NORWAY'S NUCLEAR ODYSSEY: FROM OPTIMISTIC PROPONENT TO NONPROLIFERATOR

by Astrid Forland[1]

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Although Norway is not widely remembered today as having been among the world's early nuclear powers, it was in fact the sixth country to build a nuclear reactor. Indeed, after Norway's experimental research reactor went critical in 1951, Norway stood poised to play a major role in international nuclear relations, and indeed did so for more than a decade.

Although they eventually encountered financial problems, Norwegian researchers had by 1955 already developed a technique for the separation of plutonium. Separation of plutonium on a small scale continued at the Kjeller reactor site, east of Oslo, until the early 1970s. Given that Norway's energy resources—in the form of hydroelectricity—were more than adequate for the needs of the Norwegian population at the time, speculation persists that the rationale behind the Norwegian reactor program might have been to lay the basis for nuclear weapons production. This article contends that although nuclear weapons were considered at the outset of the Norwegian program (and did have their supporters), there is no indication that a bomb program was ever put at the forefront of Norway's nuclear agenda. As a member of the North Atlantic Treaty Organization (NATO) from 1949 onwards, Norway eventually came under the American nuclear umbrella (although Norway never accepted the stationing of nuclear weapons on its territory in peacetime). More interesting from a proliferation standpoint, however, is the nuclear assistance Norway provided in these early years to other states, two of which did develop nuclear weapons. Meanwhile, Norway's own nuclear ambitions eventually faded.

Norway's nuclear history, therefore, is an important case to examine in considering the processes—both forward and backward—of proliferation. One of the intriguing aspects of the Norwegian case is the extent to which it exemplifies the euphoria created by the discovery of nuclear energy, which was taken to even greater heights under the rubric of the U.S. "Atoms for Peace" initiative. For Norway, a military nuclear program was considered too expensive and too technically demanding for a small, relatively poor country in the immediate post-war environment. But skillful nuclear advocates still developed other avenues for Norway to pursue.

The Norwegian case sheds new light on international relations in the nuclear field in the 1940s and 1950s. The basis for Norway's role as a player in the international market was its indigenous production of heavy water and its early acquisition of basic nuclear technology and know-how. Its venture into nuclear reactor construction led to Norway's establishment of close relations with several foreign countries embarking on applied nuclear research in the same period. For example, Norway set up a major joint venture with the Dutch in 1950.

Norwegian nuclear history is particularly interesting because it illuminates France's position in the first decade after World War II. Arguably, Norway's refusal to enter into a formalized cooperative agreement with France was one of several disappointments (albeit a minor one compared, for instance, to Canada's refusal to sell unsafeguarded uranium to the French) that caused France to develop a strong resentment towards its allies. Ultimately, this resentment would become a major influence on the shaping of President de Gaulle's nuclear policy.

Yet, Norway's export of heavy water to the French program helped France develop nuclear weapons sooner than would otherwise have been possible.[2] Norwegian heavy water was also used in the Israeli program. Norwegian exports in the nuclear field exemplify the extent to which commercial considerations influenced nuclear relations and nuclear control in the early nuclear age. However, Norway's inability to make its nuclear industry profitable and competitive in the international market caused the Norwegian nuclear venture to falter in the mid-1960s. The nadir was reached when the rise of the environmental movement in the 1970s halted all plans for the construction of nuclear power plants in Norway. Thus, the Norwegian case illustrates how an early enthusiasm for nuclear technology among a small group of technocrats was gradually replaced by the general public's concerns about the risks involved in the utilization of this technology.

This article explores the themes outlined above in the context of Norway's nuclear history. First, it focuses on Norway's strong belief in the virtues of nuclear power and its organization of a reactor program in the immediate post-war period. Second, it outlines the discussions about military use of nuclear energy during the same period. Third, it covers Norway's cooperation with foreign countries in the 1940s and 1950s and gives an overview of the assistance provided to foreign programs in that period. Finally, it discusses the causes for the decline of the Norwegian program and shows how Norway in the 1960s became a strong supporter of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), as well as of International Atomic Energy Agency (IAEA) safeguards.

THE POST-WORLD WAR II PERIOD: NUCLEAR OPTIMISM IN NORWAY

In the immediate post-war period, naturally enough, Norwegian politics focused to a large extent on the reconstruction of the country; investment in research and development was seen as one means to build a better society. Norway's venture into applied nuclear physics can be interpreted as an expression of this general goal.

The war had illustrated the importance of science and technology for a country's general development and standing in the world. The significance of radar for the Allied victory in submarine warfare in the North Atlantic was but one powerful demonstration of the importance of science and technology.

