SKI Report 2003:18

Research

# Making a Historical Survey of a State's Nuclear Ambitions

IAEA task ID: SWE C 01333
Impact of Historical Developments of a State's National Nuclear Non-Proliferation Policy on Additional Protocol Implementation

Dr. Thomas Jonter

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# SKI's perspective

## Background

In the year 1998 Sweden, together with the rest of the states in the European Union and Euratom signed the Additional Protocol to the Safeguard Agreement with the International Atomic Energy Agency, IAEA. The Additional Protocol gives the Agency the right of more information on the nuclear fuel cycle activities in the State. The Protocol also gives extended access to areas and buildings and rights to take environmental samples within a state. The process of ratification is going on and the Protocol will be implemented simultaneously in all EU-member states. In ratifying the agreement in May 2000, Sweden changed its Act on Nuclear Activities and passed a new act regarding access. The present estimate is that the protocol could be implemented in EU during the second half of 2003.

## Aim

When the Additional Protocol is implemented, Sweden (and the other EU-states) is to be "mapped" by the IAEA, scrutinising all nuclear activities, present as well as future plans. In the light of this, SKI has chosen to go one step further, letting Dr Thomas Jonter of the Stockholm University investigate Sweden's past activities in the area of nuclear weapons research in a political perspective. Since Sweden had plans in the nuclear weapons area it is important to show to the IAEA that all such activities have stopped. By doing this and attaching a historical review to the Swedish State declaration required by the Protocol, the IAEA will get a more transparent picture of Sweden's nuclear history. The main objective of this report is to show how this study has been performed and be an inspiration to other States to perform similar historical studies.

## Results

Dr Jonter describes his research and presents a model that the IAEA and other states can use in their investigations of a state's nuclear activities.
He has made a survey of available sources in both Swedish archives and archives abroad as well as interviewed people involved in these historical activities. The report gives reference to a lot of different sources of information and some of them might also be of use for other states in their historical research.

## Continued efforts in this area of research

No further research activities are planned.

## Effect on SKI's activities

This report will be used in connection with future contacts with other state's on similar historical survey projects.

**Project information**

Göran Dahlin has been responsible for the project at SKI.
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IAEA task ID: SWE C 01333 "Impact of Historical Developments of a State's National Nuclear Non-Proliferation Policy on Additional Protocol Implementation"

Other projects:
SKI Report 99:21 – Sverige, USA och kärnenergin, Framväxten av en svensk kärnämneskontroll 1945-1995, Thomas Jonter, May 1999, (Sweden, USA and nuclear energy. The emergence of Swedish Nuclear Materials Control 1945-1995).
SKI Report 01:05 – Försvarets forskningsanstalt och planerna på svenska kärnvapen, Thomas Jonter, March 2001 translated to SKI Report 01:33 – Sweden and the Bomb. The Swedish Plans to Acquire Nuclear Weapons, 1945-1972, Thomas Jonter, September 2001.
SKI Report 02:18 Nuclear Weapons Research in Sweden. The Co-operation between Civilian and Military Research, 1947–1972.
SKI Report 02:19 Kärnvapenforskning i Sverige. Samarbetet mellan civil och militär forskning, 1974-1972.

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# Contents

# Acknowledgements

This report was carried out as a result of the project to make a historical review of the Swedish nuclear weapons research during the period 1945-1972 at the Swedish Nuclear Power Inspectorate (Statens Kärnkraftinspektion, SKI). The project contains altogether three reports. The first report mainly analyses Swedish-American nuclear energy collaboration between 1945 and 1995. This report also contains a list of archives with documentation of nuclear material management in Sweden, the growth of international inspections and the legislation that has applied in the nuclear energy field since 1945. The second report investigates the Swedish National Defence Research Institute (FOA) and plans to acquire nuclear weapons, 1945-1972.[1]

Several persons have read and commented this text. I am especially in debt to Mr. Jan Prawitz at the Swedish Foreign Policy Institute, who has been an expert consultant to the project, and he has also read and commented on the text. At the Swedish Nuclear Power Inspectorate (SKI) and the especially at the Office of Nuclear Non-Proliferation several staff members have been consulted. Among them I am especially thankful for the advice and help given by Dr Lars Hildingsson, Deputy Director Göran Dahlin, and Dr Kåre Axell. PhD student Akhil Malaki, at the Department of Economic History at Stockholm University, has refined and corrected my English.

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[1] Jonter, Thomas, *Sverige, USA och kärnenergin. Framväxten av en svensk kärnämneskontroll 1945-1995* (Sweden, the USA and nuclear energy. The emergence of Swedish nuclear materials control 1945-1995), SKI Report 99:21; *Försvarets forskningsanstalt och planerna på svenska kärnvapen*, SKI Report 01:5, translated to *Sweden and the Bomb. The Swedish Plans to acquire Nuclear Weapons, 1945-1972*, SKI Report 01:33; *Nuclear Weapons Research in Sweden. The Co-operation Between Civilian and Military Research, 1947-1972*, SKI Report 02:18.

# Summary

In 1998, SKI initiated a project to conduct a historical survey of the Swedish nuclear weapons research for the period 1945-1972. The International Atomic Energy Agency (IAEA) became interested and accepted it in 2000 as a support program task to increase transparency and to support the implementation of the Additional Protocol in Sweden. The main purpose of the Additional Protocol is to make the IAEA control system more efficient with regard to nuclear material, facilities and research.

Other countries have now shown interest to follow the Swedish example and to make their own reviews of their past nuclear energy and nuclear weapons research. The most important aim is to produce basic information for IAEA on the nuclear activities of the past and to refine and strengthen the instruments of the Safeguard System within the Additional Protocol.

The first objective of this report is to present a short summary of the Swedish historical survey, as well as similar projects in other countries dealing with nuclear-related and nuclear weapons research reviews. These tasks are dealt with in chapter 2.

Secondly, the objective is to present a general model of how a national base survey can be designed. The model is based on the Swedish experiences and it has been designed to also serve as a guideline for other countries to strengthen their safeguards systems within the framework of the Additional Protocol. Since other States declared that they would make similar historical surveys, the SKI decided to work out a model that could be used by other countries intending to conduct such studies. Estonia, Latvia and Lithuania are participating in a co-operation project to carry out such nationally base surveys under the auspices of the Swedish Nuclear Power Inspectorate. Finland is also conducting such a survey, but it is done independently, albeit in close exchange of views between SKI and its Finish counterpart, STUK. This is described in chapter 3.

The third objective is to develop a pedagogic methodology for teaching and training researchers and officials about to start nationally base surveys. In chapter 4 the method is described. Two training courses have already been conducted. Based on the experiences from these courses the methodology will be explained and discussed.

The fourth objective of this report is to make a competence profile of prospective co-operative partners in Sweden and in other countries, who either can be used to develop training programs, or assist in carrying out the historical surveys. This task is dealt with in chapter 5.

Lastly, the fifth objective is to compile a list of databases, literature and home pages dealing with reviews of certain States' nuclear energy and nuclear weapons research. The compilation will concentrate on databases, literature and home pages, which specifically concerns survey activities in a comprehensive perspective. This task is dealt with in chapter 6.

# Sammanfattning

Den här rapporten är gjord i anslutning till ett SKI-projekt som initierades 1998 med målsättningen att göra en historisk kartläggning av den svenska kärnvapenforskningen under perioden 1945-1972. IAEA blev intresserat av projektet och accepterade det som ett stödprogramsprojekt för att stödja implementeringen i Sverige av tilläggsprotokollet till kontrollavtalet mellan EU:s icke-kärnvapenstater, EU-kommissionen och IAEA. Det huvudsakliga syftet med tilläggsprotokollet är att göra IAEA:s kontrollsystem mer effektivt gällande kärnämnen, kärntekniska anläggningar och kärnenergiforskning.

Andra stater har nu visat intresse att följa det svenska exemplet att göra historiska kartläggningar. Det huvudsakliga målet är att ta fram relevant information för IAEA som kan användas för att stärka och förfina kontrollsystemet inom ramen för tilläggsprotokollet.

Det första syftet med denna rapport är att sammanfatta den svenska historiska kartläggningen, samt att redovisa för andra liknande projekt i andra länder.

Rapportens andra syfte är att presentera en modell för hur en nationell kartläggning kan göras. Modellen är baserad på svenska erfarenheter och har skapats för att utgöra allmänna riktlinjer för andra länder i deras strävanden att förbättra sina kontrollsystem inom ramen för tilläggsprotokollet. Eftersom andra stater har påbörjat liknande historiska studier, har SKI beslutet sig för att utarbeta en generell modell. Estland, Lettland och Litauen deltar redan i ett projekt under ledning av SKI som avser att göra historiska kartläggningar. Också Finland arbetar på en nationell genomgång av landets kärnenergiaktiviteter i det förflutna. Även om det finska projektet utförs oberoende, så äger ett informationsutbyte rum mellan SKI och dess finska motsvarighet, STUK.

Det tredje syftet är att utveckla en pedagogik som kan användas i utbildning och träning av forskare och tjänstemän vilka avser att göra nationella kartläggningar. Två utbildningskonferenser har redan hållits. Denna pedagogik presenteras och diskuteras mot bakgrund av dessa erfarenheter.

Denna rapports fjärde syfte är att redovisa för en kompetensprofil över tänkbara samarbetspartner i Sverige och i andra stater, vilka antigen kan delta som föreläsare i utbildningsprogram eller på annat sätt kan bidra i arbetet med att utföra historiska kartläggningar.

Slutligen är det femte syftet att sammanställa en lista och litteratur och hemsidor över vissa staters kärnenergi- och kärnvapenforskning. Denna lista redogör huvudsakligen för litteratur, databaser och ”web”-sidor som tar upp kartläggningsaktiviteter i ett övergripande perspektiv.

# 1. Introduction

## 1.1. The aims of the report and the issues it deals with

In 1998, SKI initiated a project to conduct a historical survey of the Swedish nuclear weapons research for the period 1945-1972. The survey is now complete and contains three reports.[2] The IAEA became interested and accepted it in 2000 as a support program project to increase transparency and to support the implementation of the Additional Protocol in Sweden. The Additional Protocol, signed by the Swedish government in 1998, is an addition to the Safeguards Agreement between the non-nuclear weapon states in EU, the EU-commission and the IAEA. The purpose of the Safeguards Agreement is to verify the fulfilment of the obligations of the Non-Proliferation Treaty (NPT) of nuclear weapons. The main purpose of the Additional Protocol is to make the IAEA control system more efficient with regard to nuclear material, facilities and research. The exigency to create a more efficient safeguard system arose in 1991 when it became evident to the world that Iraq had made preparations to manufacture nuclear weapons despite its obligations within the NPT and having signed a safeguards agreement with the IAEA (about the NPT and the Additional Protocol, see chapter 3.1).

Other countries have now shown interest to follow the Swedish example and to make their own reviews of their past nuclear energy and nuclear weapons research. The most important aim is to produce basic information for IAEA on the nuclear activities of the past and to refine and strengthen the instruments of the Safeguard System within the Additional Protocol. The IAEA Task outline of January 24, 2001, charts out the aims in the following way:

The department "Safeguards Concepts and Planning" at IAEA will utilise the results of this task to obtain a generic set of concepts to be used when formulating technical policies related to

a) The impact of the past nuclear activities in triggering questions or inconsistencies resulting from
   - Assessing a State's declaration under Article 2 of INFCIRC/540 (Corrected);
   - Implementing complementary access; and
   - Performing comprehensive State evaluation
b) The added value of sharing knowledge of past nuclear activities to nuclear transparency, thus facilitating achieving a conclusion about the absence of undeclared nuclear material and activities.

In the task outline formulated by the IAEA, there are mainly four elements that should be considered:

[2] Jonter, Thomas, *Sverige, USA och kärnenergin. Framväxten av en svensk kärnämneskontroll 1945-1995* (Sweden, USA and Nuclear Energy. The emergence of Swedish nuclear materials control 1945-1995). SKI Report 99:21; *Sweden and the Bomb. Swedish Plans to acquire Nuclear Weapons, 1945-1972.* SKI Report 01:33; *Nuclear Weapons Research in Sweden. The Co-operation Between Civilian and Military Research, 1947-1972*, SKI Report 02:18.

1. Compilation of list of national laws and directives addressing civil and military programmes (for a presentation of the Swedish legislation, see appendix 1);
2. Description of the nuclear and nuclear-related material and activities performed during the period under consideration;
3. Description and analysis of the State's role and interactions in the area of international non-proliferation (see chapter 2.2):
4. Compilation of a list of the national archives relating to both civil and military nuclear energy activities (see appendix 2).

It is important to note that the Additional Protocol does not compel State Parties to the NPT to carry out such historical reviews. Nevertheless, The Additional Protocol stipulates that member-states have an obligation to give an account of current activities, and to furnish information about approved future activities relevant to the development of the nuclear fuel cycle (including planned nuclear fuel cycle-related research and development activities).

However, the SKI has taken a step further to also include what took place in the past, and to report openly on the Swedish nuclear weapons research since 1945.

