975, Westinghouse announced that it was unable to deliver more than 20% of what had been contracted. A settlement has now been reached between Westinghouse and the Swedish power companies involving both some uranium shipments and economic compensation to the power companies.

Since the autumn of 1976, the "Stipulations" Act and the "Reprieve" Act have given rise to uncertainty concerning the extent to which nuclear power will be permitted to be utilized in the future. As a result, only small quantities of uranium have been purchased. Thus, in July of 1978, SKBF signed a contract with the Canadian company Cenex Ltd. for the purchase of uranium concentrates containing 115 tons of uranium to be delivered in November of 1979. During 1979, Cenex opened a new mine in the province of Saskatchewan in Canada.

Future Swedish uranium needs will depend on the outcome of the National Referendum on nuclear power to be held in the spring of 1980.

If an immediate or relatively rapid phase-out of nuclear power is decided on, it is probable that no further supply contracts will be necessary. If it is decided that 12 reactors are to be operated, a total of 9 000 additional metric tons of natural uranium will be required for the period through 1990. Some of this fuel will be required from 1982. Annual consumption with 12 units in operation will be about 1 400 tons of uranium.

In SKBF's judgement, long-term supply contracts can be signed for these quantities of uranium.

Natural conditions exist in Sweden for uranium deposits in the form of mineralizations in crystalline rocks and in certain shales that exist in large quantity but have a relatively low uranium content.

The Geological Survey of Sweden has conducted uranium prospecting in crystalline rock with Government financing since the late 1960s. The best deposit found yet, Pleutajokk in the municipality of Arjeplog, was acquired at the end of 1975 by LKAB, who continued test drillings there until the end of 1976.

Further uranium prospecting was discussed in the Swedish Parliament in the spring of 1978. The Parliament decided that the Swedish State Power Board could once again invest in uranium prospecting through its operating budget. This opened up the possibility of a resumption of the work at Pleutajokk.

In accordance with an agreement with LKAB, SKBF will finance continued work at Pleutajokk from July of 1978. A joint consultation group in the Arjeplog municipality is following the project. Reasonably assured uranium resources have increased to 3 000 tons of uranium. During 1979, the test drillings were supplemented with studies of the background environment and recovery technique. Depending on the outcome of continued investigations and evaluations a uranium mining operation with an output of 200-300 tons per year may be undertaken.

In 1976, SKBF concluded a 5-year agreement with SGU (the Geological Survey of Sweden) on uranium prospecting within an area corresponding to approximately 50 map-sheets in southern Norrland.

Annuals costs amount to SKr 10 million at 1976 cost levels. Regional studies are being carried out within the project in the form of aerial measurements and geochemical studies as well as studies of geology, geophysics and radon levels, including test drillings. SKBF has a cooperation agreement with the Board for Government Mining Properties providing for an exchange of measurement data within the area. In this manner, the results of the uranium prospecting work will also be of value for prospecting for other minerals as well as for general planning purposes. The aerial measurements have covered approximately 40 map-sheets thus far.

At the present time, SKBF has seven exploration licences and has applied for an additional five.

Test drillings at Lilljuthatten in the municipality of Krokom have revealed a uranium mineralization in granite containing at least 1 200 tons of uranium. Continued drillings are currently underway. During 1979, an ecological inventory and studies of the present aquatic environment were initiated in cooperation with the county administration. Krokom municipality has appointed a joint consultation group to follow the investigations.

At Sågtjärn in the municipality of Ånge, test drillings have revealed a uranium mineralization containing at least 600 tons of uranium. Continued drilling is under way.

Other exploration licences and applications for such licences apply to areas within the municipalities of Åre, Ragunda, Ånge, Östersund, Ljusdal, and Ovanåker.

It is still too early to say whether any of the uranium mineralizations discovered within this project are quantitatively sufficient for exploitation. If continued geological studies and test drillings indicate that they are, studies will be made of mining and milling technique, environmental impact and economy. Studies in all of these areas are still at an early stage.

The state-financed uranium prospecting being carried out by SGU embraces two projects, namely:

- regional studies of the natural radioactivity level via aerial measurements;
- evaluation of uranium prospects, primarily in the following municipalities: Boden, Arjeplog, Arvidsjaur, Sorsele, and Storuman.

The total budget for 1979/80 is SKr 13.3 million.

The regional studies of natural radioactivity levels can reveal new uranium prospects, but are also of value for planning housing developments, so that areas with high radiation levels can be avoided.

If the local evaluations in Norrbotten and Västerbotten counties should lead to the discovery of new uranium deposits, the possibilities of coordination with Pleutajokk for ore processing in a joint recovery plant will be explored.

Ranstad in Västergötland County is surrounded by a large area containing aluminous shale, the most uranium-rich portion of which contains about 300 g of uranium per ton of shale. In 1977, LKAB applied according to the Building Act §136 a for permission for the mining and milling of 1 million tons of shale per year, which would yield approximately 200 tons of uranium per year plus certain quantities of molybdenum, vanadium and potassium fertilizer compounds. SKBF supported LKAB's application and declared themselves willing to purchase the uranium production for 10 years at a fixed price with an index clause. However, the municipalities of Skövde and Falköping vetoed the project.

The Government decided upon a continued research and development programme in Ranstad. A three-year programme was initiated on 1 July 1978 with government financing of SKr 128 million in the form of loans and grants. The programme is being conducted through Ranstad Skiffer AB (RSA), whose part-owners are LKAB, Boliden AB and Studsvik Energiteknik AB. RSA is now pursuing continued development work including project studies of the feasibility of recovering products from aluminous shale. Continued efforts are being made for protection of the external environment in the event of an industrial exploitation. Among other things the replanting of reclaimed strip-mined areas has been demonstrated.

Shale deposits exist in other locations as well, such as Jämtland and Närke counties. The uranium contents of these shales are lower than in the Ranstad area. Mining potential and recovery technique are not yet defined.

Uranium is and will continue to become increasingly strategically important as an energy raw material. The legislation of stipulations for its use, export controls and export bans, "earmarking" of deposits for certain companies etc. are signs of the importance accorded to uranium internationally.

As explained above, Sweden fulfils the requisites for meeting at least some of its needs from domestic resources. SKBF advocates the following continued efforts:

- completion of studies concerning the feasibility of mining and milling in Pleutajokk
- continued prospecting in Norrbotten/Västerbotten and in southern Norrland; if uranium deposits are found, studies should be made with respect to technique, environmental impact and economy in order to determine the prospects for benefication on a limited scale;
- comprehensive project study concerning the recovery of uranium and certain other products from the mining of 1-2 million tons of shale annually in Ranstad.

1.2 CONVERSION (transfer of uranium concentrate to uranium hexafluoride)

There are currently five industrial corporations in the West that carry out conversion, namely Allied Chemicals Corp. and Kerr McGee Corp. in the United States, British Nuclear Fuels Ltd. in Great Britain, Comurhex in France and Eldorado Nuclear Ltd. in Canada. In addition, conversion services can be purchased from the Soviet Union in connection with enrichment contracts.

Total conversion capacity in the West in 1979 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. According to current assessments, conversion capacity will catch up with demand during the 1980s, and there will be no obstacles to further capacity expansion if required.

Conversion represents only a small portion of the total nuclear fuel cost. It is roughly one-tenth of the enrichment cost.