The Norwegian venture into applied nuclear research was directly linked to the war experience. The initiator of the first reactor project was a young astrophysicist Gunnar Randers, who in 1946 had been appointed Director of the Physics division of the newly established Norwegian Defense Research Establishment (*Forsvarets forsknings-institutt* or "FFI"). Randers belonged to a contingent of around 30 Norwegian scientists who participated in defense-related research in Britain during the war. Before returning to Norway in 1945, this group of highly qualified researchers had gained the support of the Supreme Commander of the Norwegian military forces for the idea of establishing a defense research institute at home. The use of science to solve practical problems had been a revelation to many of these university educated scientists, and they were eager to preserve and build upon the expertise and experience gained from their war efforts. The FFI was set up in January 1946 at Kjeller, east of Oslo. Although the mandate of the institute was to do research for defense purposes, it was recognized that the outcome of the various research activities might be just as useful in the civilian field. For instance, one major field of research was the development and use of asdic (sonar), a technology that was as potentially useful to the large Norwegian merchant and fishing fleets as to military vessels. This double function of the research efforts was recognized from the outset.[3]

In 1947, Norway decided to construct an experimental nuclear reactor because it already possessed indigenous heavy water production, a particularly important prerequisite. At the start of the war, Norway had been the only producer of heavy water in the world. Its production was a by-product of the substantial fertilizer production of Norsk Hydro. The possession of heavy water meant that a reactor could be built using natural uranium for fuel. It seems reasonable to believe that the mere existence of the indigenous heavy water production was a major factor behind Norway's decision to go into reactor development.

Although Norway was in a fortunate position with regard to heavy water, the country was lacking in other respects. Uranium prospecting in 1946 to 1947 confirmed that indigenous uranium deposits were inadequate for reactor purposes, even though a small deposit in the southeast of Norway was considered promising.[4] There was also a shortage of qualified scientists in the field. Consequently, young researchers were sent abroad for training to Frédéric Joliot-Curie's laboratory in Paris and to various laboratories in Britain.[5]

In August 1946, Randers and Odd Dahl (who would be in charge of the construction of the reactor) travelled to the United States in order to learn as much as possible about the Manhattan Project and to discuss their plans for a Norwegian experimental nuclear reactor. The U.S. Atomic Energy Act, more commonly known as the McMahon Act, had not yet been put into effect, and they were able to visit several laboratories, although not the bomb sites or the plutonium and enrichment plants. Their American colleagues gave clear-cut advice: Norway's resources were adequate for the construction of a small reactor, but inadequate for the construction of nuclear bombs.[6] The reassurance given by the American experts was probably a decisive factor in obtaining the Ministry of Defense's support for the reactor project. The young Defense Minister Jens Christian Hauge not only gave his assent to the project, but suggested that the reactor could be financed out of money set aside for the reconstruction of Norway's defense capability. He suggested spending money that was intended for the purchase of long-range artillery on the reactor instead. The grant amounted to five million kroner, a vast sum of money for research purposes at the time. The decision to spend this much money on a research project directed by a military institution was strongly criticized by certain representatives of the physics departments at the universities in Oslo and Trondheim. However, the grant was approved by the Storting (Norway's national assembly) in July 1947 after the introduction of White Paper No. 118, which dealt with the rebuilding of Norway's defense in general.[7]

What were the reasons for launching the project? The initiators of the project clearly had high ambitions. In early 1946, Randers published a book entitled *Atomic Energy—The World's Hope or its Demise?* In the preface he voiced his strong faith in the future use and value of nuclear energy. In this vein, he wrote:

> One of the aims of this book is to give the reader the feeling that we are standing at the beginning of a long and unknown road full of possibilities, and not on the final road leading towards oblivion (...). There are still pioneers among us; people who can see new possibilities which will determine our future course (...).[8]

Such optimism about the possible uses of nuclear energy fueled the development of this form of energy. It was believed that nuclear energy would be a valuable commodity for any nation, both militarily and industrially. Its military use had already been demonstrated. Finding civilian purposes for nuclear energy was all that was left. Randers predicted everything in his book, from the use of nuclear energy in farming the desert wastelands to creating living conditions on our neighboring planets. These were, however, visions of the future. The immediate task was to lay the groundwork for the future development of nuclear energy, which meant, for example, acquiring expertise in the field. Thus, in the first round, Randers thought that it would be wise to concentrate Norway's efforts on developing a "super fuel."[9]

After his return from the United States, Randers posed the following question to the other FFI directors of research:

> If we decide that Norway should use its military budget for nuclear research, should it be specifically geared towards developing a nuclear bomb or towards possibly producing rocket fuel or towards peaceful purposes only?[10]

There is as yet no information available about the internal discussions at the FFI. But, based on public documents from 1946 to 1947, it is possible to get an impression of the defense community's thinking on this issue.