The first objective of this report is to present a short summary of the Swedish historical survey, as well as similar projects in other countries dealing with nuclear-related and nuclear weapons research reviews. These tasks are dealt with in chapter 2.

Secondly, the objective is to present a general model of how a nationally base survey can be designed. The model is based on the Swedish experiences and it has been designed to also serve as a guideline for other countries to strengthen their safeguards systems within the framework of the Additional Protocol. Since other States declared that they would make similar historical surveys, the SKI decided to work out a model that could be used by other countries intending to conduct such studies. Estonia, Latvia and Lithuania are participating in a co-operation project to carry out such nationally base surveys under the auspices of the Swedish Nuclear Power Inspectorate. Finland is also conducting such a survey, but it is done independently, albeit in close exchange of views between SKI and its Finish counterpart, STUK. This is described in chapter 3.

The third objective is to develop a pedagogic methodology for teaching and training researchers and officials about to start nationally base surveys. In chapter 4 the method is described. Two training courses have already been conducted. Based on the experiences from these courses the methodology will be explained and discussed.

The fourth objective of this report is to make a competence profile of prospective co-operative partners in Sweden and in other countries, who either can be used to develop training programs, or assist in carrying out the historical surveys. This task is dealt with in chapter 5.

Lastly, the fifth objective is to compile a list of literature dealing with reviews of certain States' nuclear energy and past nuclear weapons research. The compilation will concentrate on literature, which specifically concerns survey activities in a larger and comprehensive perspective. This task is dealt with in chapter 6.

## 1.2. Similar Non-Proliferation surveys in the world

There exists, of course, several research projects that deal with historical analyses of non-proliferation in broad terms.[3] However, to the best of my knowledge, besides the project presented in this report there exists only one other project dealing with nationally base surveys to make assessments of certain States' efforts and capabilities to manufacture nuclear weapons (i. e. how much nuclear materials was used, what facilities were in operation to produce plutonium, U-235 and heavy water, and analysis of the conducted research[4]). This project is run by the Center for Non-Proliferation Studies (CNS) in Monterey, USA:

*Status Report: Nuclear Weapons, Fissile Material, and Export Controls in the Former Soviet Union*.[5]

The project publishes an updated report on Russia's nuclear arsenal and stockpile, the status of fissile material at other sites in the former Soviet Union, and the progress of U.S. non-proliferation assistance programs. The report contains comprehensive details on:

1. The past, current, and future size and composition of the Russian nuclear arsenal;
2. All known facilities possessing nuclear weapons-usable materials;
3. The extent of U.S. and international non-proliferation assistance;
4. The history of U.S.-Russian arms control treaty negotiation and implementation;
5. The current state of nuclear export controls in key ex-Soviet republics;
6. The location of major nuclear facilities in the former Soviet Union.

The main focus is on the nuclear activities after the collapse of Soviet Union in 1991. The SKI project in this respect can be seen as complementary, since its main perspective is centred on the activities during the cold war when Soviet Union still existed.

[3] Several universities are dealing with nuclear weapons nonproliferation issues in broad terms. See, for example, Belfer Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University, is running a project and its project "Managing the Atom".

[4] Intelligence organizations like the CIA, are probably engaged in such assessments, but these reviews are not open to the public.

[5] Center of Nonproliferation Studies: http://cns.miis.edu

# 2. Review of the Swedish nuclear weapons policy

## 2.1. Swedish nuclear weapons research: a general background

To understand the nature of the Swedish nuclear-related activities, and especially the Swedish plans to produce nuclear weapons, a brief overview is needed. The Swedish plans to produce nuclear weapons, which were fully abandoned in 1968 when the Swedish government signed the NPT, was based on a dual-purpose technology. The production of nuclear weapons was designed as a part of the civilian nuclear energy development.

A civil company, AB Atomenergi (AE), was created in 1947 to deal with the civil industrial development. The company conducted research and built facilities such as reactors and a fuel fabrication plant, which were also designed to suit possible future production of nuclear weapons.

The Swedish National Defence Research Institute (FOA), which was responsible for the military use of nuclear energy, began with nuclear weapons research as early as 1945. Admittedly, the main aim of the research initiated at this time was to find out how Sweden could best protect itself against a nuclear weapon attack. However, from the outset FOA was also interested in investigating the possibilities of manufacturing what was then called an atomic bomb. FOA performed an extended research up to 1968, when Sweden signed the NPT, which meant the end of these production plans. Up to this date, five main investigations about the technical conditions were made by FOA, in 1948, 1953, 1955, 1957 and 1965, which all together expanded the Swedish know-how to produce a bomb.[6]

In the beginning of 1950's the nuclear weapons research was not public issue. However, in 1954, when the Swedish Supreme Commander advocated nuclear weapons, this research became the object of political discussions and conflicts.[7] Resistance to these plans began to emerge among the public, in parliament and even among the government, where Prime Minister Tage Erlander had been in favour of acquiring nuclear weapons well into the 1950's.[8] Not only Sweden as a whole, but also the social democratic movement, was divided on the issue. For this reason, a bill was drafted which laid down a period for consideration. This meant that Sweden could postpone a decision on the issue. According to the bill, the reason for the consideration period, or freedom of action as it has also been called, was that research had not reached the technical level at which a decision could be taken on the issue.[9] The bill laid down that, for the time being only protection research could be done, excluding research aimed directly at producing nuclear weapons. The parliament passed the bill in July 1958. However, a door was left

[6] In addition to these investigations the Swedish defence made its own study in 1962, namely "Kärnladdningsgruppens betänkande (The nuclear device group), HH 066. Declassified according to government decision Fo 95/2454/RS.
[7] *Alltjämt starkt försvar. ÖB-förslaget 1954* (ÖB 54); Kontakt med krigsmakten 1954:9-10.
[8] Erlander, Tage, *1955-1960*, Stockholm 1976, pp. 75-101.
[9] Bill 1958:110.

open for development research in the future. This door was closed when Sweden signed the NPT in 1968.

Did FOA stay within the limits of the protection research as regulated by the government? Over the years, this question has been the subject of debate and a government report. A vital task for this project was to analyse whether FOA exceeded the defined limits. Another important issue was to inquire if the plans to produce nuclear weapons were fully abandoned in 1968.

## 2.2. Conclusions of the Swedish historical survey

The results of my research can be summarised in mainly seven findings. The first deals with the United States nuclear weapons policy towards Sweden. The US policy can be analysed in two periods. In the first period, 1945-1953, the US policy towards Sweden followed the same pattern as towards the rest of Western Europe. The most important aim was to discourage and hopefully prevent Sweden from acquiring nuclear materials, technical know-how, and advanced equipment that could be used in the production of atomic weapons. During this period the Swedish plans to produce her own nuclear weapons were still undeveloped. It was, for instance, not a debated issue among political organisations or in the media.

The first priority of the US administration at this time was to discourage the Swedes from exploiting their uranium deposits, especially for military purposes. In the eyes of the Swedish actors, the US policy was considered too restrictive. As a result of this restrictive policy, Swedish researchers developed co-operation with other nations, especially with Great Britain and France. The first Swedish research reactor was actually constructed with assistance and help from the Commissariat á l'Energie Atomique (CEA).

In the next period, 1953-1960, the US policy was characterised by extended aid to the development of Sweden's nuclear energy program. Through the "Atoms for Peace"-program, the Swedish actors now received previously classified technical information and nuclear materials. Swedish companies and research institutes could now purchase enriched uranium and advanced equipment from the United States. This nuclear trade was, however, controlled by the United States Energy Commission (USAEC). The US help was designed to prevent Sweden from developing nuclear capability. The second Swedish research reactor facility, located in Studsvik and completed in 1959, was in fact constructed with US financial help and technology.

From the mid-1950's onward, Swedish politicians and defence experts realised that a national production of atomic bombs would cost much more than was estimated some 4-5 years earlier. Consequently, the Swedish officials started to explore possibilities of acquiring nuclear weapons from United States. The Swedish defence establishment assumed that even though Sweden was not a member of NATO, it would be in the US interest that the Swedish defence was as strong as possible to deter a Soviet attack.

The US administration reacted negatively to these Swedish plans. The US jurisdiction made it impossible to sell to Sweden or even to allow Sweden to possess American nu-

clear weapons. The official policy was based on the Atomic Energy Act which permitted the US government to contribute to other nations' nuclear weapons capability only if the country in question had a mutual defence agreement with United States. American officials claimed that this was not the case with neutral Sweden.

The Swedish inquiries regarding the acquisition of American nuclear weapons took place from 1954 to 1960. Although the American administration adopted a negative attitude towards these Swedish ideas from the beginning it, nevertheless, became a dilemma for the US government. Equipping the Swedish defence with US nuclear weapons was considered as a better alternative to allowing Sweden to produce her own nuclear weapons. Expert opinion within the State Department was of the consensus that, the first alternative, the US administration would have at least control over the use of the bombs; while allowing Sweden to produce her own nuclear weapons would make it harder to control.

With this risk in mind, the National Security Council (NSC) decided in April 1960 that the United States should not provide Sweden with nuclear warheads. In theory, of course, it was possible for Sweden to develop a nuclear weapons program by themselves, but it was not deemed likely by the NSC. A Swedish nuclear weapons program would cost too much for a small country like Sweden, the NSC concluded. Furthermore, such a Swedish weapons program would be dependent on American goodwill and assistance, i.e. certain materials and advanced equipment had to be imported from the United States.

The second finding of this research project considers the extent of how much the Swedish nuclear program was controlled internationally by inspections of nuclear materials and reactors in Sweden. From 1960 to 1972, it was only the United States, through the Atomic Energy Commission, which carried out inspections of nuclear materials of US origin.[10] In the period 1972-1975 the IAEA inspected materials of US origin. From 1975 and onwards all nuclear materials have been subject to IAEA control under a comprehensive safeguards agreement. In addition to this account of the international inspections taken place in Sweden, several compilations concerning the nuclear management were made:

1. A list of the Swedish laws and directives which have regulated the use of nuclear material and heavy water in Sweden 1945-1995 (for a brief summary, see appendix 1);
2. An enumeration of all the international agreements and conventions on the nuclear energy field signed and ratified by Sweden 1945-1995.[11];
3. A list of archives containing documentation on the Swedish nuclear energy development, both for civilian and military use (for a brief summary, see appendix 2).

The third conclusion deals with the nuclear weapons research carried out by the FOA and AE. Was the protection research the only research that was performed? The conclusion of this report is that FOA went further in its efforts to make technical and economic estimates than the defined program allowed, at least in a couple of instances. The find-

[10] Jonter, Thomas, *Sverige, USA och kärnenergin. Framväxten av en svensk kärnämneskontroll 1945-1995* (Sweden, USA and nuclear energy. The emergence of Swedish nuclear materials control 1945-1995). SKI Report 99:21, p. 52.
[11] Ibid., pp. 45-51.

ings in this analysis support the assumption that it was a political game that made the Swedish Government to introduce the term *protection research* to eschew criticism, while in practical terms some design-oriented research was encouraged to obtain technical and economic estimates for a possible produ ction.

The fourth finding of this research project is that Sweden reached latent capability to produce nuclear weapons in 1955. This is at least two years earlier than what is normally claimed in the international literature on nuclear proliferation. For example, in Stephen M Meyer's classic study "The Dynamics of Nuclear Proliferation", Sweden is said to have reached latent capability in 1957. Meyer's study refers to another study in this respect. An analysis of the declassified documents from FOA concludes that this is at least two years too late. [12]

The fifth result of this project is the review of the de-commissioning of the nuclear weapons research in Sweden after the NPT was signed in 1968. The report concludes that the de-commissioning of all facilities and soil was completed in 1972 [13].

The sixth result is an account for how much plutonium, natural and depleted uranium and heavy water FOA and AE had at their disposal within the research program during the period 1945-1972. The result of this investigation concerning FOA is presented in the report *Sweden and the Bomb. Swedish Plans to Acquire Nuclear Weapons, 1945-1972*. The amount of plutonium at FOA was about 600 gram as maximum. After 1972 there has been no plutonium at FOA. The amount of highly enriched uranium has been less than 100 gram.[14] The plutonium used by FOA for research was transferred to AE The last delivery took place on December 20, 1972.[15]

As already mentioned, a co-operation between FOA and AE was initiated. The civil nuclear energy programme should be designed in such way that it could include a Swedish manufacture of nuclear weapons, provided the Swedish parliament took a decision in favour of such an alternative. With a certain technique – which implies frequent changes of fuel batches – even weapons-grade plutonium could be obtained and combined with energy production for civilian purposes. The main tasks for AE within this co-operation are listed until 1968 when these plans were abandoned after Sweden signed the NPT. However, it was not analysed in detail what AE actually did for FOA, and what amounts of nuclear materials AE used in the research. But it is clear that AE had plutonium and other material that was used in context of FOA research. The data on the nuclear materials that AE had at its disposal is provided in the report, *Nuclear Weapons Research in Sweden. The Co-operation Between Civilian and Military Research, 1947-1972*. In total, AE had 12 208 g of plutonium at its disposal (including the plutonium borrowed from abroad) between 1963 and 1969.[16] (The figures are shown on pages 15 and 16). At the most AE had 202 tonnes of heavy water at its disposal which was in 1968. What happened to the heavy water when the heavy reactor water technology was abandoned in Sweden? The main part was sent to facilities in Canada and the

[12] Jonter, Thomas, *Sweden and the Bomb. Swedish Plans to acquire Nuclear Weapons, 1945-1972.* SKI Report 01:33.
[13] Ibid.
[14] Ibid., p.81.
[15] Ibid., p. 4.
[16] Jonter, Thomas, *Nuclear Weapons Research in Sweden. The Co-operation Between Civilian and Military Research, 1947-1972,* SKI Report 02:18, pp. 63-65.