During 1978, the company signed a contract with Comurhex for the conversion of uranium concentrate, which was previously produced in Ranstad. During 1979, uranium concentrate containing about 91 tons of uranium was converted by Comurhex, and a similar quantity is planned for 1981. The converted uranium is isotope-enriched in the Soviet Union and will be added to a reserve stockpile.

During 1979, the company extended its conversion contract with Eldorado to include the approximately 115 tons of uranium purchased from Cenex.

1.3 ENRICHMENT

1.3.1 The United States

As has been described in greater detail in a preceding report to the Ministry of Industry, the power companies have "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 long term fixed commitments during a 10-year-period - that have been concluded for Ringhals units 3 and 4, Forsmark units 1, 2 and 3, and Oskarshamn unit 3.

The price of enrichment under the terms of the requirement contracts was $69.80 per separative work unit (SWU) up to 29 March 1978, when the price was raised to $78.20. On 1 July 1978, the price was raised to $83.15. This price remained unchanged until 24 April 1979, when it was raised to $89.19. On 1 July 1979, the price was raised to $95.05.

The price of enrichment under the terms of long term fixed commitment (LTFC) contracts remained at $74.85 per SWU throughout the year. Not until 30 December 1978 was this price raised to $88.65.

During the year, the DOE issued new contract terms which provide considerably more flexibility than the present LTFC contracts. DOE has offered holders of the LTFC contracts the option of changing over to these new "adjustable fixed commitment (AFC) contracts", and thereby to make adjustments in delivery schedules for a reduced fee. Requests for such an exchange of contract type and postponements of deliveries in order to adjust to the current situation were submitted to DOE, and new contracts were signed September of 1979.

Enrichment services had already previously been contracted for the Swedish nuclear power programme approved by the Government authorities at that time (13 reactors). In the current situation with no more than 12 reactors, however, Sweden has a surplus of contracted enrichment services. Consequently, the enrichment contract with DOE for Oskarshamn unit 3 has been cancelled in August 1979, since this has been deemed to be the most economically advantageous alternative. The cost of the cancellation will not go beyond forfeiture of the advance payment of about SKr 14 million.

1.3.2 The Soviet Union

The 1970 Swedish-Soviet nuclear cooperation agreement permits isotope enrichment for Swedish needs in the Soviet Union. In 1974, the company signed a contract with Techsnabexport for 300 tons of separative work with delivery in 1979. In 1975, the company 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 plut an additional 300 tons of separative work for delivery in 1982-83.

Shipments of enriched uranium are currently being made from Techsnabexport to Sweden. This enriched uranium will be set aside as a reserve stock for the Swedish nuclear power plants.

1.3.3 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 of 10 800 tons of separative work 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. Plans exist for expansion to a capacity of about

2000 tons of separative work annually by the mid-1980s.

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

In 1978, France presented a new method for isotope enrichment based on chemical exchange. The method is special in that it is considered to be virtually impossible to produce highly enriched uranium according to this principle (or at least this would take several decades). This means that plants utilizing this method would not increase the risk for spread of nuclear weapons. The French now intend to build a demonstration plant in cooperation with other countries.

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

No research or development work on the isotope enrichment of uranium is currently being conducted in Sweden.

1.4 CONVERSION AND FABRICATION OF FUEL ELEMENTS

The first phase in fuel manufacture is to convert isotope-enriched uranium hexafluoride to uranium dioxide. This is done by vapourizing the uranium hexafluoride and then converting it chemically in several stages to uranium dioxide. The two most common processes are "the wet way" and "the dry way".

At Asea-Atom's fuel factory in Västerås, there is a conversion plant utilizing the "wet way" whose capacity is sufficient for the needs of the factory.

The enriched uranium dioxide is pressed into pellets, which are sintered at high temperature. These pellets are then inserted in tubes of zircaloy (a zirconium alloy). End plugs of zircaloy are welded to both ends. A number of filled tubes - usually 63 in boiling water reactors - are then assembled into a fuel bundle with a bottom plate, a top plate and spacer grids.

Asea-Atom's fuel factory in Västerås has sufficient capacity to fabricate fuel to more than cover Swedish needs. Zircaloy tubes are made in Sweden by Sandvik AB. The raw material for these tubes - sponge zirconium - is imported.

2 DISPOSAL OF SPENT FUEL AND HANDLING OF RADIOACTIVE WASTES

2.1 CENTRAL TEMPORARY STORAGE FACILITY FOR SPENT FUEL (CLAB)

As was mentioned in the preceding report to the Ministry of Industry, a preliminary study was concluded on 1 July 1977 in which the following were presented:

- design concept of CLAB
- transportation system concept
- proposal for application for site permit according to the Building Act §136 a and background information required for application according to the Nuclear Energy Act.

During the period from 1 July 1977 up to the present date, preliminary project work has been conducted with the following activities:

- applications for various permits required for erection of CLAB
- preliminary safety report
- studies for site selection
- detailed data and documentation for design of facility
- complete background for decision.

These activities will continue into the autumn of 1979 and the spring of 1980.

2.1.1 Licensing

The following licensing permits are required or have been obtained for the erection of CLAB:

- site permit according to Building Act §136 a for construction of CLAB in Simpevarp was granted by the Government on 14 December 1978;

- on 19 June 1979, the Swedish Nuclear Power Inspectorate recommended that permit according to the Nuclear Energy Act §1 be granted; the Government's permit was obtained on 23 August 1979, with the provision that construction was not to start prior to 1 May 1980;

- permit according to the Environmental Protection Act was granted by the National Franchise Board for Environmental Protection on 10 July 1979;

- the Kalmar County Administration's exception (according to the Building Act §54:3) from the obligation to apply for a building permit was obtained in August 1979;

- it is deemed possible to obtain commencement permit from the County Employment Board after a detailed timetable for commencement of construction and a manpower forecast have been submitted, i.e. it is deemed to be possible to obtain a permit within a few weeks of a decision to commence work.