Military Plans

A synopsis of the work carried out in the Physics Division of the FFI in 1946 to 1947, suggests that in the winter of 1946 Randers wrote two reports to the Minister of Defense, both bearing the heading: "Atomic Bomb."[11] The contents of these reports are unknown. Thus, the principle available sources containing information about the thinking of the defense community about the origins of the reactor project are a number of technical reports from the FFI to the Defense Commission.[12]

The Defense Commission was set up in 1946 to plan the organization of Norway's future defense. One major lesson learned from the German invasion of Norway in 1940 was that Norway must strengthen its defense. However, no general consensus existed as to how this lesson should be put into practice. The military leadership's first priority was to reconstruct the national defense as rapidly as possible. But Hauge, the defense minister, who had also been one of the leaders of Norway's main resistance movement during the occupation, thought otherwise. His first objective was to raise the overall *quality* of Norway's defense, and he was willing to proceed with the reconstruction through a gradual process in order to achieve this aim. In December 1946, the Storting accepted a plan for reconstruction along these lines. The Defense Commission had been established to make the preliminary analysis upon which the plan was to be based.[13]

In the reports from the FFI to the Defense Commission, there were three chapters that dealt with the use of nuclear energy in future military conflicts. The first chapter was written by the directors of research at the FFI along with miliary representatives and several other outside experts.[14] The second chapter was written by Egil Ronæss, the director of the Chemical Division. His chapter dealt with, among other things, the use of radioactive gases.[15] The third chapter was an appendix to the report that specifically outlined the consequences of nuclear weapons for future warfare. This chapter was penned by Gunnar Randers, but it represented the view of a special committee established by the Supreme Command Technical Advisory Committee to discuss this particular topic.[16] Altogether, the technical reports discussed three different ways of using nuclear energy in the military field: for a nuclear bomb; for a fuel for ships, airplanes, tanks, or rockets; or for the production of radioactive gases.

The attitude towards the uses of nuclear energy, as they were portrayed in these three chapters, varied somewhat. The chapter written jointly by the directors of research and Randers's chapter gave the impression that the nuclear bomb was a revolutionary defense tool; that nations possessing this instrument would be in a singular position; and that this held true even for small nations. And yet, a Norwegian nuclear weapons production program was not deemed likely, for two reasons. Norway's scientific, technical, and economic resources were considered too limited for nuclear weapons production, even though the country had all the necessary raw materials. Moreover, there was some doubt as to whether it would be wise for Norway to produce nuclear bombs, even if it turned out that Norway did have the prerequisites to do so. The jointly written report expressed a fear that the existence of nuclear bombs on Norwegian soil would actually increase the risk of attack in a war because of their mere presence. It was suggested that an alliance with one of the nuclear powers could be an alternative to having a domestic nuclear bomb production program. This solution was mentioned in the form of a question, with the understanding that this was a political question.

In the chapter written by Randers, the attitude towards having a national nuclear bomb production program was far more positive. He argued that the possible production of nuclear bombs should not be considered solely from the point of view of financial costs, but also according to the "effectiveness" of the investment measured in military strength. Randers noted that:

> Nuclear weapons are expensive to produce. However, it is also true that if one looks at the cost of securing a positive result in warfare, instead of the cost of a single weapon, then it appears that nuclear weapons are the cheapest weapons one can have.[17]

This chapter concluded that so long as there were no established international controls over nuclear energy, a country should not forswear the possibility of using nuclear weapons for defense purposes. The same difference of opinion was evident in the two chapters' respective discussions of the possible use of nuclear energy as a source of power for ships, airplanes, tanks, or rockets. The collaborative chapter took a categorical stand against such ideas. By contrast, the special committee plead its case for making the air force more effective by using a "super fuel" based on nuclear energy for the propulsion of airplanes. Randers's chapter ended with the following characterization:

> For the time being, one has (...) no choice. Either one must give up the hope of having an effective defense, or one must aim at a future with the possibility of using nuclear weapons without effective cautionary rules and regulations. Nuclear weapons in this context do not necessarily mean the bomb, but also nuclear fuel for planes and rockets.[18]

The question of using radioactive material, especially plutonium, for defense purposes was discussed in detail in Ronæss's chapter on biochemical warfare. He explained how radioactive gases could be used in warfare and on how defense against this type of gas warfare could be organized. He concluded that Norway must conduct its own research in this field in order to build up an effective defense. The authors of the collaborative chapter agreed to a large extent with Ronæss's judgment. The other directors of research at the FFI and the Supreme Command Technical Advisory Committee's military representatives also considered it possible that radioactive material could be used in future warfare.