United States. The Canadian AECL received 164 472 kg on October 15, 1970. This heavy water was intended to be used in the Marviken reactor. On August 28, 1974, 23 000 kg was dispatched to Canada and 25 155 kg to the United States (USAEC).[17]

The seventh outcome of this project is an account of the reactors and other facilities where nuclear materials activities (especially with plutonium, enriched uranium and heavy water) have taken place at AE. In an appendix to the report, a list of all these facilities is presented.[18]

## 2.3. Sweden's role and activities in the area of international Non-Proliferation.[19]

Sweden is sometimes described as an example of a State which had a nuclear weapons development programme but in the end decided not to manufacture nuclear weapons. Results of the nuclear weapons research that Sweden conducted before 1968 could, after the signing of the NPT, are used in the banner of non-proliferation. Accordingly, the Swedish government became a strong and competent actor in the international efforts to work against the spread of nuclear weapons. However, one shall not forget the fact that prior to 1968, Sweden was engaged in the international efforts to control the use and development of nuclear weapons. In the end of 1940's, the Swedish government strongly supported the negotiations within UN to find out a way to put the existing US nuclear weapons under international control in return of all other States' pledge to refrain from acquiring nuclear weapons capability. Even if these efforts came to nothing, Sweden became active and supportive in other attempts to control or stop proliferation.

It was under the Swedish chairmanship of Dr Sigvard Eklund that the first Geneva conference was held in 1955 on the Peaceful Uses of the Atom. The Geneva conference was convened with the purpose of establishing an international organisation that would help countries in the world to initiate research in the field of civilian nuclear energy.[20]

It was obvious from the outset that IAEA could not solve all the non-proliferation issues immediately. Different proposals on how IAEA should proceed were formulated in the coming years. Ireland came out with the first proposal to establish a non-proliferation treaty. Sweden was also actively engaged in this area and proposed in 1961 the establishment of an open-ended non-atomic club and played a very active role in the NPT negotiations that lasted until 1968.

The country's efforts developing and strengthening the non-proliferation field has continued. New initiatives and proposals have been formulated by Sweden within the NPT Review Conferences, the First Committee of the UN General Assembly, and the Con-

[17] Work documentation of deputy head of the Office of Nuclear Non-Proliferation, Göran Dahlin, SKI, during the years 1987 to 1988.
[18] Ibid., pp. 67-68.
[19] This chapter is mostly based on van Dassen, Lars, *Sweden and the Making of Nuclear Non-Proliferation: From Indecision to Assertiveness*. SKI Report 98:16, and Prawitz, Jan, *From Nuclear Option to Non-Nuclear Promotion: The Sweden Case*. Swedish Institute of International Affairs, Research Report 20, 1995.
[20] In 1961, Sigvard Eklund became the second Director General of the IAEA. He remained in his post for 20 years, leaving the Agency on 30 November 1981.

ference on Disarmament. During the negotiations on the Comprehensive Test Ban Treaty in the Conference on Disarmament in 1993, Sweden played a very vital role.

Sweden has also played an important role in the process of enhancing the efficiency of the safeguards aspects of the NPT. In this respect, the Swedish proposal to develop the Additional Protocol is worth mentioning (for the background and functioning of the Additional Protocol, see chapter 3).

In the late 1960's, Sweden joined an informal multilateral co-operation on nuclear export controls with the US, Britain, Canada and a few other States capable of exporting advanced nuclear technologies. In this area, Sweden has continued its efforts to create a more efficient export control system. For example, Sweden has been a strong co-operating partner within the Zangger Committee and the Nuclear Suppliers Group(NSG) since the 1970's.

After the collapse of the Soviet Union, it became obvious that several new States were in need of support in the non-proliferation field. Sweden has developed various support programs since 1992. SKI is the responsible body to carry out these support programs in Central and Eastern Europe in order to strengthening their capacity to prevent the spread of nuclear weapons.[21] Since 2001 the name of this co-operation project is Swedish Nuclear Non-Proliferation Assistance Programme (SNNAP). Several activities have been conducted and/or realised in this co-operation program. Worth mentioning is the establishment of national export systems in the Baltic Sates, the initiated national and regional based co-operation system to fight illicit trafficking of nuclear material, the creation of a modern legislation in the nuclear energy field in Russia, and various technical support in order to create a more efficient safeguards system in the former Soviet Union States. The co-operation between SKI and the relevant authorities of the Baltic States to carry out historical surveys in the non-proliferation field is a part of the SNNAP support program.

[21] A presentation of the support program, see Lars van Dassen, "Öst-stödprogram för nukleaär icke-pridning", *Nucleus*, 2002:1.

# 3. How to make a nationally base historical survey of Non-Proliferation

## 3.1 The Additional Protocol – general background

How can proliferation of nuclear weapons be checked and even stopped? The main tool is the commitments expressed in the Non-Proliferation Treaty (NPT). There are, however, other methods that can be employed to prevent States from acquiring nuclear weapons. To use of military force is one way, which has been a topic of lively debate in the case of Iraq. Another way in combating the proliferation of nuclear weapons is to use nationally base export control systems. The international co-operation on export control between nations is organised through the so-called international regimes. An international regime, or more specific a control regime, is an organised co-operation between several States sharing common values and objectives. In the nuclear energy field we have, for example, the Zangger Committee and NSG, two control regimes which have been created as to reduce illegal traffic of nuclear materials and nuclear technology. However, it is important to emphasise that a regime co-operation is a political and *not* a legal commitment. Consequently, international sanctions can not be enforced if a State is violating a regime's undertakings. The political commitment means that the country in question has promised to adjust the national legislation to be in line with the goals and purposes of the control regime.[22] These international regimes are often seen as complements to the NPT.

The NPT has today been adhered to by all States of the world but four (188 States have signed. India, Israel, Pakistan and East Timor are the only exceptions) and consists of eleven Articles. The treaty forbids nuclear weapons states (NWS) to transfer nuclear weapons devices or help non-nuclear weapons states (NNWS) to produce such weapons. Moreover, the NPT forbids NNWS to acquire nuclear weapons, and in accordance with the Article 3, NNWS have to conclude a safeguards agreement with IAEA. The Safeguards Agreement gives the IAEA the right to carry out inspections in the State Parties to control a State's possession of nuclear materials such as uranium and plutonium. Furthermore, the NPT stipulates that each member-state shall not supply nuclear material or facilities to a nation that has not concluded a safeguards agreement with the IAEA.

Even though the NPT, which has been in force since 1970, has meant a step forward in the non-proliferation area, it is obvious that the treaty and its application have its weaknesses. Despite the fact that Iraq has signed the NPT and a safeguards agreement was in force, the Iraqis were able to fool the system. Following the Gulf war in 1991, the UN inspectors found out that Iraq had built facilities for the clandestine manufacture of nuclear weapons. It became obvious that the IAEA control system was not strong enough to guarantee that a State is not violating the Treaty clandestinely.

[22] For a discussion of the international export control in the nuclear energy field, see Hildingsson, Lars, "Exportkontroll inget modernt påfund", *Nucleus*, 2002:1.

After discussions in the IAEA General Assembly a decision was taken to change and make the nuclear material control system more efficient. As a result, a model of an extended and more efficient safeguards system has been designed - INFCIRC/540 (Additional Protocol). This model is written as an addition to the safeguard agreements, and the intention is that all State Parties who have safeguards agreements with IAEA will sign and implement it.[23] The main purpose of the Additional Protocol is that the State Parties will deliver more information to IAEA and that the Agency has an extended right to conduct inspections. The State is obliged to provide IAEA with, for example:

- Information on research and development activities regarding transformation/enrichment of nuclear material, production of nuclear fuel, reactors, reprocessing of nuclear fuel
- Relevant information on control of nuclear material which is listed by IAEA
- A general description of all buildings on each site. The description shall include a map of the site
- Information specifying the location, operational status and the estimated annual production capacity of facilities such as zirconium tubes and reactor control rods, uranium mines and concentration plants, and thorium concentration plants
- Information regarding quantities, uses and locations of nuclear material exempted from safeguards pursuant to Article 36 (b) and 37 of the Safeguards Agreement
- Information regarding export and import of specific facilities and non-nuclear material
- General plans for the succeeding ten-year period relevant to the development of the nuclear fuel cycle (including planned nuclear fuel cycle-related research and development activities).[24]

## 3.2 The Additional Protocol – how it can be used

Can a historical survey of a State's nuclear related past serve the implementation process of the Additional Protocol? And what other advantages can be gained from reviewing certain States' nuclear energy and nuclear weapons research in the past?

The main purpose is to increase transparency. The Additional Protocol was designed to enhance the possibilities to control the State Parties activities to create a higher level of trust and confidence in the overall control system. The implementation processes of the Additional Protocol means that different countries will be "mapped" by the IAEA, scrutinising all nuclear activities, present as well as future plans. Sweden, Finland, Latvia, Lithuania and Estonia have chosen to go a step further and also include what took place in the past. Although the Additional Protocol does not compel member states to carry out such historical reviews, these States have decided to report openly on nuclear weapons research since 1945.

[23] *Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards, INFIRC/540*. IAEA 1998.
[24] About the Additional Protocol and how to implement it, see Larsson, Mats, "Integrerad safeguard-Effektivare kontroll trots färre inspektioner", Nucleus 2000:3-4.

A transparency which also includes the past nuclear related activities should not just only be seen as a certain individual State's principal willingness to show openness. More importantly, the account of the historical activities can serve as a help to support the new and better safeguards control system in a concrete and practical level. For example, a routine control by an IAEA inspector might reveal inconsistencies and uncertainty of the accounts regarding the nuclear material in a reactor plant in a specific country. To solve the problem it might be necessary to go through documents from the past, before the State *per se* signed the control system agreement with the IAEA. In fact, in this particular example, the IAEA inspector has the right according to the Additional Protocol to be provided with valid documentation in order to verify matter and establish the reason for the incorrect information. If an historical survey of the State's nuclear energy activities had been made in this specific case the problem might have been addressed at once. In other words, a review of a State's nuclear past can not only be of help to solve concrete problems but also be used as an instrument to prevent uncertainties and inconsistencies from occurring.

For this reason, the co-operation projects between Sweden, Estonia, Lithuania, Latvia to make historical surveys of nuclear energy activities have been based on one essential criterion: *each State has declared the tentative willingness to submit the results of the conducted historical survey of its nuclear energy activities as a part of the State Declaration according to the Additional Protocol.*

The Additional Protocol constitutes a wide range of obligations and rights. There is no need to concentrate on all information that is asked for in the articles when an historical survey is about to be conducted. For example, there is probably no need to look for information about specific tubes and pumps that were used for certain reactor solution in the 1960's even though the Additional Protocol includes this in its model. Every individual State has its own specific history and it is hard to generalise when a manual of how to carry out a review of the past should be formulated.

However, the Additional Protocol stipulates certain areas, which can serve as a guideline for all participating countries' nationally base reviewing of nuclear related activities. In the case of Sweden, the plans to acquire nuclear weapons are central for the analysis. For this reason, the Swedish studies are focused on nuclear weapons research and the plans to produce weapons-grade plutonium within a natural uranium heavy water reactor system.

Finland had no plans to manufacture nuclear weapons but had reluctantly accepted a co-operation pact with Soviet Union in 1948. As a result of this Finnish-Soviet co-operation pact, it became important for Finland to proceed cautiously in the relation with Soviet Union to avoid being dragged into a nuclear weapons conflict. Therefore, the Finnish study will be focused on how the non-proliferation policy was used as a tool to alleviate the Soviet nuclear weapons strategy in the region. In addition, the Finnish report like the Swedish studies will also include information such as facilities where nuclear related activities took place, and account for the national legislation concerning the management of nuclear material.[25]

[25] See Arno Ahosniemi, "The History of Finnish Nuclear Non-Proliferation During the Cold War". Paper presented at Seminar on How to Make National Based Historical Surveys of Non-Proliferation of Nuclear Weapons, Stockholm, September 16-18, 2002; "Non-Proliferation History of Finland", paper presented at Nordic Society for Non-Proliferation Issues, Bergen, Norway October 16-17, 2002.

The historical survey of Estonia will, on the other hand, be focused on mainly two issues: i. e. the uranium mining and milling at the Sillamäe plant, and the activities at the Soviet naval training center at Paldilski. The Lithuanian nuclear experience is somehow different to that of Estonia. Accordingly, the Lithuanian study will probably focus on the Ingnalina reactor plant and the dismantling of Soviet nuclear weapons in Lithuania (as well as decommissioning of these sites).