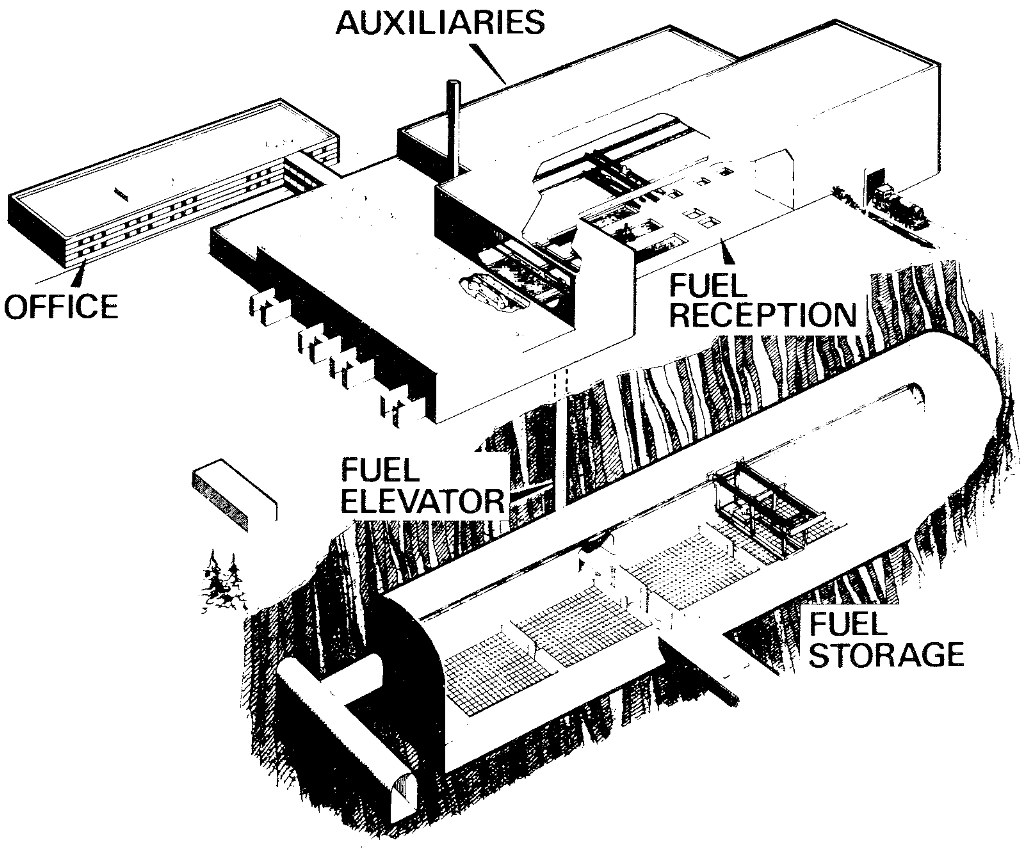


Figure 2. Central Temporary Storage Facility for Spent Fuel (CLAB)

2.1.2 Timetable and investment

Phase I of the project (1 500 tons of storage capacity) is scheduled to take 53 calendar months from the time of the start of the site work (no earlier than 1 May 1980) up to the time when spent nuclear fuel can first be received by the facility).

The investment cost at the price level as of January 1979 for Phase I has been tentatively estimated at about SKr 910 million (before index adjustment and interest). The investment for 3 000 tons of storage capacity has been estimated at about SKr 1 000 million.

The costs for the transportation system are not included in the estimate.

A storage capacity of 1 500 tons corresponds to 14 years of discharge from the six nuclear reactor units now in operation. 3 000 tons of capacity will permit storage for 12 years of the discharge from 12 reactor units. The reprocessing contracts mentioned below and those already signed by the power industry will extend these times.

2.2 REPROCESSING

In March of 1978, the Nuclear Fuel Supply Company, acting on behalf of Sydkraft and the Swedish State Power Board, signed a reprocessing contract with Cogema for a nominal quantity of 620 metric tons of spent nuclear fuel, of which 160 tons were for Sydkraft and 460 tons for the Swedish State Power Board. This quantity will be shipped to Cogema's plants at La Hague in Normandy during the 1980s.

On the basis of this contract, continued operating permission has been granted for the Barsebäck 2 unit.

As is reported under 2.3.1.1, the contract is part of the documentation submitted with the application for the permission granted on 20 June 1979 to charge the Ringhals 3 and Forsmark 1 units with nuclear fuel.

The contract provides for reprocessing in a new plant to be built in La Hague. The construction work has commenced.

Under the terms of the contract, some 30 or so power companies in Belgium, Holland, Japan, Switzerland, Sweden, and West Germany have jointly agreed with Cogema, which draws upon the collective French experience in this field and is also responsible for France's own reprocessing programme, that Cogema shall build and operate a reprocessing plant. The plant will be financed jointly by its customers through payments remitted as the work progresses.

A Joint Committee with representatives of all customers will monitor plant operations continuously. Two persons from SKBF are on the committee. The contract also provides that the customers may engage an auditing firm.

Uranium and plutonium obtained from reprocessing are the property of the customer and are naturally subject to all applicable national and international regulations. Cogema has agreed to store the plutonium.

Cogema already has an operative reprocessing plant at La Hague. It is primarily intended for the reprocessing of spent nuclear fuel from French gas-cooled reactors, but now that France is changing over to light water reactors, this plant will also eventually work entirely with nuclear fuel from light water reactors. Reprocessing of light water reactor fuel has been executed in campaigns when gas-cooled fuel did not have to be reprocessed. The results are good, and more than 100 tons of spent nuclear fuel from light water reactors have been reprocessed in this plant.

The contract provides (all customers are subject to the same terms) that both parties have the right to demand that the radioactive waste from reprocessing be sent back to Sweden, but naturally only in such form that Swedish, French and international authorities can approve it for transport and storage.

Since the parties to the contract cannot anticipate future policy decisions by agencies or governments, reprocessing will not be commenced unless specifications have been approved. However, Cogema has already confirmed that it can convert the high-level waste to the form (glass) specified in the Swedish KBS report. Cogema has more than 20 years of experience in this area and an automatic industrial-scale plant commenced operation during the year. Operating results have been good here as well.

Through June of 1979, 180 waste cylinders of chromium-nickel steel have been filled with a total of 40 cubicmetres of high-level waste glass. Each cylinder is 1 metre high and has a diameter of 0.5 metre. The waste cylinders are being stored in air-cooled temporary storage facilities in Marcoule.

The vitrification process has achieved the expected performance in operation. Future vitrification plants in La Hague will have the same design.

OKG has long had a reprocessing contract for 140 tons with British Nuclear Fuels Ltd. (BNFL). During 1979, three shipments of a total of 33 tons of spent fuel have gone to Windscale in England, after receiving approval from the United States.

Following extensive hearings with participants from BNFL as well as a number of other groups opposed to nuclear power, the British Government has decided that BNFL may build a new reprocessing plant at Windscale. The planned new plant is called THORP 1 and is intended for English and Scottish spent fuel from AGRs (Advanced Gas-cooled Reactors) as well as for spent light water reactor fuel from other countries. A smaller reprocessing plant designed for the treatment of breeder reactor fuel was recently dedicated in Dounreay in Scotland.

2.3 WASTE HANDLING AND FINAL STORAGE

2.3.1 Nuclear Fuel Safety Project (KBS)

During the first half of 1978, the efforts of the project were concentrated on completing a report on the handling and final storage of spent nuclear fuel. The Swedish "Stipulations Act" provides for this option as an alternative to accounting for a safe final storage of vitrified high-level waste from reprocessing.

The intention was that plans would then be made for continued long-range measures within this area, with a timetable coordinated with the actual implementation of a terminal storage of radioactive waste.

As a result of the Government's decision to require a supplementary geological investigation before the provisions of the Stipulations Act could be considered to have been fulfilled, however, the work of the project during the winter of 1978/79 was completely taken up by the execution of this supplementary study.

It was not until the summer that priority could be given to planning for future activities. However, this planning work has had to contend with a great deal of uncertainty owing to the current inquiry into organizational and financing matters for radioactive nuclear wastes and owing to the impending National Referendum on nuclear power. At present, activity within the project is being maintained at a level corresponding to that during 1979.

Besides activities stemming from the Stipulations Act, the framework of the project was broadened during 1979 to include studies of a system for the handling of low- and medium-active waste.

Furthermore, joint international research has been continued at an experimental station situated in granite at a depth of 350 metres in the Stripa Mine. Discussions are being held concerning a continuation and broadening of this joint work.

The following is an account of the official treatment of the two KBS reports as well as descriptions of efforts being made within the area of low- and medium-active waste and at Stripa.