The technical reports from the FFI to the Defense Commission were written before Randers and Dahl's visit to the United States. This visit seemed to confirm that Norway would have the resources needed for the construction of a nuclear reactor, but not enough resources to build a nuclear bomb. At the end of 1946, Randers prepared a work plan for the Physics Division of the FFI. The work plan did not give any clear answer to Randers's own question as to whether or not Norwegian nuclear research should be directed towards constructing nuclear bombs, producing rocket fuel, or developing an energy source for peaceful purposes. This work plan stated that the FFI, with the support of the Ministry of Defense, had decided to pursue nuclear energy research, and that it must be based upon what would be possible to build by using only one's own resources in the beginning. With regard to the question of purpose, the work plan took a wait-and-see attitude; the reactor represented the first step towards the industrial utilization of nuclear energy. It characterized additional developments as being interesting for both defense and civilian uses, but it emphasized that the reactor itself had no military value.[19] All in all, the work plan represented a toning down of Randers's earlier view concerning the use of nuclear energy (as put forward in his chapter on nuclear bombs in the technical report to the Defense Commission). His new level-headed tone regarding the military aspect of nuclear energy research seemed quite in line with the views expressed in the joint chapter of the same report.

The White Paper introduced by the Ministry of Defense to the Storting seemed to confirm this wait-and-see attitude. The part of the paper that dealt with nuclear energy research was formulated in quite general wording. It stated that the reactor could be used in all general research in the country, both military and industrial. With regard to the military aspect, the White Paper stated generally that the country needed to obtain knowledge about nuclear energy in order for it to organize its defense, including civil defense, on a scientific basis. It was pointed out that it was not feasible for a small nation to produce nuclear weapons. Nevertheless, the Ministry of Defense noted that, in the long-run, technical advancements in this area conceivably could "make nuclear energy a part of even a small nation's defense program."[20] All the same, it was emphasized that the planned reactor would not be able to produce enough plutonium to manufacture a nuclear bomb.

References to civilian uses of the reactor were vague. Apart from the fact that the reactor would produce radioactive isotopes that could be used in medicine and biology, the general point of view was that the reactor was valuable as a source of neutron production and as a tool for studying chain reactions. The White Paper stressed that chain reactions were the basic elements for the development of nuclear energy, but almost nothing concrete was mentioned about planned uses of nuclear energy.

It is highly likely that the wording in the White Paper reflected the planners' uncertainty as to what would be the upshot of nuclear energy research at Kjeller and what would be achieved by starting along this path. At the same time, the White Paper itself represented a manifestation of the extent to which the Ministry of Defense was behind nuclear research. It was also an expression of the Ministry's confidence in Randers's positive assessment of the future role of nuclear energy in society, however vaguely defined that role was at this time.

In retrospect, a clear line appears from Randers's ideas about a "super fuel" in 1946, to a project for developing nuclear reactors for ship propulsion, which eventually was started up in the early 1950s. Thus, the ambiguity of White Paper No. 118 also could have been to some extent deliberate. Certain sections of the White Paper were clearly formulated with a view to placating the displeasure of the university sector. Hauge himself has acknowledged that the supporters of the project feared until the end that there would be trouble when the White Paper was put before the Storting.[21] This did not happen, yet the resistance from the university sector proved to be so strong that the reactor project was separated from the FFI, and a separate, civilian nuclear research institute, the Institute for Atomic Energy (IFA), was created next to FFI at Kjeller.[22]

INTERNATIONAL COOPERATION AND ASSISTANCE TO FOREIGN PROGRAMS

When the Kjeller reactor went critical in 1951, Norway became the sixth country in the world to construct a nuclear reactor. The successful outcome of the project had depended to a considerable degree on assistance from foreign countries. One of Randers's major assets had been his ability to establish and maintain a wide network of contacts.

Nevertheless, international cooperation in the nuclear field was restricted due to the monopolistic policy pursued by the United States until the introduction of the Atoms for Peace initiative. The McMahon Act prohibited American cooperation with other countries, with the exception of Britain and Canada. The wartime agreement between the British and the Americans also prohibited the British from giving assistance to foreign countries. From the very outset of the Kjeller reactor project, the Norwegians hoped for a modification of the American policy that would make it possible to cooperate more closely with British and American research institutions and to buy material and technology from those two countries. Both Randers and Dahl had close contacts with British and American researchers. Dahl had spent 10 years at the Carnegie Institute in Washington, D.C., constructing nuclear particle accelerators. Randers had been a research fellow in astrophysics at the University of Chicago before moving to Britain to join the defense research efforts there.[23] In Britain, he had worked under Sir John Cockcroft, until Cockcroft was transferred to Canada to take over responsibility for constructing the Chalk River reactor. After the war, Cockcroft was, by all accounts, personally very encouraging to Randers, but Britain's "special relationship" with the United States prevented any closer cooperation for a long time. In 1947 to 1948, Norway repeatedly made formal requests to the British authorities asking for assistance with the construction of the Kjeller reactor. All requests were turned down by the British Ministry of Supply.[24]

Cooperation with France

Thus, France and Sweden became the countries with which the Norwegians maintained the closest relations in the early post-war period. France became the foreign country that contributed the most, by a wide margin, to the Norwegian venture in the late 1940s.