The Latvian survey will deal with the dismantling of Soviet nuclear weapons on Latvian territory.

In addition, there are other reasons to carry out historical surveys besides increasing transparency. For instance, an account for the plutonium, U-235 and heavy water holdings of the past can serve as a means to combat illegal trafficking of nuclear materials which can be used in a nuclear weapons manufacture. In the same way, an historical survey can also include documentation of research data, facilities and other components, which can be used to produce basic information for manufacture of nuclear explosive devices. After the collapse of Soviet Union, we know that some nuclear materials and research devices got adrift.[26] Are there still nuclear materials adrift and how much is possibly out in the black market? A thorough scrutiny of the past nuclear- related traffic in countries previously being parts of the Soviet Union, as well as in other countries, could in this respect be used as a tool to prevent that such materials and components falling into wrong hands. Furthermore, such historical reviews can be used as instruments to assess how many and how strong nuclear weapons are theoretically possible to produce by terrorists and rouge States.

Another reason to carry out historical reviews is that it will develop competence in nuclear energy matters and provide the knowledge on each State´s past nuclear experience in particular. This enhanced knowledge will probably make the processes of implementing the Additional Protocol more smooth and enable a more efficient future safeguards systems control to evolve.

[26] See for example, Maerli, Morten Bremer, *Atomterrorisme*. Norsk utenrikspolitisk institutt 1999.

# 4. A model on how to make nationally base historical surveys. Examples taken from the Swedish study

In this chapter the method to develop a pedagogic methodology for teaching and training researchers and officials about to start nationally base surveys is described. Sweden has arranged two training courses. Based on the experiences from these courses the methodology will be explained and discussed.

## A. General inventory of accessible information

In the case of the Swedish survey, the first objective was to make a general inventory of the nuclear operations in the country since 1945. How could this be done without too much time-consuming archive work? A general overview was needed which was not to be found in Sweden, but across the Atlantic in the gigantic archive National Archives in Washington, DC. The reason for this was that United States' global nuclear energy policy since World War II was designed to prevent proliferation of nuclear weapons. The US administration collected extended information about all nations' nuclear energy activities. The United States Atomic Energy Commission (USAEC) which was responsible for the nuclear trade, particularly since the "Atoms for Peace"-programme was launched in the mid-1950's, followed every participating nation's developments in this respect. Detailed reports were sent to the US government regarding the progress of the Swedish nuclear energy operations, especially after the mid-1950's when Sweden embarked on serious plans for the production of nuclear weapons.

On several occasions the US archives have given detailed information on Swedish issues that are scarcely found in Sweden. The most spectacular example is from the end of the 1950's. In the US files, I found exhaustive reports on how the Swedish military, diplomats and researchers belonging to the military establishment started to explore the possibilities of acquiring nuclear weapons from the United States. The Swedish available archives hardly have any information about these talks. There is not enough room here to explain the reason behind this silence. A bold guess is that the Swedish non-aligned policy made the officials cautious when documenting sensitive information in foreign policy matters.

Going through the reports and analysis by the State Department, CIA and USAEC gave me the general picture that I was seeking for. Through this archive research I could study organisation charts of the Swedish nuclear energy projects, identify key people involved in the activities, and even trace the dates when important meetings were held. The reports gave me useful information to follow up in the Swedish archives. Most important, they have provided me with well-informed summaries and evaluations of the aims and capabilities of the Swedish nuclear development. In this context, it is crucial to understand that at this time much of the documentation concerning nuclear weapons related research conducted by the Swedish National Defence Research Institute (FOA) was classified.

It is likely that other States with which United States co-operated in the nuclear energy field have similar sensitive aspects, which have not been documented. Regarding the Baltic States, the nuclear energy and nuclear weapons related issues were only dealt with by trusted Russians during the cold war. The expert groups who will carry out the historical surveys in Estonia, Latvia and Lithuania will probably have to go to Russia and Moscow to look for valid information. In their efforts to find detailed documentation of the their nuclear pasts, they will have to make these archive trips to Russia. Most likely, the major portion of the essential information concerning nuclear related research taken place in the Baltic States will be found in Russia.

## B. To make a profile of a State's nuclear energy research

After making a general inventory based on the American documentation, I could start the work in the Swedish archives to map out how the nuclear energy projects have been organised since 1945. An important task was to locate the concerned government authorities, organisations, private companies, universities and research institutions involved in the activities, and who wielded authority at different times. To what extent were these organisations and companies involved in nuclear research and development? This part of the survey can be of much help in tracking the information and documentation, which is otherwise hard to find.

## C. Compile a list of laws regulating the use of nuclear materials and heavy water

Another aspect of a State organising its nuclear energy research deals with the emergence of a national legislation on the management of nuclear materials. In the case of Sweden, the task was to make a list and summarise the national laws that have regulated the use of nuclear materials and heavy water since 1945 (see appendix 1). Essential questions are; how have the import and export regulations been designed since 1945? Who has had the permission to use sensitive nuclear materials and under what conditions?

In this context, it is also important to study the official secret acts and additional regulations, and especially how they work in practice in the archives, which contain documentation on nuclear-related and nuclear weapons research. That the national legislation stipulates certain rule is one matter, it can be a quite different matter how it works in practice. How do the routines work regarding those who will have access to certain archives containing technical information, which can be used for a manufacture of nuclear weapons?

## D. Compile a list of international agreements and conventions

To make a profile of a State's nuclear energy research and non-proliferation policy more complete, a list of all international agreements and conventions in the nuclear energy field which have been signed and ratified has to be included.

## E. Compile a list of bilateral agreements in the nuclear energy field

Additionally, a list of bilateral agreements in the nuclear energy field between Sweden and other states was compiled. It is also important to notice that not all the necessary co-operation went through bilateral (government controlled) agreement procedures. If a State used other procedures it is, of course, important to find documentation on this co-operation to make a reliable survey.

## F. The emergence of a nuclear materials control system

How was the control system organised before NPT entered into force? Based on the first exposition of the Swedish archives, as well as a comparison with the US general picture, it was now possible to make a first review of the Swedish nuclear activities. This archive research was combined with a study of government reports and literature on the emergence of the Swedish nuclear energy and nuclear weapons research.

Sweden had a long history prior to the enforcement of the IAEA Safeguards system, which took place in 1975. Initially, the control system for nuclear material and reactor facilities was worked out in the company, AB Atomenergi (AE), which was responsible of the development of civilian nuclear energy. Going through the protocols, research and annual reports in the archives at Studsvik (former AE), the contours of the pre-safeguards system emerged.

Now it was possible to start analysing how the Swedish nuclear materials control system has been developed over the years. This includes a list of international inspections of nuclear materials and nuclear facilities in Sweden. An important aim was to show how the early inspection routines were worked out, and how they developed later on, especially with regard to the co-operation with the US and IAEA.

Additionally, an important task was to account for the possessions of nuclear materials and heavy water that were at disposal of different companies and authorities until the safeguards agreement with IAEA came into force. This is especially essential regarding nuclear materials that can be used for manufacturing nuclear weapons, such as weapons-grade plutonium and highly enriched uranium (HEU). In addition, a survey can investigate into what has happened to the nuclear materials and the heavy water after it was used.

Another urgent task was to check whether nuclear materials existed that were not accounted for in the information handed over to the IAEA.

Table 4.1 below provides an example (from the Swedish survey) of what a State's possession would look like before the safeguards agreement with IAEA went into force:

**Table 4.1 Possessions of plutonium: 1956-1972**[27]

Import and export

| Date | Record number | Applier | Sender/Receiver | Subject |
|---|---|---|---|---|
| 630117 | AETR 18<br>AETR 442 | AE | USA | Import of 500 g Pu |
| 631025 | Rfk<br>TW6/Bik<br>AETR/AE | AE | USA | Export of 500 g Pu |
| 640824 | Rfk<br>AETR 48 | AE | United Kingdom<br>UKAEA | Import of 200 g Pu[28] |
| 650805 | Rfk<br>AETR 85 | AE | USA<br>USAEC | Import of 399 g Pu |
| 661012 | Rfk<br>AE/442<br>AETR 147 | AE | United Kingdom<br>UKAEA | Import of 404 g Pu[29] |
| 690210 | Rfk 5/69<br>AE/444<br>AETR /69 | AE | United Kingdom<br>UKAEA | Import and export of 8 000 g Pu |
| 690616 | Rfk<br>Div/442 | BRD | AE | 3 500 g Pu (1) |

(1) The last-mentioned figure for the year 1969 is related to the permission to transport 3 500 g plutonium. In the end, only 2.7 kg plutonium were imported.[30]

[27] Jonter 2002, p. 65.

[28] The plutonium was used for research purposes by FOA. For the amount of plutonium which FOA had at its disposal, see Jonter 2001, p. 77.

[29] Ibid.

[30] Hultgren, Åke, "The Plutonium Fuel laboratory at Studsvik and its activities". IAEA Symposium "Plutonium as a Reactor Fuel". Brussels, 1967; *Upparbetning av Ågestabränslet 1969*, September 1995, appendix 23.

Table 4.2 below illustrates how an account of a State's possession of heavy water can look like (from the Swedish nuclear survey):

**Table 4.2 AB Atomenergi's possession of heavy water: 1956-1972[31]**

| | |
|---|---|
| 1959 | 36 tonnes (26 tonnes from the United States and 10 tonnes from Norway). This amount was inspection-free, i.e. it could be used without control from the seller)[32] |
| | 50 tonnes[33] |
| 1967 | 115 tonnes |
| 1968 | 202 tonnes (of which 164 472 kg to be used in the Marviken plant was under inspection of United States)<br>The heavy water came mainly from three countries: the United States, the Netherlands and Norway. |

## G. Compile a list of archives concerning both civil and military nuclear activities

Another important task was to make a list of Swedish archives housing documentation about both civil and military nuclear energy activities (see appendix 2): such an archive should show in general terms what each archive contains, especially with regard to nuclear materials, facilities and equipment which could be used in a production of nuclear weapons. It is also important to investigate whether the archives in question are open for the public or for research.

## H. To make a list of reactors, facilities and laboratories where nuclear materials activities took place

To enable an evaluation of a State's latent capability to produce nuclear weapons, a list of all facilities where nuclear materials activities (especially involving plutonium, uranium and heavy water) took place have to be made. This list has also to account for where these reactors, laboratories and buildings are located, and the their technical capacities of these. The following example is taken from the third report of the Swedish survey[34]:

R 4 (Marviken) was a heavy water reactor, which was ready to be taken into operation in 1968, but the project, was abandoned. The reactor was firstly planned as natural ura-

[31] Jonter 2002, p. 64.
[32] "Möjligheterna att hålla R3/Adam inspektionsfri", 5 February 1959; "AE Utredningar om Tungt vatten 1957-1967, 1970-1974 (SKI tillstånd). Uran 1956-1962, Allmänt 1957-1959 Prognoser 1960", VD-arkivet, CA, Studsvik AB.
[33] Olof Forssberg's study (basis), p. 145.
[34] Jonter, Thomas, *Nuclear Weapons Research in Sweden. The Co-operation Between Civilian and Military Research, 1947-1972,* SKI Report 02:18.

nium heavy water reactor, later changed to be loaded with 40 tonnes of 1-2 % enriched uranium from Great Britain. The heavy water was imported from the United States.