2.3.1.1 Vitrified Waste from the Reprocessing of Spent Nuclear Fuel

On 6 December 1977, the Swedish State Power Board applied to the Government for permission in accordance with the Stipulations Act to charge the third unit at the Ringhals power station with nuclear fuel. In support of its case, the Board referred to reprocessing contracts and the KBS report entitled "Handling of Spent Nuclear Fuel and Final Storage of Vitrified High-Level Reprocessing Waste". A similar application was submitted on 6 April 1978 by Forsmarks Kraftgrupp AB for the first unit at the Forsmark power station.

The Government decided to subject the material to thorough scrutiny and sent it to 20 Swedish reference bodies for consideration and comment. An equal number of foreign persons/organizations were also asked to examine the material. At the same time, the KBS material was also being examined by the Energy Commission. All of these examinations were concluded before July of 1978. The rest of the summer was devoted to a number of summaries and evaluations of the received material.

After its evaluation of the background material submitted in support of the applications, the Government decided on 5 October 1978 to postpone approval of the applications with the following explanation of its decision:

- "The Government considers the reprocessing agreement referred to in the application to comply with the requirements of the Nuclear Power Stipulations Act. However, in assessing whether the prerequisites for an absolutely safe final storage of the high-level waste have been met, the Government finds that certain supplementary geological studies are required for full compliance with the provisions of the Act.

- The Stipulations Act does not require the applicant to specify a definite site for the final repository. However, in this case the Act requires that the applicants demonstrate the existence of an area or areas in Sweden which possess such characteristics that a terminal storage of the high-level waste can be effected there in compliance with the requirements of the Act.

  The supplementary geological investigation should therefore demonstrate that a sufficiently large rock formation exists at the depth in question and possesses the other characteristics stipulated by the KBS safety analysis. In this connection, the Government wishes to emphasize that the requirements on the volume and configuration of the rock formation are dependent upon the quantity of the radioactive waste as well as the geometric layout of the final repository. The design of the rock repository originally described by KBS may have to be modified in accordance herewith.

  Consequently, the Government finds that further test drillings and associated loggings and measurements are required in rock areas which, according to the applicant, possess the aforementioned geological characteristics.

  For the reasons cited, the application cannot be approved at the present time."

As a consequence of this Government decision, KBS carried out supplementary drillings and measurements in the Sternö and Finnsjö areas. The results from the Sternö area were compiled in a report entitled: "Supplementary geological studies". The report was submitted on 20 February 1979 to the Government in the form of an appendix to a new application for charging permission for Ringhals 3 and Forsmark 1.

The Government directed the Swedish Nuclear Inspectorate to review the matter, and the Inspectorate submitted its findings on 27 March 1979. In its conclusions, the Inspectorate states:

- "In its overall assessment of the safety of the repository, the Inspectorate finds that the supplementary study has not given the Inspectorate reason to alter its previous opinion, as stated in its report of 9 May 1978, that the KBS proposal for the handling of spent nuclear fuel and the final storage of high-level waste fulfills the requirements imposed by the Stipulations Act. Thus, in the view of the Inspectorate, the available material indicates acceptable possibilities for the storage in Swedish bedrock of waste from at least Ringhals 3 and Forsmark 1."

Two members of the Board's executive committee recorded their reservations.

On 20 June 1979, the Government approved the applications of the two power companies for permission to charge Ringhals 3 and Forsmark 1 with nuclear fuel. The permission was coupled to the condition that the power companies should:

- "continue the work on the final storage of high-level waste obtained from reprocessing or of unreprocessed spent nuclear fuel, either within the company or within a special project group, in order to gather further knowledge concerning the final storage of these types of radioactive material."

2.3.1.2 Spent, Unreprocessed Nuclear Fuel

During the first half of 1978, KBS completed a second report. This report dealt with the handling and final storage of spent unreprocessed nuclear fuel and was entitled: "Handling and Final Storage of Unreprocessed Spent Nuclear Fuel".

This material was sent to the Ministry of Industry and also presented at a specially arranged Nordic seminar on 28 September 1978 in Stockholm.

The Ministry of Industry decided that this report should also be circulated for examination and comment both nationally and internationally. This examination is currently being conducted, and as regards the Swedish reference bodies it will be finished by 1 December 1979. The findings of the foreign reference bodies will be received in early 1980.

Since this report on spent nuclear fuel does not constitute supporting documentation for any application for charging permission in accordance with the Stipulations Act, the examination is being performed (according to the Ministry of Industry) for the purpose of enabling the Government to develop a strategy for the handling and final storage of radioactive waste.

2.3.2 Low- and Medium-Active Waste

Low- and medium-active waste is obtained both from nuclear reactor operation and from the reprocessing of spent nuclear fuel. According to the reprocessing agreement concluded between SKBF and Cogema, SKBF shall - unless otherwise agreed - be responsible for the final storage of an amount of low- and medium-active waste from reprocessing which is proportional to the portion of the reprocessing plant's capacity utilized by SKBF.

In comparison with the high-level waste, the low- and medium-active waste obtained from nuclear reactor operation is of large volume, but has a low level of radioactivity. These wastes are easier to handle and dispose of. At present, they are being stored at the nuclear power stations.

Low- and medium-active waste from reprocessing will be returned to Sweden no earlier than 1990. Most of this waste can be placed in final storage together with the waste from nuclear reactor operation, while the more advanced final repository is required for the rest.

Low- and medium-active waste is also obtained from the dismantling of nuclear power plants. Such waste consists of steel and building materials that have been contaminated with radioactive substances or activated by neutron radiation. It is of the same character as part of the operating waste and can be disposed of in a similar manner.

SKBF's owners have decided that studies shall be conducted within the KBS project in order to obtain the information required to design the handling equipment and final storage facilities for low- and medium-active waste. Work on this was commenced at the beginning of the year. The initial phase has consisted of an inventory of problems and theoretical studies. As regards the final repository itself, a central facility for low- and medium-active waste (ALMA), KBS has followed the work in this area being conducted by the National Council for Radioactive Waste (PRAV). The work within KBS is oriented towards the commissioning of a final repository for reactor waste and the like by the end of the 1980s.

2.3.3 The Stripa Programme

In July of 1977, an agreement was reached between SKBF and the US Energy Research and Development Administration (ERDA) concerning certain joint research efforts in Stripa with regard to the final storage of radioactive waste in crystalline rock. The work of ERDA has since been transferred to the US Department of Energy (DOE), which has thereby become SKBF's counterpart to the agreement. The US work at Stripa has been entrusted by the DOE to Lawrence Berkeley Laboratory (LBL).

Stripa is an abandoned iron ore mine near Ludvika. Adjacent to the ore body is a granite massif which is easily accessible from existing drifts. This has made it possible to establish a research station in rock of suitable type and at realistic depth (350-400 m) quickly and at moderate cost.

The Stripa experiments, which were begun during the latter part of 1977, have included the following main parts:

- large-scale heating tests, where electric heaters lowered into boreholes simulate the high-level waste containers

- "time-scaled" heating test, where an electric heater in a borehole is used to obtain a picture of the heating process over a longer period of time than the actual test period

- hydrological and geochemical studies

- supporting studies incorporating geophysical measurements, stress measurements in rock, laboratory studies of the properties of the rock material etc.