There were two important reasons for France's willingness to give assistance. First, there was France's need to import heavy water from Norway. Norwegian export of heavy water to France had started in 1940 when Norsk Hydro's general director agreed to hand over to France the totality of Hydro's stockpile, 185.5 kilos in all. The deal took the form of a gentleman's agreement,[25] and the heavy water was brought to France less than a month before the German invasion of Norway in April 1940.[26] France paid for the delivery after the end of the war.

When the Germans invaded France in June 1940, French researchers fled with the heavy water to England, where they continued their research at the Cavendish Laboratory in Cambridge. In December 1940, they demonstrated for the first time that it was possible to produce nuclear energy with natural uranium.[27] This demonstration was also an important link in the chain leading to the production of the atomic bomb.

In April 1945, the French government again contacted the Norwegian government in exile in London, about securing new supplies of heavy water. New negotiations followed in the autumn, after the return of the Norwegian government to Oslo. Soon, deliveries of heavy water to the French nuclear program became a routine matter. During the whole post-war period, Norway has provided the French program with about 100 tons of heavy water.[28]

Second, the French wanted to build up European cooperation in the nuclear field as a counterweight to American domination. The monopolistic American policy was strongly resented by the French, who had contributed to the war efforts in this field. The French had been decisive in persuading the British that the atomic bomb could be built, and the British had been equally decisive in persuading the Americans to launch the Manhattan Project. Furthermore, several scientists based in France before the war had played a key role in the construction of the British-Canadian reactor at Chalk River. Joliot-Curie's assistant Hans Halban directed the project in the beginning, and other participants included Lew Kowarski and Bertrand Goldschmidt.[29] In the post-war era, Bertrand Goldschmidt would play an important role in French nuclear relations with other countries. The French particularly resented the "special relationship" between the United Kingdom and the United States in the nuclear field, which meant that the British were given preferential treatment by the Americans, while the French were left to cope on their own. They therefore encouraged other European countries to go into nuclear research and development.

Norway no doubt benefited hugely from cooperating with the French Commissariat à l'Energie Atomique (CEA). The CEA received and trained Norwegian researchers in their laboratories. Odd Dahl was permitted to spend weeks at the French reactor site of Châtillon, studying the design of the first French heavy water reactor Zoé. He also had the opportunity to discuss the design of the Norwegian reactor with Kowarski. Furthermore, the French supplied the Kjeller reactor with reflector graphite.[30]

Norway's main problem in constructing the reactor was lack of uranium, the actual energy source. Due to the Anglo-American monopoly of all Western controlled uranium sources, no uranium was available in the international market. Intensive prospecting had started up in several countries, including Sweden, a country rich in uranium reserves, but the utilization of such sources was years away. Norway's indigenous uranium reserves were scarce. The most promising deposit was a small one in the southeastern part of the country. But even if Norway could eventually extract sufficient uranium from this deposit, the Norwegians would still lack the necessary technology to refine the indigenous uranium. In 1948, the French volunteered to assist the Norwegians in refining their uranium. At this stage, however, the Norwegians had become reluctant to accept more French assistance for fear that overly close relations with the French might be harmful to Norwegian interests.

During a visit to Paris in the winter of 1948, Randers and Dahl told Joliot-Curie that they feared a hostile American reaction to eventual Norwegian-French cooperation.[31] In late 1948, the administrative director of the CEA, Raoul Dautry, suggested to the Norwegian ambassador in Paris that Norway and France should continue working together in order to establish a European nuclear industry independent of the two superpowers,[32] but the Norwegians did not follow up on this suggestion either.

As the Norwegians made progress with the design of the reactor tank, the lack of uranium was felt more and more acutely. In October 1949, Joliot-Curie told Randers that the CEA would be willing to provide the Kjeller reactor with uranium, provided that the French-Norwegian cooperation was formalized in an agreement.[33] He also wanted the Kjeller reactor to be acknowledged as a French-Norwegian pile. The Norwegians were very reluctant to accommodate Joliot-Curie. This reluctance resulted partly from the fear of a small power being dominated by a larger power. Randers, in particular, resented the thought of having to put up "a French flag" at Kjeller. But Norway's reluctance was also due to fear of a hostile American reaction to an eventual agreement. The Americans' negative attitude towards the French nuclear development program in general and Joliot-Curie's leadership in particular was well-known, and the American scientific attache in Paris had told Randers that the Americans did not trust Joliot-Curie.[34] Joliot-Curie's membership in the French Communist Party was increasingly held against him, and his anti-NATO stand did not improve his position. Eventually, he was forced to resign in 1951. The Norwegians were undoubtedly sensitive to the American position. For Randers, collaboration with the Americans and the British in the nuclear field remained the ultimate goal. He was convinced that the United States would eventually be forced to relinquish its monopolistic and secretive policy in the civilian nuclear field. This belief was one of the reasons he advocated a total openness regarding nuclear research and development.[35]