**Table 4.3 Data on Marviken HWR:**

| | Superheating | Boiling reactor |
|---|---|---|
| Capacity, thermal | 463 MW | 593 MW |
| Capacity, electrical | 132 MW | 193 MW |
| Core inventory | 26,3 ton $UO_2$ | +7,3 ton $UO_2$ |
| Enrichment | 1,35 % U-235 | 1,75 % U-235 |
| Heavy water | 180 tonnes | |
| Operating pressure | 49,5 bar | |
| Temperature | 259° C | 472° C |
| Temperature, feed water | 120° C | 126° C |

## I. Analysis of a State's nuclear weapons research

If a State has conducted specific research to develop nuclear weapons, these activities have to be included in the historical review.
In the case of Sweden, the aim was to analyse the nuclear weapons research carried out by FOA since 1945, a field that so far had not been analysed by historians, political scientists or other researchers. Admittedly, the issue had been touched upon in articles and studies, in a very general way, describing the main aspects of Swedish official policy. The texts were not based on a thorough review of sources relating to the activities of FOA during the relevant period from 1945 until 1968, when Sweden signed the NPT.[35]

## J. Co-operation between civilian and military nuclear energy research

In this part of a review, the co-operation between the civilian and military research to produce nuclear weapons is investigated. By and large, to initiate a nuclear weapons programme implies that a wide range of competence and natural resources have to be brought together. Consequently, even the civil nuclear energy sector has to be a part of a State's historical survey of non-proliferation. In many cases, it might not be enough to

[35] See for example Agrell, Willhelm, *Alliansfrihet och atombomber. Kontinuitet och förändring i den svenska försvarsdoktrinen 1945-1982*, Stockholm 1985 and *Svenska förintelsevapen. Utveckling av kemiska och nukleära stridsmedel 1928-70*, Lund 2002; Björnerstedt, Rolf, "Sverige i kärnvapenfrågan", *Försvar i nutid*, 1965:5; Forssberg, Olof, *Svensk kärnvapenforskning 1945-1972*, (government report) Stockholm 1987; Fröman, Anders, "Kärnvapenforskning", in *Försvarets forskningsanstalt 1945-1995*, Stockholm 1995, and *FOA och kärnvapen – dokumentation från seminarium 16 november 1993*, FOA VET om försvarsforskning, 1995; Garris, Jerome Henry, *Sweden and the Spread of Nuclear Weapons*. University of Calfornia, Los Angels, Ph. D; Jervas, Gunnar, *Sverige, Norden och kärnvapnen*, FOA report C 10189-M3. September 1981; Larsson, Christer, "Historien om en den svenska atombomben". *Ny Teknik*, 1985-86; Lindström, Stefan, *Hela nationens tacksamhet: svensk forskningspolitik på atomenergiområdet 1945-1956*, Stockholm 1991; Larsson K-E, "Kärnkraftens historia i Sverige", *Kosmos*, 1987; Larsson, Tor, "The Swedish Nuclear and Non-nuclear Postures", *Storia delle relazioni internazionali* 1998:1.

only concentrate on co-operation between the private nuclear energy sector and the military research, it may be necessary to include investigations on how universities and smaller private companies were involved in these activities. For instance, in Sweden, several universities and private companies conducted studies on certain topics of research to produce basic information for manufacture of Swedish nuclear weapons.

Even though the FOA study dealt with the co-operation between FOA and AE to make technical preparations for a nuclear weapons production, the picture was far from clear. I could show what main tasks AE were responsible for within this co-operation and what reactors and other facilities the company had in its possession. However, rather little was known about what AE did in detail and what consequences it had for the project as a whole. Another unsolved issue was how much heavy water, plutonium of weapons quality, enriched, natural and depleted uranium AE used or had in its possession between 1945 and 1972. The important questions that needed to be answered were: what laboratories, reactors and facilities were used for activities with nuclear material, especially with plutonium, enriched uranium and heavy water, and where were they located? With which companies and research institutions did AE collaborate to obtain technical information to base the development of nuclear weapons? What was the purpose of this collaboration and what was achieved?

## K. Using interviews as a method

In addition to the archive work, I conducted interviews with former employees at AE and FOA who were involved in this research. This part of the presented model can give new knowledge and perspectives that are hard to find in the archives. This is especially important in cases when documentation is lacking or is scarce. This method was of much help in studying co-operation between FOA and AE, where in some cases the documentation was not enough.

In an interview situation, it is important to proceed cautiously and with an attitude that will create confidence. In the initial phase of my research project, most of the individuals I contacted were sceptical to the idea of being interviewed. There are several reasons for this.

Firstly, research concerning the Swedish nuclear weapons was a very secret activity. The former employees of FOA or AE are still very loyal to the organisation or company, even though the cold war is over.

Secondly, there might also be a fear among these ex-professionals that they will be used by journalists who might distort facts. When an historian like me calls them up wanting to talk about the co-operation between the civilian and military research to manufacture nuclear weapons, it might only arouse suspicion.

Thirdly, there might also be a tendency of constriction among individuals who have been involved in top-secret nuclear weapons research. Since nuclear weapon in itself has in some sense been associated with a conduct of a technology capable to destruct humanity, some of the involved might have harbour guilt feelings. A voice might whis-

per: “I don’t want that my grandchildren to know that I was involved in plans to manufacture nuclear weapons in the 1950’s”.

Fourthly, it might also be in the interest of an organisation or a company to hinder researchers accessing certain documentation concerning nuclear weapons. Another circumstance one has to understand is that there may also be officials or researchers who want to degrade or otherwise take revenge on former colleagues for certain reasons. The motives for this can be personal conflicts, or that a certain individual feels he has been treated badly and wants to retaliate. The risk is overwhelming that such feelings can result in misinterpretations or even false information. As a critical trained researcher one needs to ask the question: “Who is saying this, and what motivates him or her to make a specific statement?”

## L. Evaluation of a State’s capability to produce nuclear weapons.

How is it possible to evaluate a State’s capability to produce nuclear weapons? The Additional Protocol does not demand such an evaluation. From my point of view, it is not possible to make an analysis of the nuclear weapons activities in a country without such a model. To estimate the Swedish capability, I used a model from the American political scientist Stephen M Meyers study *The Dynamics of Nuclear Proliferation*. With his model I could define essential terms such as “nuclear weapons programme” and “latent capability”.
Why do certain States choose move from latent capability to operational capability? Meyer distinguishes four steps in the process from the decision to finished nuclear explosive devices:

- A State decides to acquire latent capability to manufacture nuclear weapons
- A State has reached latent capability
- A State decides to manufacture nuclear weapons
- A State possesses nuclear weapons.

A State is regarded as having a nuclear weapons programme when the intended programme has been started with an aim of producing at least one nuclear explosive device per year on an average for several years. It is immaterial whether the State in question has any plans for a weapon carrier or whether nuclear weapons tests are planned.

In addition, a State is regarded as having achieved latent capability when it has achieved the capability to carry out the above nuclear weapons programme. But how can the latent capability of a State be measured in a more concrete sense?
A great deal of resources is needed to carry out a complete nuclear weapons programme. Firstly, purely material resources such as steel, concrete and obviously nuclear materials are needed. Secondly, scientific expertise is needed. This means more than simply having sufficiently developed nuclear physics and nuclear chemistry available; the scientific knowledge must extend to other areas such as classical mechanical engineering, thermodynamics, kinetic theory and the metallic properties of uranium and plutonium. Thirdly, a State needs the technical know-how and extensive organisational

ability to be able to design and run the programme. It will also need to have developed the capacity to maintain and replace parts in an efficiently functioning nuclear weapons programme.[36]

Meyer divides the possible latent capability of States into three categories:

1. A State entirely lacking in nuclear infrastructure, and which decides to produce finished nuclear explosive devices, it would take up to six years from the initial experiments to produce the first nuclear weapon.
2. A State with a modest nuclear infrastructure, the goal of producing the first device could be achieved in two to three years.
3. A State with an advanced nuclear infrastructure would be able to produce a finished nuclear explosive device within a maximum of two years. Such a State possesses practically everything that is needed apart from the actual weapons factory. There are two forms of advanced capability: either the State has both a plutonium-producing reactor and a reprocessing plant (or a "hot cell"), or it has a uranium enrichment plant. In either case, the country in question has practically all the resources needed to start a nuclear weapons programme.[37]

Criteria for latent capability of producing nuclear weapons
The tables are taken from Meyer, Stephen, *The Dynamics of Nuclear Proliferation,* Chicago, 1986.

TABLE 25
PRELIMINARY LIST OF RESOURCE DEMAND COMPONENTS FOR THE BASE CASE ATOMIC WEAPONS PROGRAM

| |
|---|
| Previous national mining activity |
| Indigenous uranium deposits |
| Metallurgists |
| Steel |
| Construction work force |
| Cement/concrete |
| Chemical engineers |
| Nitric acid (production capacity) |
| Electricity (production capacity) |
| Nuclear engineers/physicists/chemists |
| Nuclear graphite (production capacity) |
| Electronics/explosives specialists |
| Capital costs of various plant facilities |
| Research, development, testing, and engineering costs |
| Initial operating costs of the process plants |
| Industrial engineers: civil structural, electrical, mechanical specialties |

[36] Meyer, Stephen M, *The Dynamics of Nuclear Proliferation*, Chicago 1987.
[37] Ibid., p. 37.

TABLE 24
RESOURCE DEMAND COMPONENTS BY STAGE

| Stage | Resource Demand Components |
|---|---|
| 1. Mining | Indigenous uranium deposits Previous national mining activity Initial operating costs |
| 2. Milling | Metallurgists<br>Chemical engineers<br>Concrete, steel<br>Construction force<br>capital<br>Research, development, and testing (RD&T) costs<br>Initial operating costs |
| 3. U-metal conversion | Metallurgists<br>Chemical engineers<br>Concrete, steel, electricity<br>Construction force<br>Capital<br>RD&T costs<br>Initial operating costs |
| 4. Fuel fabrication plant | Metallurgist<br>Electricity<br>Capital<br>RD&T costs<br>Initial operating costs |
| 5. Production reactor | Industrial engineers<br>Nuclear engineers/physicists<br>Metallurgists<br>Chemical engineers<br>Concrete, steel, electricity<br>Graphite production capacity<br>Construction force<br>Capital<br>RD&T costs<br>Initial operating costs |
| 6. Plutonium reprocessing plant | Chemical engineers<br>Nuclear engineers<br>Industrial engineers<br>Metallurgists<br>Concrete, steel, electricity<br>Nitric acid<br>Construction force<br>Capital<br>RD&T costs<br>Initial operating costs |
| 7. Weapons Fabrication Laboratory | Nuclear physicists<br>Metallurgists<br>Explosives/electronics experts<br>Electricity<br>Construction force<br>Capital<br>RD&T costs of weapon<br>Initial operating costs |

# 5. A pedagogic methodology

This chapter presents a pedagogic methodology, based on the experiences from two conferences/seminars on the theme of carrying out historical surveys within the co-operation projects between SKI and the Baltic States. I will first describe the different stages in the initiated co-operation project and how it is meant to work in practice. Thereafter, I will deal with the conducted training programs and show how they suit in the overall context.

SKI and the Baltic counterparts have signed an agreement to carry out the historical surveys. In order to enable this survey, each Baltic regulatory agency has set up an expert group consisting of three experts. The intention is that the expert groups shall consist of one technical expert from the regulatory agencies or research institutes/universities, one staff member with extensive administrative/political experience and a trained historian or political scientist familiar with archive research. It is up to each regulatory agency to choose the experts; however, it is important that the selected individuals are dedicated to the course and have profound writing abilities. For example, in the case of the Lithuanian expert group the members were recruited outside the regulatory agency, from two research institutes and from Vilnius University. However, the State Nuclear Power Inspectorate (VATESI) of Lithuania will serve as the responsible body administrating the project on the national level. Each expert group will work as a team together with Dr Thomas Jonter who will act as a supervisor and the overall co-ordinator of the co-operation project. The group will write a report of about 30 pages, which will be translated into English.

The co-operation project is decided to last for less than one year (10 months) in this particular case. The experts are carrying out the project as a part-time work. The timetable can, of course, be extended depending on the nature of nuclear weapons and nuclear energy related activities in this specific case. For instance, the Swedish survey contains three reports which took almost four years to complete (it was carried out by one researcher on a part-time basis). Sweden has a long nuclear history of both civilian and military use of nuclear energy. Therefore the Swedish survey had to cover several aspects that required a thorough analysis. This is not the case with the Baltic States, where most of nuclear-related activities concerned Soviet defence facilities dealing with nuclear weapons (except in Lithuania where the Ingnalina reactor plant went into operation in 1983).

All together the project consists of four meetings/seminars starting with a training course. The training course is designed to equip the expert groups with the needed basic knowledge in order to carry out the surveys (see the program below). In the next phase, the expert groups will make a domestic inventory of available sources to be used for a national review (archives, individuals and other information sources). In addition to this work, a first initial inventory in the Russian archives will be made. The intention is to investigate how much information is available regarding the Soviet nuclear weapons and nuclear-related policy in the Baltic area. In the second meeting, the information situation and the project in progress will be discussed. A third meeting will be held to sum up the work in progress and to discuss further steps to accomplish the project. In

the fourth meeting, the reports should be presented at a seminar with special guests invited from SKI, IAEA and other organisations dealing with non-proliferation issues. After the seminar the reports will be published and hopefully added to the State Declaration according to the Additional Protocol, which means that the co-operation project is complete.

## 5.1. How to design a training program

The first training course in the project took place on September 16-18, 2002.[38] Altogether 18 persons from Estonia, Finland, Lithuania and Sweden participated in the seminar in Stockholm. In this chapter I will use the program from the first seminar in order to explain how the course was worked out and why the specific themes were chosen.
Appendices 3 to 7 referred to in the program below are available in the electronic version of this report that can be found on the SKI website, www.ski.se.