The main experiments have been preceded by certain smaller-scale heating tests carried out by KBS alone. Otherwise, responsibility has been divided in such a manner that KBS has been responsible for blasting and drilling work as well as operation of the mine, while LBL has been responsible for instrumentation and execution of the tests. Among other things, a sophisticated computer system has been installed.

The joint project is scheduled for completion in 1980 and a comprehensive evaluation of the test results has been begun. To date, some 15 or so technical reports have been published from the joint Swedish-US project at Stripa. Among some of the results are:

- the temperature measurements have shown that the calculation models used reflect reality very well

- measured movements and stresses in the rock resulting from heating are considerably lower than calculated, probably due to the fact that some of the movements are absorbed by fractures in the rock mass.

The hydrological and geochemical data are being processed and can be expected to provide valuable new contributions to existing knowledge within these areas.

A considerable value of the Stripa experiments is that they have led to the development and improvement of methods and instruments needed for later studies, when a final repository is to be built.

The total cost of the Swedish-US project at Stripa has amounted to about SKr 58 million, of which KBS is liable for about SKr 13 million and DOE for about SKr 45 million.

International interest in the Stripa project has been very keen. As a result, the OECD/NEA arranged a symposium at Stripa in September of 1978, which later led to discussions of continued joint international projects. The prospects for such a joint project taking concrete form before the end of the year appear to be good. KBS has presented a proposal for a large scale test to be carried out at Stripa during a 4-year period. A part of a final repository will be simulated with electric heaters taking the place of the waste bodies. The main object of the test will be to study the behaviour of and the conditions in the backfill material in the storage holes and tunnels. The proposal also includes certain hydrogeological studies in long horizontal boreholes from the lower regions of the mine. In a later phase, in situ studies of how different elements travel with the groundwater are planned. The Stripa experiments are based entirely on simulated waste containers. No high-level waste products will be used in the experiments. Nor is the Stripa mine suitable for use as a final repository.

2.4 TRANSPORTATION

In the process of nuclear power generation, different types of radioactive products and waste are created which must be transported to temporary storage, to treatment and to final storage.

All Swedish nuclear power stations are located on coasts and have harbours. This will also be the case with the central temporary storage facility for spent fuel (CLAB). Foreign plants providing reprocessing services also have access to harbours.

For this reason, SKBF is currently designing a transportation system based on sea transports that can handle all pertinent types of radioactive materials and wastes. The determining factor for the design is the high-level products, i.e. spent nuclear fuel and vitrified waste from reprocessing, but arrangements are also made for accomodating other waste products from the operation of nuclear power plants and from reprocessing. These latter so-called "low- and medium--active wastes" comprise the larger portion in terms of volume.

2.4.1 Transportation System

The central unit in the transportation system is a specially-designed ship (Fig. 3 below).

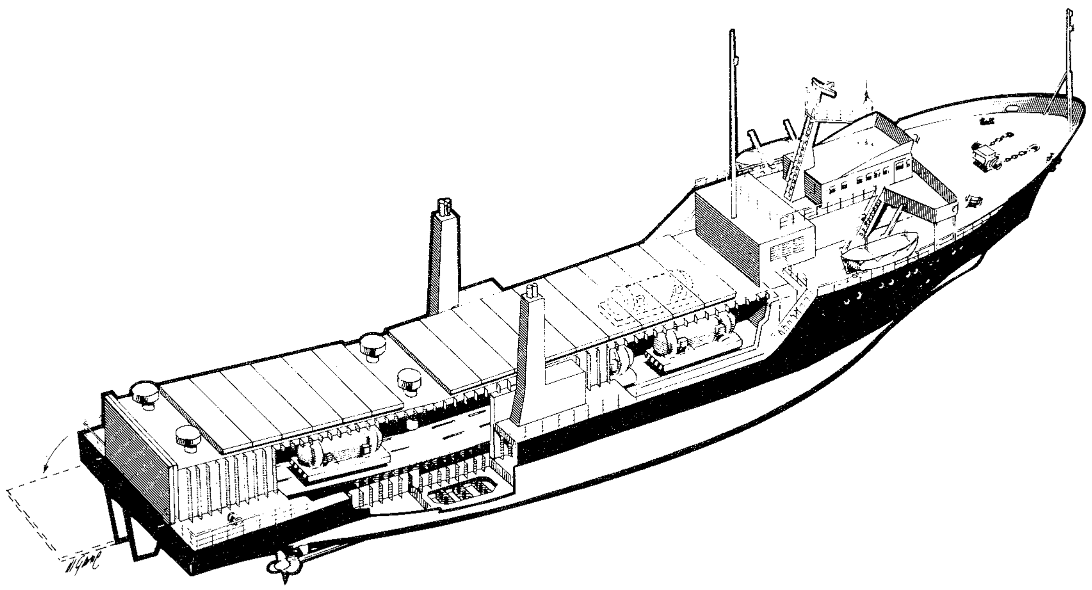


Figure 3. Specially-designed transportation ship

The specifications for the ship are based on the rules for Imco type 1 chemical tankers, which include, among other things, double hull. The ship, of 1900 dwt, is also being designed to Finnish-Swedish ice class 1A, has special radiation shielding and special ventilation. The hold is 10 x 54 metres with a height of 5 metres. Loading and unloading can be done either by crane or by means of "roll on - roll off". The design is currently being examined by the Swedish authorities.

Special shipping containers, known as "transport casks", will be used to transport spent fuel from the Swedish nuclear power plants to the central storage facility (CLAB) and for shipment to reprocessing abroad under the terms of current contracts. International specifications (IAEA) govern the design of such casks. They will also be used for the return transport of the high-level vitrified waste. Specially built containers can be used for the low- and medium-active waste.

A terminal transportation system is being investigated for the handling of various types of packages in harbours.

The transportation system for spent fuel is expected to be ready for use by 1982. It will later have to be revised to accommodate containers and, possibly - depending upon the future size of the Swedish nuclear power system - another ship for the transportation of low- and medium-active wastes in connection with the commissioning of a final repository for these wastes.

2.4.2 Transport Casks for Spent Nuclear Fuel

Through its participation in a working group organized at the time of the signing of the French reprocessing contracts, SKBF has kept track of developments on the transport cask side. In addition to the above-mentioned IAEA specifications, the casks must also conform to the "Cogema Cask Acceptance Criteria" issued in November of 1978. European cask designers are attempting to make their designs conform to these requirements. Thus far, one design has received Cogema's approval, namely the one developed by Nuclear Transport Ltd.

SKBF has received quotations both directly from different manufacturers and from Cogema.

During the autumn of 1979 SKBF plans to purchase transport casks for Swedish needs.

2.5 URANIUM AND PLUTONIUM FROM REPROCESSING

Uranium with a higher content of uranium 235 than normal in natural uranium as well as plutonium are obtained from reprocessing. Both of these products have a high energy content and can be reused in the fuel cycle. In the enrichment contracts with DOE, it is therefore foreseen that a certain portion of the uranium to be enriched may derive from reprocessing. This has not been more precisely specified, however. Other countries with enrichment plants, mainly France and the Soviet Union, presumably have the same policy. In practice, Sweden cannot expect to obtain any return uranium until a significant quantity of Swedish spent nuclear fuel has been reprocessed, i.e. not before around 1985.