Randers's advocacy of openness was a further impediment to a closer French-Norwegian cooperation. When Joliot-Curie started pushing for a formal agreement of cooperation, one of the inducements he offered to the Norwegians was an invitation to learn the French methods for the extraction of plutonium from spent fuel. This offer was made on the condition that the Norwegians would keep what they learned to themselves.[36] Such a condition contradicted Randers's policy of treating reactor construction the same way as the results of basic research. The aim was to publish, and the ultimate aim of publishing was to convince the Americans that their policy of secrecy would not prevent other countries from pursuing nuclear research. For all of these various reasons, formal cooperation along the lines suggested by the French did not suit Norwegian interests. When the issue of cooperating with France was finally settled at the cabinet level in March 1950, the Ministry of Defense stated that it feared possible harmful consequences of eventual French-Norwegian cooperation and, for this reason, considered it impossible to enter into a formal cooperation agreement with the French.[37]

Norwegian-Dutch Cooperation

In February 1950, the Norwegians found an unexpected solution to their uranium problem, when they learned that the Netherlands possessed a small stockpile of uranium oxide that had hitherto been kept secret. The Dutch were planning to launch themselves into applied nuclear research, and Hans Kramers, a leading Dutch physicist, travelled to the Scandinavian countries looking for potential partners in the field. The Dutch and the Norwegians immediately agreed to unite their two projects, although it was agreed that the Kjeller reactor would remain a Norwegian reactor. The Dutch would supply the uranium for the reactor, and they would take part in the final stages of its construction. This arrangement solved the acute Norwegian uranium problem, and the Dutch got a flying start in the field of reactor development.[38]

One problem remained to be solved, however. The Dutch uranium was in the form of raw material, and neither the Dutch nor the Norwegians possessed the necessary refinement technology. Once more the French were eager to do the job, but the Dutch in particular did not like the idea. At this stage, the United Kingdom Atomic Energy Authority suddenly agreed to barter the Dutch uranium oxide for British uranium metal, produced specifically for use in nuclear reactors. The decision came as a total surprise to the Norwegians, who had asked the British for uranium in 1948 but had never received an answer. The British had not been able to give a positive response due to American opposition. Now, they were willing to go ahead with or without American consent.[39] The change of policy might have been aimed at preventing the French from acquiring a leadership position within a budding European nuclear cooperation. At least, this was how the French interpreted it.[40]

Initially, the Norwegian-Dutch cooperation was a highly successful one. However, from the mid-1950s, the venture ran less smoothly. The construction of the Kjeller reactor had served both countries' interests. But once the discussions on a follow-up reactor got under way, it soon became evident that Norway and the Netherlands had different points of departure for the application of nuclear energy. While the Netherlands saw nuclear energy as the primary solution to its power problem, Norway's energy needs were provided for through hydropower. In the early 1950s, Norway's interest in nuclear energy was focused on its potential use for ship propulsion. This orientation was obviously a consequence of Norway's status as an important shipping nation. The Institute for Atomic Energy, therefore, started to plan for the construction of a prototype reactor for ship propulsion. In 1953, the Dutch and Norwegians agreed to build jointly a prototype that would serve as a training ground for both the possible construction of power stations and ship propulsion mechanisms.[41] The Dutch and Norwegians discussed several different reactor types and locations for construction during 1954, without making a decision.[42] In the midst of these discussions, the end of the American policy of secrecy led to a review of the Dutch plans.

In July 1955, the Dutch set up a new research establishment, the Foundation Reactor Centre Netherlands (RCN). This new creation was linked to a decision to buy a whole reactor equipped with enriched uranium from the United States instead of building a second reactor jointly with the Norwegians. The Dutch distanced themselves from the Norwegians because they were afraid that the connection with Kjeller might complicate the nuclear cooperation agreement they were negotiating with the United States.[43] In November, the Dutch and the Norwegians agreed that the new Dutch reactor center and the Institute for Atomic Energy at Kjeller would pursue their reactor development independent of each other. This agreement signalled the beginning of the end of Dutch-Norwegian cooperation. A new cooperative agreement was signed in 1955, effective until 1958, when it was extended for one more year.