### Seminar program

The first day

Session 1, 9:30-12:15

| | |
|---|---|
| 9:30-9:45 | *Welcome and Opening*, Sarmite Andersson, Project Manager, SKI, and Dr Lars Hildingsson, SKI. |
| 9:45-10.15 | *Reviewing the Swedish Nuclear Weapons Program – Background and Results*. Dr Thomas Jonter, Stockholm University. |
| 10:15-11:00 | *Production of Fissile Material*. Dr Lena Oliver, Swedish Defence Research Agency.<br>(the lecture including pictures, see appendix 3) |
| 11:30-12:15 | *Nuclear Proliferation and Preventive Measures.* Dr Lena Oliver, Swedish Defence Research Agency.<br>(the lecture including pictures, see appendix 4) |
| 12:15-13:45 | Lunch Break.<br>Session 2, 13:45-17:30 |
| 13:45-14:45 | *The History of NPT*, Jan Prawitz, Senior Research Fellow, Swedish Institute of International Affairs.<br>(the presented paper, see appendix 5) |
| 14:45-15:30 | *The Nuclear Weapon Arsenals Worldwide*.<br>Dr Gunnar Arbman, Swedish Defence Research Agency.<br>(the lecture including pictures, see appendix 6) |
| 16:00-16:45 | *The History of Finnish Nuclear Non-Proliferation During the Cold war*.<br>Arno Ahosniemi, Researcher, University of Helsinki. |
| 16:45-17:30 | *Discussions* |

[38] The second training program was held in Riga in Latvia in November 25-26, 2002 which was shorter, more intense and adjusted to the needs of the Latvian expert group.

The second day

Session 3, 9:15-12:00

9:15-10:00 *How to Work in Russian Archives.* Dr Helene Carlbäck, Södertörn University-College.

10:00-10:30 *The Soviet Nuclear Weapons Policy During the Cold War.* Wilhelm Unge, Researcher, Swedish Defence Research Agency.
(the lecture including pictures, see appendix 7)

11:00-12:00 *How to Make an Historical Survey of Nuclear Weapons Research – How it can be Designed.* Dr Thomas Jonter. Stockholm University.
(The lecture, see chapter 3.2)

Session 4, 13:30-17:00

13:30-14:15 *Nuclear Energy Activities in Estonia during the Cold War.*

14:15-15:00 *Nuclear Energy Activities in Lithuania during the Cold war.*

15:30- 17:00 *General Discussions: How to carry out co-operation Between Sweden, Finland, Estonia and Lithuania*.

The third day

9:30-12:00 *Planning of further co-operation between SKI, VATESI, EKK and STUK. End of the seminars.*

In the first presentation, "Production of Fissile Material", different methods and materials needed to manufacture nuclear weapons were described. The essential steps in a nuclear weapons program concerning the fissile materials were presented. Various methods to enrich uranium and reprocess plutonium to produce weapons-grade fissile materials were also a part of this lecture. (for the lecture including pictures, see appendix 3).

In the second lecture, "Nuclear Proliferation and Preventive Measures", the means to reduce the proliferation of weapons-grade materials and manufactured weapons of mass destruction were described (for the presentation, see appendix 4). In the context of what is needed in a nuclear weapons program (motive, competence, fissile material, financial resources, certain devices, tests etc), counter measures such as global disarmament policies, support programs, sanctions, export control regimes were discussed. In addition, the efforts to combat illicit trafficking were also included in the presentation. This theme is very important since the aim of the co-operation project is to trace the disposal of weapons-grade fissile materials such as enriched uranium and plutonium, and heavy water in the past.

The historic background of the NPT and the present situation of the non-proliferation in the world ("The History of NPT") was a topic of a lecture. Besides the emergence of NPT, other important regimes in combating the spread of nuclear weapons were discussed as well as how certain NPT-articles have been interpreted (for the presentation, see appendix 5).

In addition to the presentation of the history of NPT, a lecture on the present nuclear weapons situation was held ("The Nuclear Weapon Arsenals World-wide", see appendix 6). The purpose is to describe the present situation in the nuclear weapons field in order to create a broader context and understanding of the importance to make a historical review.

The planned study of Finland's Non-Proliferation policy during the Cold War was presented. Even though the report will contain lists of used facilities where nuclear material activities took place and account for holdings of plutonium, enriched uranium and other nuclear materials, Mr. Ahosniemi's investigation focused on the political aspects. In the view of Mr. Ahosniemi, the most interesting part in the Finnish case is to analyse how Finland acted on non-proliferation issues, especially in the light of the State's relations with the Soviet Union.

In the presentation "How to work in Russian archives" the archive situation was discussed. Different approaches to access certain documentation were dealt with, i.e. how to establish not only personal contacts, but also co-operation with Russian historians and archivists to find vital information. Another idea mentioned in the lecture was to hire a group of Russian historians to make an inventory of accessible archives in order to find out if it is worth the trip to Russia or, otherwise, what is needed to open up the doors to certain archives in Russia.

An overview of the Soviet nuclear weapons policy during the cold war was presented. Even the present situation in Russia was described. In addition, the lecture dealt with the nuclear weapons production complex in the Soviet Union during the cold war in order to establish a context for the planned studies concerning the Baltic States (for the lecture including pictures, see appendix 7).

A general model of how a historical survey of a certain State's nuclear activities can be designed was presented (for the model, see chapter 3.2). In the lecture, it was emphasised that every individual State has its own specific history in the nuclear field, and it is hard to generalise. However, the Additional Protocol stipulates certain areas that can serve as a guideline for all participating countries' national based reviewing of nuclear related activities. In the case of Sweden, the plans to acquire nuclear weapons were central for the analysis, while the Finnish study focused on the political aspects.

The last issue in the program was to discuss and plan further co-operation.

# 6. A competence profile of possible co-operative partners

In order to make historical surveys of non-proliferation of nuclear related and nuclear weapons research activities you need to co-operate with different types of experts.
Besides the different regulatory agencies in Estonia, Latvia, Lithuania, Norway and Finland, the Swedish Defence Research Agency (FOI) have been the most important co-operation partners in this co-operation project. Several researchers have been involved in the first seminar (training program) held at Villa Söderås in Stockholm, September16-18, 2002. The researchers have made presentations of certain fields in the non-proliferation area, and they can also be used as expert consultants.

Gunnar Arbman: PhD in Physics, Director of Research, member of International Institute for Strategic Studies, London, and member of the Swedish Pugwash board. Dr Arbman is expert on nuclear weapons effects, and he has also dealt with societal and disarmament and arms control issues related to nuclear weapons since the early 1970ths.
Lena Oliver: PhD in nuclear physics, specialist in trans-uranium isotopes. Dr Oliver conducts studies on enrichment and reprocessing of plutonium related to nuclear weapons.
Wilhelm Unge: Operational Analyst and security policy expert (especially regarding Russian nuclear weapons policy).

Jan Prawitz, Senior Research Fellow, Swedish Institute of International Affairs. Mr.Prawitz has a long career in nuclear weapons area. He started to work at FOA (1956-1970) in the 1950´s on nuclear weapons research. Between 1970-1992 he was the Special Assistant for Disarmament to the Minister of Defence. He has also been the scientific advisor of Sweden's Disarmament Delegation (1962-1992). Since 1993, he is a visiting scholar at Swedish Institute of International Affairs and is dealing with nuclear weapons issues. Mr. Prawitz is an expert consultant to the SKI-project and has been involved in the process of developing the training programme.

Center for Non-Proliferation Studies (CNS), Monterey, USA. In August 2002, a meeting was held in Stockholm with the director of CNS, Dr William Potter, regarding a co-operation within the historical survey of non-proliferation project in the former Soviet Union. CNS possesses a vide range of competence in the non-proliferation field, especially interesting for the SKI-project is its programmes dealing with non-proliferation in Russia.
There are several experts at CNS dealing with the Russian (Soviet) nuclear weapons infrastructure and can be used as consultants and invited to make presentations on certain important issues.

Frank Barnaby, PhD in physics, former scientist with the UK Atomic Weapons Establishment, Director of SIPRI 1971-81, member of the Oxford Research Group. He is currently dealing with nuclear terrorism. Dr Barnaby is co-operating with Dr Thomas Jonter to work out a model of how to assess a State's nuclear weapons capability. The aim of this co-operation is to define a number of indicators that can be applied to a country

to determine if it has a nuclear weapons programme and, if it indeed has, what progress has been made.

Helene Carlbäck, PhD in history at Södertörn University-College, expert on Russian-Swedish relations. She has a long experience of working in archives in Russia and Soviet Union. Dr Carlbäck will help the SKI project in getting access to archives in Russia concerning nuclear weapons and nuclear energy activities in the former occupied Baltic States, and even other former Soviet republics.

Emeritus Professor Nils Göran Sjöstrand, Department of Reactor Physics at Chalmers University of Technology, Gothenburg, has an extensive experience in the nuclear reactor field as a researcher. Professor Sjöstrand has been of great help in examining the work in progress and reports.

At the Office of Nuclear Non-Proliferation at SKI, several officials have been involved in the project:
Sarmite Andersson, Project Manager, Swedish Nuclear Non-Proliferation Assistance Programme (SNNAP)
Göran Dahlin, Deputy Director
Lars Hildingsson, PhD, co-ordinator for the support programme to the IAEA Safeguards
Kåre Axell, PhD, co-ordinator for the research on nuclear non-proliferation
Lars van Dassen, Director, Swedish Nuclear Non-Proliferation Assistance Programme (SNNAP)

# 7. A list of databases, home pages and literature concerning reviews of certain State's nuclear energy and nuclear weapons research in the past.

The compilation is focused on databases, web pages and literature, which specifically concern survey activities from a larger and comprehensive perspective.

## Nuclear weapons technology in general:

Diehl, Sarah J., Moltz, James Clay, *Nuclear Weapons and Non-Proliferation: A Reference Handbook*.
Grace, Charles S., *Nuclear Weapons: Principles, Effects and Survivability*. London: Brasseys, 1994.
Rhodes, Richard, *The Making of the Atomic Bomb.* Touchstone Books, New York, reprint edition 1995.
– *Dark Sun: the Making of the Hydrogen Bomb*. Touchstone Books, New York, reprint edition 1996.

## Production of Fissile Material:

Bodansky, David, *Nuclear Energy – principles and Prospects*. Springer Verlag, 1996.
Choppin, G, Rydberg, J, Liljenzin, J-O, *Nuclear and Radiochemistry and Nuclear Chemistry*. Oxford: Buttersworth, 1995.

Home pages regarding information on fissile material and manufacture of nuclear weapons:

http://www.uic.com.au/
http://www.llnl.gov
http://ead.anl.gov/uranium/
http://www.meab-mx.se
http://news.bbc.co.uk/hi/english/uk/newsid_647000/647981.stm

## Nuclear Non-Proliferation regime

Ahlström, Christer, *The Status of Multilateral Export Control Regimes. An Examination of Legal and Non-Legal International Co-operation*. Iustus: Uppsala 1999.
Avenhaus, R., Kremenyuk, V., Sjöstedt, S., *Containing the Atom: International Negotiations on Nuclear Security and Safety*, IIASA, Lexington Books, 2002. IV.
Fischer, David A. V., *Stopping the Spread of Nuclear Weapons: The Past and Prospects*. New York and London: Routledge, 1992.
Gardner, Gary T., *Nuclear Proliferation*. A Primer. London: Boulder, Colo: Lynne Rienner, 1994.

Prawitz, Jan, "The History of the NPT Regime". Paper presented at The Seminar on How to Make National Base Historical Surveys of Non-Proliferation of Nuclear Weapons, Riga, Latvia, 25-26 November, 2002.
Scheinman, Lawrence, *The International Atomic Energy Agency and World Nuclear Order*. Washington, DC: Johns Hopkins University Press, 1987.
Shaker, Mohamed I, *The Nuclear Non-Proliferation Treaty*, vols. 1 and 2. London: Oceana, 1980.
Simpson, John, and Howlett, Darryl (eds.), *The Future of the Non-Proliferation Treaty*. New York: S:t Martin´s Press, 1995.
Spector, Leonard, "Neo-Non-Proliferation", *Survival*, 37 (1) (Spring 1995): 66-85.
*The United Nations and Nuclear Non-Proliferation*, United Nations Blue Books Series III (Sales No. E. 95.I.17), 1995.
Willrich, M., *Non-Proliferation Teaty: Framework for Nuclear Arms Control*, The Michie Company, Charlottesville, 1968.