Plutonium can be used as a fissionable material in light water reactors of the same type as those in which the plutonium was formed as well as in fast reactors, which also permit a very efficient utilization of natural uranium.

Both Cogema and BNFL contractually committed themselves to store plutonium on a temporary basis. In Sweden, no step will be taken until guidelines have been established for plutonium use, whereby the international development in this area is of importance. In an exchange of letters concerning the reprocessing agreements the Swedish and French governments have agreed that the plutonium obtained from the reprocessing of Swedish spent nuclear fuel will not be transported or used until the governments have come to a special agreement in this respect. There is currently no preference for using the plutonium in one way or another, but it represents an energy resource and an economic value which should not be wasted.

Altogether, the recovery of uranium and plutonium from reprocessing will permit a saving of 30% or more on natural uranium.

3 COSTS OF THE NUCLEAR FUEL CYCLE

The price of natural uranium on the world market was low in the beginning of the 1970s. Capacity and production exceeded demand. As a result of this weak demand and low price - which could be charged for production from existing and written-off plants - the uranium industry did not invest in prospecting or new mines. When the 1973 oil crisis led to plans for the expansion of nuclear power facilities and thereby a more long-range purchasing strategy for uranium at the power companies, the price rose rapidly. In the beginning of 1976, the price reached a level of about $40/lb uranium oxide. From 1976 to October of 1979, the price for immediate deliveries (the spot market) has remained nearly constant at $43/lb uranium oxide, which is equivalent to SKr 475/kg uranium ($1 = SKr 4.25) (see Fig. 4).

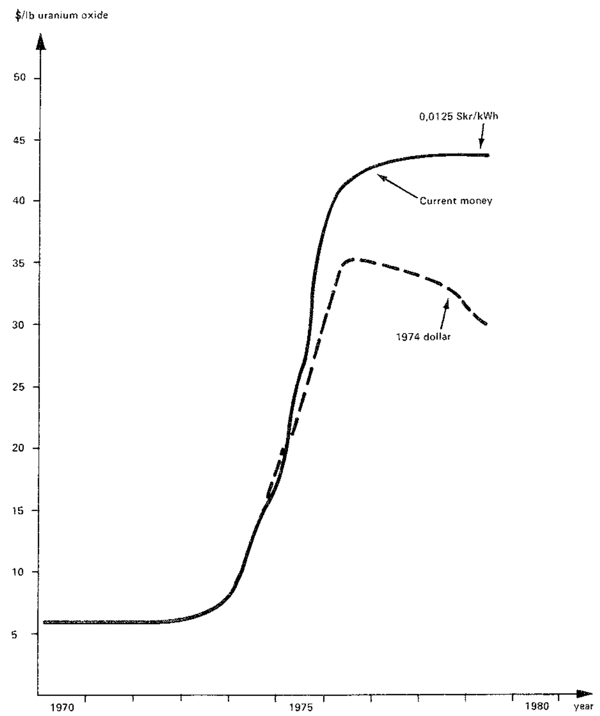


Figure 4. Price of uranium for immediate purchase
Source: NUEXCO

Long-term supply contracts may call for lower price. When this price is adjusted to 1976 purchasing power, uranium is seen to be cheaper in 1979 than it was in 1976. The cost of uranium is now about SKr 0.0125 per generated kWh. The price of uranium now appears to be stabilized at a level that permits a vital uranium industry, and the price (adjusted for inflation) can be expected to remain relatively stable over the next few years.

The other stages on the supply side - converting, isotope enrichment and fuel fabrication - entail processing of the material in various forms. The price of these services seems to be relatively stabilized, when adjusted for inflation. The costs of the "back end" of the nuclear fuel cycle, involving reprocessing and final storage of waste, have been calculated with crediting of the value of uranium and plutonium extracted from the spent fuel. A lower and a higher value have been calculated.

The table below presents nuclear fuel costs for 1979, in that year's monetary value:

Supply of nuclear fuel		
Uranium concentrate	\$ 43/lb uranium oxide	SKr 0.0125/kWh
Conversion	\$ 5/kg uranium	SKr 0.0005/kWh
Isotope enrichment	\$ 92/enrichment unit	SKr 0.0073/kWh
Reserve stocks		SKr 0.0005/kWh
Fuel fabrication, incl. boxes	SKr 800/kg uranium	SKr 0.0036/kWh
		SKr 0.025/kWh

Disposal of spent fuel	Low alternative	High alternative
	SKr 0.006 per kWh	SKr 0.015 per kWh
Total nuclear fuel costs	SKr 0.031 per kWh	SKr 0.040 per kWh

Assuming that the spent fuel from 12 reactors (in operation for about 30 years) is reprocessed and that the active waste is conditioned, transported, temporarily stored and terminally isolated in a final repository, the l o w alternative represents a case where the costs for the waste are estimated low and credit for extracted uranium and plutonium is estimated high. A certain real price increase is hereby assumed for uranium, while a value corresponding to the amount of energy represented by the material is assumed for plutonium. In the h i g h alternative, the costs for the wastes are estimated high and credit for extracted uranium and plutonium is estimated low. Today's price is assumed for uranium and no credit at all is given for plutonium.

The so-called "Consequence Inquiry" is based on the same premises as those used here.

If the costs of uranium rise more rapidly in the future than is assumed in the low alternative, this will mean that the credit given for recycled uranium and plutonium will rise. In the future, with high fuel costs, the "back end" of the nuclear fuel cycle may even operate at a profit.

In the direct disposal alternative, the spent fuel from 12 reactors (in operation for about 30 years) will be transported, temporarily stored, encapsulated, and terminally isolated in a final repository. Since there is no reprocessing of the fuel, no value can be credited here. The costs for the final storage of spent fuel in this case will be greater than for waste after reprocessing. With the premises and assumptions made in the KBS work, the cost is calculated to lie between the given limits "low" and "high".

The dismantling of nuclear power plants and the treatment of active waste from the nuclear power plants directly are not included. The costs of dismantling are estimated to be 10-15% of the costs of acquisition at the time of dismantling. Today, the dismantling costs, including the costs for treatment of active waste from the stations, correspond to up to about SKr 0.005 per kWh.

Zero interest has been assumed in the calculations referred to above. This leads to a higher calculation result for the costs than if interest is included.

The costs for the back end of the nuclear fuel cycle fall due after or long after the time of the corresponding electric power production. Consequently, the producers make allocations for this purpose. Current legislation permits such allocations, but not allocations for demolition costs. (Related organizational and financial questions are currently the subject of a government inquiry.)

In 1978, the National Tax Board allowed an allocation for fiscal purposes of max. SKr 0.008 per kWh. Consequently the nuclear power producers include future costs in current rate-setting.

The total nuclear fuel cost of SKr 0.031-0.040 per kWh, of which SKr 0.0125 is for the natural uranium, can be compared with the fuel cost for oil in a condensing power plant, which is about SKr 0.15 per kWh (SKr 700 per ton of oil). This does not include the

the costs of compulsory stocks, nor the costs of dealing with the waste products of oil combustion (acidified soil and water, cleaning of flue gases). The gas cleaning cost alone (estimated at SKr 0.02 per kWh) for condensing power generation from oil (or coal) is of the same magnitude as the entire costs for the back end of the nuclear fuel cycle, as given above.