In the mid-1950s, there had been plans for building a full-scale reprocessing plant at Kjeller. A few milligrams of plutonium had in fact already been extracted in the laboratory in 1954.[44] But when the Dutch chose to buy a reactor from the United States, instead of building one jointly with the Norwegians, the Institute for Atomic Energy decided to spend the money originally intended for the reprocessing plant on the construction of a new reactor.[45] Plans were made for the construction of a prototype reactor for ship propulsion. The Norwegians had problems realizing this project, however. In the end, the Organization for Economic Cooperation and Development (OECD) decided to finance it, and it eventually materialized in the form of the Halden reactor. This reactor was acknowledged as a Norwegian reactor, but it was administered by the OECD.

The decision to abandon the plans for a full-scale reprocessing plant also turned on the fact that the OECD was building a reprocessing plant, the Eurochemic, at Mol in Belgium. The Norwegians and the Dutch were both investors in this project, which would permit them to reprocess their spent fuel abroad. Nonetheless, an experimental reprocessing facility was built at Kjeller. This facility made it possible for the Dutch and the Norwegians to learn the extraction technique without having to make a major investment. The limited extraction of plutonium at Kjeller continued until the early 1970s. In addition to the Norwegians and the Dutch, Swedish researchers made use of the facility from the early 1960s onwards.[46]

In recent years, a debate has continued in Norway about the amount of plutonium extracted from spent fuel in Norway; the purpose of the plutonium extraction; and the end use of the plutonium. The debate was initiated by one of the Norwegian researchers Torbjorn Sikkeland (now a professor at the University in Trondheim), who extracted the first few milligrams of plutonium at Kjeller in 1954. He had left Kjeller by 1956 because he had not been satisfied with the storage facilities at the site. In 1993, he suggested that some of the plutonium produced in Norway might have been meant for the then-secret Swedish bomb program.[47] A Swedish researcher also has maintained that the plutonium extracted was meant for a joint Swedish-Norwegian bomb program. The plutonium allegedly had been shipped to Sweden for the purpose of making such bombs.[48] These allegations have been categorically rejected by the Norwegian Institute for Atomic Energy, as well as the government. The Institute maintains that only 200 grams of plutonium were produced at Kjeller. Out of these, 10 grams were lost in the process, 29 grams were exported to Sweden, 88 grams to the Netherlands, and 71 grams to Belgium.[49] These data have been confirmed by the government. Moreover, they seem to be corroborated by an agreement entered into by the Dutch and the Norwegians in 1960.

When formal Dutch-Norwegian cooperation came to a halt in 1959, the question of dividing the spoils was raised. In particular, the Dutch wanted compensation for the five tons of uranium raw material that they had supplied to the Kjeller reactor. The countries also needed to agree on the ownership of the plutonium produced in the reactor. According to J. M. van Splunter, the plutonium in question amounted to 400 grams.[50] It is not entirely clear from van Splunter's writings, however, whether the 400 grams had already been produced by 1960, or if the 400 grams represented an estimate of the total amount that would be extracted. The two countries agreed to share the plutonium between them, each taking 200 grams.[51]

Thus, the 200 grams reported to have been produced by Norway at Kjeller seem to be in accord with the Dutch-Norwegian agreement, provided that the 400 grams referred to had not already been produced by 1960. If that were the case, the figures given by Norwegian authorities would not make sense, given that the extraction continued into the early 1970s. Moreover, it would seem that the figures provided by the Institute and confirmed by the Norwegian government do not include the total production at Kjeller, but merely the Norwegian part of it. Furthermore, it is a fact that the plutonium extracted by the Eurochemic reprocessing plant in Belgium has never been mentioned in official reports. Recently, it became known that this plutonium amounted to three kilos.[52] Such an amount had been sold to a German company in the late 1960s, apparently without being subjected to safeguards.[53] Thus, there are indications that the government has been less than forthcoming about the extent to which Norway has been involved in plutonium production. Yet, the government's reticence does not necessarily imply it is trying to cover up the existence of a previously secret bomb program, as some critics seem to be suggesting. Nevertheless, the amount of plutonium produced might indicate a wish to establish a nuclear capability. Still, the evidence suggests that during the period of plutonium production, the Norwegians were more keen on making money than bombs.

Norway's Export of Heavy Water to Israel

The most controversial Norwegian nuclear export was the sale of 20 tons of heavy water to Israel in 1959. The Israelis contacted the Norwegians in 1956, making an informal request through the chairman of the Labour Party and a Labour member of the Storting.[54] A similar request was made simultaneously to the American government. The Israelis obviously hoped to be treated in the same way as the Indians, whom the Americans had supplied with heavy water a year before without insisting on controlling its use. In the Israeli case, however, the Americans insisted on safeguards.[55] When Gunnar Randers and the board of Noratom, the exporting firm, learned about the Israeli desire to buy a large quantity of heavy water, they were eager to sell. To Randers, such a deal represented a potential breakthrough to the international market.[56] The early negotiations took place in the winter and spring of 1958. Thus, they coincided with the negotiations of the U.S.-Euratom nuclear agreement in which the control aspect of the deal was a core issue, hotly debated within the IAEA.[57] The Euratom countries insisted on the establishment of a special safeguards system within the Euratom area and administered by Euratom. From the perspective of Vienna, such a system represented a breach of the principle of international control.