## Home pages regarding disarmament verification:

CTBTO in Vienna: www.ctbto.org
Prototype IDC in Arlington, USA: www.pidc.org
Center for Monitoring Research (CMR), USA: www.cmr.gov
Verification Research Training & Information Centre (VERTIC): www.vertic.org
Nuclear Explosion Monotoring Research and Engineering (NEM R & E) Program: www.nemre.nn.doe.gov/nemre/
NORSAR, Norway: www.norsar.no
http://www.iaea.org/worldatom/index.shtml.
Nuclear Free Zones: www.opanal.org
http://disarmament.un.org

## Home pages regarding Non-Proliferation organisations

Carneige Endowment for International Peace: www.ceip.org
Institute for Science and International Security: www.isis-online.org

Center of Non-Proliferation Studies: http://cns.miis.edu
Databases of importance:
CNS maintains five databases of current and archived information: 1) the Nuclear Abstracts Database, 2) the Missile Abstracts Database, 3) the China Profiles Database, 4) the NIS Non-Proliferation databases, and 5) the WMD Terrorism Database
www.iaea.org
NRDC National Resources Defense Council, Washington, DC: www.nrdc.org/nuclear/

## About the present nuclear weapons situation in the world:

SIPRI YEARBOOK 2002
About different risk States´ nuclear (weapons) programs:
www.fas.org/nuke/guide/index.html

## Nuclear weapons in Russia and Soviet Union

Bertsch, Gary K., Potter, William C., *Dangerous Weapons, Desperate States : Russia, Belarus, Kazakstan, and Ukraine.* New York, N.Y.: Routledge, 1999.
Bukharin, Oleg A., Cochran, Thomas B, Norris, Robert S., *Making of the Russian Bomb: From Stalin to Yeltsin*. Westview, 1994.
Bunn, Matthew, *The Next Wave: Urgently needed Steps to Control Warheads and Fissile Materials with Harvard University´s Project on Managing the Atom.*
Dalton, Russell J, *Critical Masses : Citizens, Nuclear Weapons Production, and Environmental Destruction in the United States and Russia*. Cambridge, Mass.: MIT, 1999.
Feoktistov, Lev P., *Nukes are not Forever*. Moscow, 1999.
Holloway, David, *Stalin and the Bomb: the Soviet Union and Atomic Energy, 1939-1956*. New Haven, Conn.:London: Yale University Press, 1996.
Josephson, Paul R, *Red Atom. Russia´s Nuclear Power Program from Stalin to Today*. W. H. Freeman and Company, New York, 1999.
Podvig, Pavel, *Russian Strategic Nuclear Forces*. MIT Press, 2001.
*Nuclear energy and Security in the Former Soviet Union* / edited by David R. Marples and Marilyn J. Young: Boulder, Colo.: Westview Press, 1997
*Status Report: Nuclear Weapons, Fissile Material, and Export Controls in the Former Soviet Union*: http://cns.miis.edu
Tikhonov, Valentin, *Russia´s Nuclear and Missile Complex. The Human Factor in Proliferation.*

## Historical surveys of Non-Proliferation:

SKI Reports:
Jonter, Thomas, *Sverige, USA och kärnenergin. Framväxten av en svensk kärnämneskontroll 1945-1995* (Sweden, USA and nuclear energy. The emergence of Swedish nuclear materials control 1945-1995). SKI Report 99:21.
*Sweden and the Bomb. Swedish Plans to acquire Nuclear Weapons, 1945-1972*. SKI Report 01:33.
*Nuclear Weapons Research in Sweden. The Co-operation Between Civilian and Military Research, 1947-1972*, SKI Report 02:18.
*Status Report: Nuclear Weapons, Fissile Material, and Export Controls in the Former Soviet Union*: http://cns.miis.edu
Department of Energy (DOE), *Draft Non-Proliferation and Arms Control Assessments of Weapons-Usable Fissile Material Storage and Plutonium Disposition Alternatives*: http//www2.dp.doe.gov/www.nn.doe.gov/nn/index.html

## Nuclear terrorism

Lee, Rensselaer W, *Smuggling Armageddon: the Nuclear Black Market in the Former Soviet Union and Europe*. Basingstoke: Macmillan 1998.
Maerli, Morten Bremer, *Nuclear Terrorism: Threats, Challenges and Responses.* Oslo: Den norske Atlanterhavskomité, 2002.

## Reviews

*Bullentin of the Atomic Scientists:* www.thebullentin.org
*International Security*
*Non-Proliferation Review*: http://cns.miis.edu

# 8. Literature


Agrell, Willhelm, *Alliansfrihet och atombomber. Kontinuitet och förändring i den svenska försvarsdoktrinen 1945-1982*, Stockholm 1985.

– *Svenska förintelsevapen. Utveckling av kemiska och nukleära stridsmedel 1928-70*, Lund 2002.

Ahosniemi, Arno ,"The History of Finnish Nuclear Non-Proliferation During the Cold War". Paper presented at Seminar on How to Make National Base Historical Surveys of Non-Proliferation of Nuclear Weapons, Stockholm, September 16-18, 2002;
– "Non-Proliferation History of Finland", paper presented at Nordic Society for Non-Proliferation Issues, Bergen, Norway October 16-17, 2002.

Björnerstedt, Rolf, "Sverige i kärnvapenfrågan", *Försvar i nutid*, 1965:5.

Erlander, Tage, *1955-1960*, Stockholm 1976.

Forssberg, Olof, *Svensk kärnvapenforskning 1945-1972*, (government report) Stockholm 1987.

Fröman, Anders, "Kärnvapenforskning", in *Försvarets forskningsanstalt 1945-1995*, Stockholm 1995, and *FOA och kärnvapen – dokumentation från seminarium 16 november 1993*, FOA VET om försvarsforskning, 1995.

Garris, Jerome Henry, *Sweden and the Spread of Nuclear Weapons*. University of Calfornia, Los Angels, Ph. D Thesis.

Hildingsson, Lars, "Exportkontroll inget modernt påfund", *Nucleus*, 2002:1.

Hultgren, Åke, "The Plutonium Fuel laboratory at Studsvik and its activities". IAEA Symposium "Plutonium as a Reactor Fuel". Brussels, 1967.

– *Upparbetning av Ågestabränslet 1969*, September 1995.

Jervas, Gunnar, *Sverige, Norden och kärnvapnen*, FOA report C 10189-M3. September 1981.

Jonter, Thomas, *Sverige, USA och kärnenergin. Framväxten av en svensk kärnämneskontroll 1945-1995* (Sweden, USA and nuclear energy. The emergence of Swedish nuclear materials control 1945-1995). SKI Report 99:21.

– *Sweden and the Bomb. Swedish Plans to acquire Nuclear Weapons, 1945-1972*. SKI Report 01:33.

– *Nuclear Weapons Research in Sweden. The Co-operation Between Civilian and Military Research, 1947-1972*, SKI Report 02:18.

Larsson, Christer, "Historien om den svenska atombomben". *Ny Teknik*, 1985-86.

Larsson K-E, "Kärnkraftens historia i Sverige", *Kosmos*, 1987.

Larsson, Mats, "Integrerad safeguard-Effektivare kontroll trots färre inspektioner", *Nucleus* 2000:3-4.

Larsson, Tor, "The Swedish Nuclear and Non-Nuclear Postures", *Storia delle relazioni internazionali* 1998:1.

Meyer, Stephen M, *The Dynamics of Nuclear Proliferation*, Chicago 1987.

*Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards, INFIRC/540(Corrected)*. IAEA 1998.

Lindström, Stefan, *Hela nationens tacksamhet: svensk forskningspolitik på atomenergiområdet 1945-1956*, Stockholm 1991.

Maerli, Morten Bremer, *Atomterrorisme*. Norsk utenrikspolitisk institutt 1999.

Prawitz, Jan, *From Nuclear Option to Non-Nuclear Promotion: The Sweden Case*. Swedish Institute of International Affairs, Research Report 20, 1995.

– *The History of NPT*, paper presented at the seminar on "How to make Make a national Base Historical Surveys of Non-Proliferation of Nuclear Weapons", Riga, Latvia, 25-26 November, 2002.

van Dassen, Lars, *Sweden and the Making of Nuclear Non-Proliferation: From Indecision to Assertiveness*. SKI Report 98:16.

– "Öst-stödprogram för nukleaär icke-pridning", *Nucleus*, 2002:1.

# Appendix 1: Swedish legislation on nuclear energy

There are three types of legislation in Sweden regulating the use of nuclear energy. The first group of laws concerns possession of nuclear facilities and nuclear material, and management and terminal storage of used nuclear fuel and radioactive waste. The second group covers the State of emergency in case of nuclear power plant disasters. Finally, the third group stipulates rules concerning damages and insurance issues in nuclear power plants.

In this presented list of legislation, the emphasis is on the first group, particularly laws dealing with nuclear materials.

In 1945, the first law in the nuclear energy field was passed in Sweden when legislation concerning the management of uranium was introduced. The reason for this was that the U S government pressed Sweden to initiate export control of the Swedish uranium deposits to prevent other States from acquiring the material. The American government viewed that Swedish uranium could be used by Soviet Union or other States to manufacture nuclear weapons. In order to enforce export control as soon as possible an amendment to a law from 1866 was made: The Coal Deposits Act (Lagen om stenkolsfyndigheter m m, 1886:46). Besides regulating export control of uranium, the purpose was to enable concessions of production of uranium.

Changes were introduced to the 1947 Act of Coal Deposits to conform to the uranium production that was initiated. Amendments to the Act were passed in 1950 and 1953 in order to enable the use and export of uranium, thorium, beryllium etc.
Moreover, the Act underwent changes in 1956 and 1960 to adjust to the new demands in the Swedish nuclear energy developments.

The first integrated legislation on the use and management of nuclear energy was passed in 1956. The Atomic Energy Act (Atomenergilagen, 1956:306) regulated permission to build, posses and operate nuclear reactors and facilities for reprocessing of nuclear materials. This Act replaced the old 1947 Act of Coal deposits.

At the same time the law was passed, a national regulatory agency was founded, *Delegationen för atomenergifrågor* (Delegation of Nuclear Energy Matters). In addition to this regulatory agency, a body to deal with safety issues was created, namely *Reaktorförläggningskommitten*. This body was placed under the *Delegationen för atomenergifrågor*.

In 1958, The Radiation Protection Act (Strålskyddslagen, 1958:110) was passed. The responsible regulatory body was Medicinalstyrelsen.

In 1960, the so called Uranium Act was passed. The legislation was created to facilitate extended production of Swedish uranium.
The Certain Mineral Deposits Act (Lagen om viss mineralfyndigheter, 1974:890) came into effect in 1974.

In 1984, The Atomic Energy Act (Atomenergilagen, 1956:306) was replaced by the Act on Nuclear Activities (Lag om kärnteknisk verksamhet, 1984:3). The reason for introducing this new Act was to create a more co-ordinated regulation of the most essential laws concerning the nuclear energy field. Another reason for a new legislation was connected to the Swedish obligations within a membership of IAEA and the ratification of the NPT. Broadly speaking, this membership meant that Sweden had to conform with the conventions and agreements that were ratified. In addition, sharper safety demands had been initiated since the Act of Atomic Energy was passed which implied the need for a more suitable set of rules and regulations. This was particularly the case concerning the management of used fissile materials and the extended demands of safety in the nuclear technical facilities and transportation of nuclear materials.

In 1991, a new legislation regarding the management of minerals was passed, the so called Minerals Act (Minerallagen 1991:45).

When Sweden became a member of European Union, the preconditions for the management and legislation concerning the nuclear technology was changed for both SKI and the Swedish facilities. Euratom regulations took immediately effect on January 1, 1995, and the Swedish Agreement with IAEA was replaced by the Agreement between non-nuclear weapon states in EU, the EU-Commission and the IAEA, INFCIRC/193.

In 2000, the Act on Nuclear Activities (Lag om kärnteknisk verksamhet, 1984:3) was changed.

**A Brief Summary of important Treaties Related to Non-Proliferation**

1956 Bilateral Agreement with the United States
1963 PTBT, Partial Test Ban Treaty
1968 Bilateral Agreement with Finland
1968 Bilateral Agreement with Switzerland
1968 NPT, Non-Proliferation Treaty
1969 Bilateral Agreement with Soviet Union (valid to the end of 2000)
1970 Ratification of NPT
1972 Interim Trilateral Agreement with IAEA, United States and Sweden
1975 Safeguards Agreement with IAEA
1976 Bilateral Agreement with Canada
1981 Bilateral Agreement with Australia
1984 New Bilateral Agreement with United States (terminated 1996)
1995 Euratom Treaty Chapter 7
1995 EC 3227/76
1995 EC 3381/94 and Council Decision 94/942/CFSP
1998 CTBT, Comprehensive Test Ban Treaty
1998 The Additional Protocol was signed
2000 EC 1334/0053

# Appendix 2: Preliminary compilation of archives concerning documentation on both civil and military use of nuclear energy in Sweden

## Parliament, governments, authorities (riksdag, regering och myndigheter)

Government (Riksdagen)
Riksdagens utskott
Archive: Riksdagsbiblioteket
Telephone:+46 8 786 4000.

Department of Trade (Handelsdepartementet)
The department was responsible for nuclear energy between 1945 and 1967. Documentation on roughly everything concerning the development of nuclear energy in Sweden during this time.

Department of Finance (Finansdepartementet)
The Departementet of Finance was responsible of nuclear energy issues in Sweden in the period 1967-1968. By and large, the documentation concerns everything regarding the Swedish civilian nuclear energy development at that time.

Department of Industry (Industridepartementet)
The Departementet of Industry was responsible of nuclear energy issues in Sweden in the period 1969-1987. By and large, the documentation concerns everything regarding the Swedish civilian nuclear energy development at that time.
Archive: Centralarkivet vid regeringskansliets förvaltningskontor
Fredsgatan 8
Stockholm
Telehone +46 8 405 24 88.
Older documents are to be found at the National Archives of Sweden.

Department of Commerce (Näringsdepartementet)
Archive: Centralarkivet vid regeringskansliets förvaltningskontor
Fredsgatan 8
Stockholm
Telephone: +46 8 405 24 88.

Department of Trade (Näringsdepartementet och handelsdepartementet)
Archive: Centralarkivet vid regeringskansliets förvaltningskontor
Fredsgatan 8
Stockholm
Telephone +46 8 405 24 88.