The cost of electric power generation from oil (as well as from coal) is also far more sensitive to variations in the price of oil (coal) than nuclear power generation is to the price of uranium or the cost of the entire nuclear fuel cycle.

A 50% rise of the oil price leads to an increase of the kWh costs of SKr 0.075, while a 50% rise of the price of natural uranium increases the generating costs by SKr 0.006 per kWh.

4 SECURITY OF SWEDEN'S NUCLEAR FUEL SUPPLIES

Greater security from the viewpoint of supplies has been and can be obtained with nuclear power plants as compared with oil- or coal-fired power plants.

Normally, new fuel is added once a year by replacing approximately 20% of the reactor's fuel content. Sweden has a domestic fuel element factory and a conversion plant for producing uranium dioxide. Work in progress in these plants constitutes an additional reserve beyond what is in the reactor. This reserve enables the Swedish nuclear power units to be kept operating for at least one year following a cut-off of imports of enriched uranium.

The 1975 oil storage committee proposed that emergency supplies should be stockpiled for one additional year of operation of the nuclear power plants. The Swedish Government has, however, decided (Bill 1976/77:74) that emergency supplies should not be stockpiled, in view of the fact that the power companies intend to build up reserve stocks.

On the basis of enrichment agreements with the Soviet Union concluded during 1974-75, such reserve stocks started to be built up in 1979. Natural uranium from Agnew Lake Mines and from Ranstad has been converted via Eldorado Nuclear Ltd. and Comurhex, and isotope-enriched in the Soviet Union. By the end of 1979, sufficient reserve stocks are expected to have been built up to supply the needs of between three and four units for one year, corresponding to a total of about 14 TWhe. Both enriched and depleted uranium in the form of uranium hexafluoride comes from the Soviet Union in cylinders. The total quantity of uranium is equal to the quantity of natural uranium delivered to the Soviet Union. The enriched uranium is stored at Asea-Atom's fuel factory in Västerås and the depleted uranium is stored in Studsvik.

Continued deliveries of enrichment services from the Soviet Union for the reserve stocks are planned during 1981, corresponding approximately to the annual need for one unit.

The reserve stocks may be built up further during 1982 and 1983.

As far as the disposal of spent nuclear fuel is concerned, capacity exists at the nuclear power plants for temporary storage. This buffer capacity will be increased to more than 10 years discharge of fuel from the nuclear power plants by the proposed construction of a central temporary storage facility for spent nuclear fuel, planned to be able to receive such fuel from the mid-1980s, plus a transportation system. These facilities, together with systems currently being developed in Sweden for the handling and final storage of the radioactive wastes arising from nuclear power production, will provide freedom of choice with regard to the back end of the nuclear fuel cycle and a high degree of independence from industrial and political developments abroad.

5 INTERNATIONAL FACTORS AND INTERNATIONAL COOPERATION

5.1 THE INTERNATIONAL NUCLEAR POWER ENVIRONMENT

The conditions surrounding the nuclear power and the nuclear fuel cycle are matters of international urgency and cannot be isolated as national concerns.

Aside from factors of a more conventional nature - such as research, transfer of technology, uneven geographical distribution of raw materials and certain production services (enrichment), international trade, financing etc., which do have a certain international character - two factors place nuclear power and the nuclear fuel cycle in a particularly global perspective.

The first factor has to do with satisfactory safety against accidents and release of radioactivity, while the second factor concerns measures to prevent peaceful uses of nuclear power from contributing towards the proliferation of nuclear weapons.

The importance of acceptable international rules for both of these areas can be appreciated when considered in view of the fact that there are more than 200 nuclear power plants in operation in the world and an additional 250-300 under construction at the present time.

Safety against major accidents is mainly related to the design and operation of the reactors and will not be dealt with here. Safety against unintentional releases of radioactivity is related to the design and operation of both reactors and various facilities within the nuclear fuel cycle including final repositories, where an unsuitable design can give rise to undesirable dose burdens on the biosphere in a distant future. KBS deals with this question as it pertains to the back end of the nuclear fuel cycle.

In SKBF's view, the necessary scientific, technologic and economic prerequisites exist to enable nuclear fuel cycle industries all over the world to conduct their operations, including waste management and disposal, with a degree of safety that is perfectly acceptable from the viewpoint of society.

The important question then is to make sure that the necessary rules, organization and advance planning are established to ensure that the necessary measures really will be adopted. Obviously, this is also a matter of international concern. International cooperation in this area is far-reaching and international guidelines have been adopted in many areas. Here we can mention the ICRP's standards for individual and collective dose burdens, design standards for transport packages for radioactive products etc. Especially in view of the large quantities of nuclear fuel and waste that will have to be managed as a result of the present worldwide expansion of nuclear power facilities, SKBF is however of the opinion that further efforts are required to achieve generally accepted international safety guidelines.

The second factor - the risk of nuclear weapon proliferation - has been a matter of international political concern ever since the 1950s.

Following is a brief resumé of the technical background.

Uranium is the raw material both for nuclear fuel for peaceful energy generation and for the basic materials in nuclear explosives, i.e. uranium which has been highly enriched (over 95%) with regard to the isotope uranium 235 or a special grade of plutonium (weapon-grade plutonium). The plutonium that is created in the fuel during the operation of nuclear reactors of the light water type is not suitable for use in advanced nuclear weapons. It is, however, possible to fabricate a detonable nuclear explosive using such reactor plutonium as a base.

Reprocessing plants for light water reactor fuel can, with minor modifications, be used to produce weapon-grade plutonium from special low-burnup fuel. Enrichment plants built for low enrichment for civilian fuel can only be used for high enrichment after more extensive alterations. The technology for producing qualified raw material for nuclear weapons does not constitute a particularly difficult obstacle to any country that has resolved to manufacture nuclear weapons. In actual fact, countries with nuclear weapons have special reactors and facilities for this fabrication. The question of nuclear weapon proliferation is therefore chiefly a political question and not a technical one. Nevertheless, measures must be taken to make it impossible or very difficult for peaceful nuclear power products and plants to be used as a source of raw materials for nuclear explosives or nuclear weapons.

International trade in the goods and products of the nuclear fuel cycle as well as access to so-called "sensitive technology" (enrichment and reprocessing) are therefore regulated by political constraints.

Adherence to the Nuclear Proliferation Treaty (NPT) with submission to monitoring through the International Atomic Energy Agency (IAEA) has been the international conditional framework that has enabled international trade to proceed relatively well.

After India's demonstration of nuclear capability in 1974, however, supplier countries - including the United States and Canada - have bilaterally imposed regulations on short-term approvals of the receiver country's nuclear measures, particularly with respect to the back end of the nuclear fuel cycle.

Through the Uranium Institute, SKBF has actively participated in analyses and proposals concerning the consequences of trade and supply, summarized in the following publications:

- Government Influence on International Trade in Uranium (October 1978)

- The Nuclear Fuel Bank Issue as Seen by Uranium Producers and Consumers (May 1979).

SKBF considers it urgent that international political agreements be arrived at so that the international exchange of goods and services necessary for continued nuclear trade can be pursued in a manner which also satisfies reasonable requirements on long-range planning by the receiver countries.

Against this background, continued determined efforts must be made on the part of the Swedish State and Swedish authorities with regard to these international questions. SKBF is prepared to assist in such efforts.