Department of Foreign Affairs (Utrikesdepartementet)
The archive contains documentation on the Swedish nuclear development in relation to other States (both military and civilian aspects).
Archive: Utrikesdepartementet, Contact person: The Director of Archives
Telephone +46 8 405 10 00.
Older documents are to be found at the National Archives of Sweden.

**Government Authorities**

Swedish Nuclear Power Inspectorate (Statens kärnkraftsinspektion, SKI)
The SKI archives contain documents from the predecessor of SKI, Delegationen för atomenergifrågor (DfA) and Reaktorförläggningskommittén (RFK).
Since SKI, DfA och RFK have been the national regulatory authority during the period 1945-1975 the archives contain all aspects of the civilian nuclear emergence and management in Sweden
Archive: SKI
106 58 Stockholm
Telephone: +46 8 698 84 00.

The Swedish Radiation Protection Authority (Statens strålskyddsinstitut, SSI)
Archive: Karolinska sjukhuset
171 16 Stockholm.
Telephone: +46 8 729 71 00.

Swedish Defence Research Agency (FOI, Totalförsvarets forskningsinstitut, former Försvarets forskningsanstalt, FOA)
Documentation on research concerning protection and development of nuclear weapons.
Some documenatation has been transferred to the Military Archives of Sweden (se below)
Archive: Enköpingsvägen 126
172 90 Stockholm.
Telephone: +46 8 706 30 00.

The Military Archives of Sweden (Krigsarkivet)
The archives contain documentation on the military policy concerning nuclear weapons.
Archive: Banérgatan 64
115 88 Stockholm.
Telephone: +46 8 782 41 00

The Swedish Research Council
Documentation from Atomic Committee (Atomkommittén) is stored in the archive (1945-1959), Statens råd för atomforskning (1959-1977).
Some documenatation has been transferred to the Military Archives of Sweden
Archive: VR (Vetenskapsrådet)
Regeringsgatan 56
103 87 Stockholm.
Telephone: +46 8 546 44 000

Närings- och teknikutvecklingsverket (NUTEK), (former Statens tekniska uveckling, STU)
Archive: Liljeholmsvägen 32
117 86 Stockholm.
Telephone: +46 8-681 91 00
Fax: +46 8-19 68 26

**Private Companies**

Alfa-Laval AB
Rubin Rausings gata
221 86 Lund.
Telephone: +46 46 36 70 00, fax: +46 46 36 49 50.

Alfa Laval Celleco Production AB (Hedemora verkstäder)
Box 207
776 28 Hedemora.

Avesta Sheffield (Avesta Jernverk AB)
Archive: Vasagatan 8-10
Box 163 77
103 27 Stockholm.
Telephone: +46 8 613 36 00. Contact person: Gunnar Danielsson.

Axel Johnson AB
Stureplan 3
103 75 Stockholm.
Tele: +46 8-788 50 00, fax: +46 8 788 50 10

Bofors AB (Nyqvist och Holm AB, Trollhättan)
681 80 Karlskoga.
Telehone: +46 586 810 00, fax. +46 586 857 00. Contact person: Sven Jungmarker.

Byggentreprenörerna
Norrlandsgatan 15 D
Box 7835
103 98 Stockholm.
Telephone: +46 8 698 58 00, fax: +46 8 698 59 00.
Contact person: Ivar Hultin.

Celcius AB
Eriksberg, Box 8954
402 74 Göteborg.
Telephone: +46 31 65 86 00, fax: +46 31 51 61 05.

ELAJO Mekanik AB
572 29 Oskarshamn.

Eriksbergs Varv
Landsarkivet i Göteborg
Telephone: +46 31 778 68 00.

Gullspångs Kraft AB (Skandinaviska Elverk AB, Uddeholms Kraft, Voxnan Kraft AB)
Box 1643
701 16 Örebro
Telephone: +46 19 21 81 00, fax: +46 19 26 24 23.

Götaverken
Landsarkivet i Göteborg.
Telephone: +46 31 778 68 00.

Ingenjörsakademien (IVA)
Grev Turegatan 14
Box 5073
102 42 Stockholm.
Telephone: +46 8 791 29 00, fax: +46 8 611 56 23.

Karlstads Energi AB
651 84 Karlstad.
Telephone: +46 54 29 50 00. Contact person: Willy Persson.

Kockums Varv
Malmö stadsarkiv.
Contact person: Jan Östergren.

Kvaerner-KAMFAB (Karlstads Mekaniska verkstads AB)
Karlstad.
Telephone: +46 54 17 16 00. Contact person: Sven Larsson.

Kvaerner Pulping AB (Götaverken Ångteknik AB)
Göteborg.
Telephone: +46 31 50 10 00. Contact person: Bobby Björk.

Kärnkraftskommunernas Samarbetsorgan (KSO)
SSK
205 80 Malmö
Telephone: +46 40 34 22 45.

Kärnkraftsäkerhet o Utbildning AB (KSU)
Studsvik
Box 1039
611 29 Nyköping.
Telephone: +46 155 26 35 00, fax: +46 155 26 31 91.
Contact person: Magnus Kjellander.

Lindholmens varv
Johnsonkoncernens arkiv.
Nordstjernan AB
Stureplan 3
103 75 Stockholm
Telephone: +46 8 788 50 00, fax: +46 8 788 50 10.

Motala Verkstad AB
Landsarkivet
Vadstena.

Nordiska Armaturfabriken, (NAF)
Linköping.
Telephone: +46 13 31 61 00. Contact person: Clas Hane.

OKG Aktiebolag
572 83 Oskarshamn.
Telephone: +46 491 860 00, fax: +46 491 860 90. Contact person: Sven- Olof Fröberg.

Ranstad Mineral AB (f d Svensk Alunskifferutveckling, f d Ranstad Skifferaktiebolag)
The archive contains documentation on uranium extraction.
Archive: Ranstadsverket, Contact person: Bengt Lilljha.
520 50 Stenstorp
Telephone: +46 500 45 30 40
Fax: +46 500 45 31 09.

Sandvik AB
811 81 Sandviken.
Telephone: +46 26 26 00 00, fax: +46 26 25 03 40. Contact person: Anders Persson

SAQ Kontroll AB (AB Svensk Anläggningsprovning)
Alströmmergatan 12
Box 49306
100 29 Stockholm.
Telephone: +46 8 617 40 00, fax: +46 8 651 70 43.

Skellefteå Kraft AB
Box 802
931 28 Skellefteå.
Tele: +46 910 77 25 00, fax: +46 910 77 77 93.

Stiftelsen för Skeppsteknisk Forskning (Statens skeppsprovningsanstalt)
Landsarkivet i Göteborg.
Telephone: +46 031 778 68 00.

Stockholm Energi AB
Tegeluddsvägen 1
155 77 Stockholm.
Telephone: +46 8 671 70 00, Contact person: Bertil Forsström.

Stora Kraft AB
791 80 Falun.
Telephone: +46 23 78 00 00, fax: +46 23 78 24 55.

Studsvik AB (former AB Atomenergi)
The archives contain documentation on the civilian and military use of nuclear energy.
Archive: Studsvik AB
611 22 Nyköping.
Telephone: +46 155 22 10 00
Fax: +46 155 26 30 00.

SVAFO
Brahegatan 47
Box 5864
102 40 Stockholm.
Telephone: +46 8 665 28 00, fax: +46 8 661 57 10. Contact person: Bo Sundman.

Svenska Kraftverksföreningen (and former CDL, KRAFTSAM)
Centralarkiv
Olof Palmes gata 31, 6 tr.
101 53 Stockholm.
Telephone: +46 8 677 25 60, fax: +46 8 677 25 65. Contact person: Bo Lexmark.

Svensk kärnbränslehantering AB (SKB) (former Svensk kärnbränsleförsörjning AB)
Centralarkivet, huvudkontoret
Brahegatan 47
Box 5864
102 40 Stockholm,.
Telephone: +46 8 665 28 00.

Sydkraft AB (Båkab, Krångrede)
205 09 Malmö.
Telephone: +46 40 25 50 00, fax: +46 40 97 91 16

Trustor Precision Components (Bulten-Kanthal)
734 27 Hallstahammar.
Telephone: +46 220 219 88. Contact person: Rune Pennerud.

Uddcomb Engineering AB (Uddcomb AB, Uddeholms AB, Degerfors järnverk)
Box 65
371 21 Karlskrona.
Telephone: +46 455 33 45 00.

Vattenfall AB
The archive contains documentation on the emergence and building of the Swedish reactor facilities (Marviken och Ågesta).
Archive: Huvudkontoret
Tekniskt arkiv
Jämtlandsgatan 99
Råcksta gård
162 87 Stockholm.
Telephone: +46 8 739 50 00
Fax: +46 8 739 61 75.

VBB
Gjörvelsgatan 22
Box 34044
100 26 Stockholm.
Telephone: +46 8 695 60 00, fax: +46 8 695 66 10.

Westinghouse Atom AB (former ABB Atom AB, Asea Atom AB)
The archives contain documentation on the civilian use of nuclear energy.
Archive: Westinghouse Atom AB
721 63 Västerås.
Telephone: +46 21-34 70 00, Contact person: Lennart Sundin.
Fax: +46 21 41 4190

Wibe (Hebo)
Box 401
792 27 Mora

Ångpanneföreningen AB
Centralarkiv
Fleminggatan 7
Box 8133
104 20 Stockholm.
Telephone: +46 8 657 10 00, fax: +46 8 650 91 18.

**Universities**

Uppsala University
Department of Radiation Research.
Uppsala
Contact person: Anders Bäcklin.
Telephone: +46 18 471 0000

University of Lund
Department of Nuclear Physics
Lund

Royal University of technology
Department of Reactor safety. Contact person: Baj Raj Segal.
Department of Nuclear Reactor Physics. Contact persons: Arne Johnson,
Waclaw Gudowski.
Department of Nuclear Chemistry. Contact person: Ivars Neretnieks.
Kärntekniskt centrum. Contact person: Ingmar Tirén.

Chalmers University of Technology
Department of Reactor Physics.
Gothenburg
Contact person: Imre Pazsit.
Reactor technology: Bryan McHugh.
Department of Nuclear Chemistry. Contact person: Jan-Olov Liljenzin, Jan Rydberg.

**International organisations**

European Commission
200 Rue de Loi
B-10 49 Brussels, Belgium,

European Commission
DG-TREN-H
Bâtiment Cube
Plateau de Kirschberg
LU-2920 Luxembourg.
Telephone: +352 43011

International Atomic Energy Agency (IAEA)
Wagramerstrasse 5
Box 100
A-1400 Vienna
Austria

National Archives (NA), Washington, DC
8601 Adelphi Road
College Park, Maryland 20740-6800, USA
Civil Branch: State Department
Military Branch

NKS-Sekretariatet
Postboks 30
DK-4000 Roskilde.
Telephone: +45 4677 4045, fax: +45 4677 4046
Nuclear Energy Agency (OECD)
12 Boulevard des Iles

F-92130 Issy-Les Moulineeaux
France.
Telephone: +33 14 52 48 200

**Private archives**

| Name | Company/archive |
|---|---|
| Aler, Bo | Studsvik AB (Atomenergi AB) |
| Andersson, Gunnar | Atomförsäkringspoolen |
| Björgerd, Anders | Sydkraft |
| Brynielsson, Harry | Studsvik (Atomenergi AB) |
| Cederwall, Gustav | Handelsdepartementet |
| Ekström, John-Olof | Sandviken |
| Eklund, Sigvard | Studsvik AB (Atomenergi AB) |
| Erlander, Tage | Arbetarrörelsens arkiv |
| Gimstedt, Olle | OKG |
| Grafström, Erik | Vattenfall |
| Gullberg, Rolf | OKG |
| Gustafsson, Lars | Vattenfall |
| Gustafsson, Torsten | Lunds universitetsbibliotek |
| Håkansson, Hans | Industridepartementet |
| Hörnander, Olof | Statens kärnkraftsinspektion |
| Lallander, Sven | Vattenfall |
| Larsson, Lars Gunnar | Industriförbundet |
| Larsson, Yngve | Sydkraft |
| Leine, Lars | Asea-Atom |
| Liljha, Bengt | Ranstad Mineral |
| Lindell, Bo | Strålskyddsinsitutet |
| Lindström, Torsten | Asea |
| Mileikowsky, Curt | Asea |
| Moding, Philip | Kärnkraftskommunernas SO |
| Nicolin, Curt | Asea |
| Norrby, Jonas | Vattenfall |
| Pettersson, Lars | Kommunikationsdepartementet |
| Jan-Erik Ryman | Stockholm Energi |
| Setterwall, Max | Elektroindustriföreningen |
| Svenke, Erik | SKBF |
| Tunhammar, Elam | Atomenergi |
| Undén, Östen | Kungliga biblioteket |
| Wetterlundh, Sune | Sydkraft |
| Wivstad, Ingvar | Vattenfall |
| Öhrström, Lennart | Vattenfall |
| Önnesjö, Karl-Erik | Handelsdepartementet |