5.2 INFCE

At the initiative of President Carter, an international investigation into the safeguarding of the nuclear fuel cycle with respect to nuclear weapon proliferation was started in 1977. This project is known as the International Nuclear Fuel Cycle Evaluation (INFCE).

The work is conducted in groups within the following areas:

I	Fuel Availability
II	Enrichment Availability
III	Security of Supply
IV	Reprocessing
V	Fast Breeder
VI	Spent Fuel Management
VII	Waste Management and Disposal
VIII	Advanced Fuel Cycles

Representatives of SKBF are participating in the work within groups I, III, IV, VI and VII. The working groups are expected to complete their work during the latter half of 1979, and the entire INFCE project is expected to have completed its work by early 1980. It is hoped that this work will lead to a more generally accepted basis for national and international policy in the field of nuclear power.

5.3 SKBF's OTHER INTERNATIONAL CONTACTS

In addition to those discussed above, the SKBF has other international contacts of different types.

The various supply contracts which run for many years entail international cooperation.

Another form of cooperation is the participation of experts from SKBF in various working groups within international bodies or other organizations. During 1978 and 1979, such organizations have included INFCE as well as the IAEA and the NEA. The Uranium Institute is an organization with members representing uranium producers and consumers. Three working groups have been formed within the Institute. Personnel from SKBF have participated in two of these groups, namely in the group for trade and in the group for environmental questions.

A third form is joint development work. As has been mentioned above, KBS and the US Department of Energy are involved in joint research in the Stripa project. KBS also has other extensive international contacts in relation to numerous aspects of waste management and disposal.

In the CLAB project, the French company SGN (Société Général pour les Techniques Nouvelles) has been engaged and the cooperation of DWK (Deutsche Gesellschaft für Wiederaufarbeitung von Kernbrennstoffen mbH) in West Germany has been enlisted.

In connection with the reprocessing agreement with Cogema, a "Joint Committee" has been organized with participants from Cogema and all customer companies from Japan, West Germany, Switzerland, Belgium, Holland, and Sweden. Separate working groups are dealing with different questions in connection with the agreement and the project.

6 GOVERNMENT INQUIRIES IN THE FIELD OF NUCLEAR ENERGY

Current inquiries by committees appointed by the Ministry of Industry in areas of importance for nuclear power producers in Sweden.

6.1 REVIEW OF LEGISLATION IN THE FIELD OF NUCLEAR ENERGY

A review of legislation in the field of nuclear energy is being carried out by a parliamentary committee under the chairmanship of Director General Valfrid Paulsson.

The main purpose of the committee is to investigate the possibilities of coordinating current legislation within the field of nuclear energy in order to obtain an all-encompassing body of legislation. According to the committee's terms of reference, a premise for this work shall be that supreme responsibility for activities within the field of nuclear energy shall rest with the state, while direct responsibility shall, as far as is possible, rest with those who have permission to conduct various types of nuclear energy activities.

The committee should particularly study the need for legislation concerning the management of spent nuclear fuel and high-level waste and the handling of decommissioned or other unused facilities for nuclear activities. The legislation proposed by the committee should, with regard to spent nuclear fuel and radioactive waste, be formulated so as to give the state firm control over the entire waste area. The possibility of making permission under the Atomic Energy Act conditional upon certain obligations should also be studied. Among other things, the new legislation should provide that the permit-holder is liable for all expenses and obligated to undertake all measures stemming from the activity and arising after the activity has ceased. The committee's legislative proposals, in combination with the results of domestic and international work within the field of nuclear waste, should constitute part of the basis for the review of the entire waste issue which should be carried out around 1982-1983. In this connection, all current licenses granted for nuclear power plants will probably be reviewed.

The committee shall submit its final report no later than 30 June 1981.

6.2 RADIOACTIVE WASTES – ORGANIZATIONAL AND FINANCING MATTERS

County Governor Bertil Löfberg has been appointed chief investigator and instructed to submit proposals for organizational and financing matters with respect to the radioactive waste arising from nuclear power generation. According to Löfberg's terms of reference he shall present proposals for how the handling of radioactive waste and spent nuclear fuel should be divided organizationally between the state and the power industry and how a system for the financing of future expenses for these activities should be designed. Löfberg shall also give an account of the research and development work which is being conducted within the field of spent nuclear fuel and radioactive waste and present a proposal for how long-range research should be organized in the future. The inquiry shall also clarify the division of roles between the supervisory authorities and the organizations which are proposed to be given responsibility for the future handling of spent nuclear fuel and radioactive waste. The inquiry was to have been completed by 1 October 1979, but is not expected to be finished before the turn of the year 1979/80.

6.3 REACTOR SAFETY INQUIRY

In May of 1979, a committee called The Swedish Government Committee on Nuclear Reactor Safety was appointed for the purpose of carrying out an inquiry concerning reactor safety against the background of the accident at Three Mile Island (TMI), reactor unit 2. This committee, which is chaired by Hans Löwbeer, consists solely of scientists and experts within technical fields pertinent to an evaluation of nuclear power accidents and nuclear safety. According to its terms of reference, the committee shall evaluate the accident at TMI, unit 2, and judge the risks of a similar accident occurring in Sweden. In addition, the committee shall ascertain whether the accident at TMI is sufficient cause for a reassessment of the risks associated with the utilization of nuclear power. Finally, the committee shall present proposals for safety-enhancing measures that should be adopted at the Swedish nuclear power units. A final report on the committee's work is due 30 November 1979.

6.4 CONSEQUENCE COMMITTEE

In order to shed light on the consequences of a phase-out of nuclear power, a special committee was appointed in June of 1979. This committee, under the chairmanship of Director General Lennart Sandgren, adopted the name of the "Consequence Committee".

According to its terms of reference, the Consequence Committee shall shed light on the consequences of a phase-out of nuclear power, assuming that this phase-out takes place over a 10-year period starting in 1980. The consequences for the nation's supply of energy, the national economy, the balance of payments and the competitive strength and development of Swedish industry will be reported. The committee will also analyze the price trend for energy and the consequences for the municipalities and power companies that would be directly affected by a phase-out of nuclear power. As a basis for its work, the Consequence Committee will make use of the material produced by the Energy Commission and the guidelines for energy policy set forth in the Government's Energy Bill 1978/79:115. The committee is to report its findings no later than 15 November 1979.

6.5 OTHER INQUIRIES WHICH COULD BE OF IMPORTANCE FOR QUESTIONS CONCERNING NUCLEAR FUEL

The organization of government agencies within the field of energy has been the subject of an inquiry conducted by Director General Sven Moberg since July of 1979. According to the terms of reference for this inquiry, Moberg shall, as special investigator, examine questions pertaining to the organization of state agencies etc. within the field of energy and certain questions pertaining to the future functions and organization of the Swedish State Power Board.

The basis for the review shall be that the future organization in the field of energy shall afford the comprehensive overview necessary for maintaining an optimum balance between state efforts for the supply and conservation of energy and between various measures within these areas. The terms of reference for the inquiry also include attempting to establish within which areas and under which forms the Swedish State Power Board's plant facilities can best be utilized. The investigator's work shall not include the state-owned companies within the energy sector or the state organization for energy tax matters. Nor shall the work encompass questions pertaining to the state organization within the field of nuclear safety. The investigator should submit a report on his findings no later than 1 June 1980.