It was generally acknowledged that if the Americans were to accept what was perceived to be Euratom self governance, the chance of securing a wider safeguards system through the IAEA (in accordance with the IAEA statute) would be small.[58] The IAEA's negotiation of the first safeguards document was pending, and this raised concerns about possible implications of nuclear trade deals for the development of international nuclear safeguards. The Norwegian Ministry of Foreign Affairs, as well as Randers (a personal advisor on nuclear energy matters to U.N. Secretary-General Dag Hammerschöld), surely must have been well acquainted with the on-going discussions. This knowledge may explain the Foreign Ministry's insistence that the sale would only take place if the Israelis agreed to subject the heavy water to international control. The Noratom board was also worried about this aspect of the sale.[59]

Randers was probably inclined to sell "without strings," as long as the Americans did not object. Without mentioning a possible Norwegian supply to Israel, he had in fact asked Philip Farley, the special assistant to the secretary in atomic energy matters, whether the United States found the prospect of the Israelis building a 40 megawatt (MW) reactor "ominous." Farley had not replied directly, but had suggested that supply to Israel might present an opportunity for imposing IAEA safeguards.[60]

The Israelis were adamant that they would not accept control on their territory by a big power.[61] This attitude was not unusual at the time. Control measures imposed by the industrialized Western world on recipient Third World countries were perceived as being "discriminatory."[62] Randers may well have sympathized to a certain extent with this attitude, given his past efforts to promote openness and cooperation on an equal basis. He certainly did not like the idea of imposing control via bilateral agreements because this meant that the control measures imposed on recipient countries were bound to vary from case to case. Neither did he like the idea of having to exercise control on foreign territory. With the exception of the United States, no country had developed methods for controlling nuclear activities in recipient countries, and none liked the idea of having to do so. This reluctance was one reason why small supplier countries tended to support efforts establish a control regime that would be administered by the IAEA.[63]

Finally, there was the unresolved issue of whether to define heavy water as a "trigger" item or not. The IAEA statute made it clear that nuclear materials and whole reactors would be subject to control, but the provision regarding equipment and non-nuclear materials was less clear. On one hand, several countries, such as France and South Africa, were strongly against defining heavy water as a trigger item. On the other hand, the United States strongly supported the inclusion of heavy water, in accordance with the American Atomic Energy Act, which clearly subjected heavy water to control. It was thus reasonable to expect that the American position in the forthcoming negotiations on the development of the IAEA safeguards document would be to regard heavy water as a trigger item. Furthermore, the technical importance of heavy water for the production of plutonium was indisputable.

The Norwegian Ministry of Foreign Affairs insisted on attaching safeguards to the supply to Israel.[64] The producer, Norsk Hydro, had misgivings about the entire sale.

Norsk Hydro feared that the interests of the fertilizer firm in Egypt might be jeopardized if the agreement became known in the Arab world.[65] This fear was the reason why ultimately the heavy water was not exported directly from Norway. Instead of shipping it directly, Norway bought back 20 tons of heavy water from the United Kingdom and had it shipped from the British Isles to Israel.[66] The British knew about its destination and accepted the re-export without insisting on safeguards.[67]

When faced with the Foreign Ministry's insistence on safeguards and a Norwegian draft agreement they did not like, the Israelis invited Randers and his wife to Israel. They were wined and dined and taken sight-seeing, without a word being said about the heavy water agreement.[68] In the end Randers brought the topic up himself, and new talks about the control issue followed.[69] At the end of the talks, which continued after Randers's return to Norway, the Israelis agreed to give a guarantee that the heavy water would only be used for peaceful purposes and that Norway would have the right to verify this. Israel also agreed that the control function might in due course be transferred to the IAEA. But, Israel was adamantly against permitting the Norwegians to control the heavy water inside the plant, and the Norwegians accepted that they would merely have the right to ascertain the existence of the heavy water outside the reactor.[70] Of course, this compromise was a serious loophole that foreshadowed the position reluctant countries would take in connection with the negotiations of the NPT in the 1960s. Yet, there can be no doubt that the control arrangement—such as it was—went further than required by the IAEA statute, the only international instrument regulating nuclear trade at the time of the agreement. Heavy water would not be defined as a trigger item until its inclusion in the Zangger Committee's list.[71]

CAUSES OF THE DECLINE OF THE NORWEGIAN NUCLEAR PROGRAM

The Norwegian belief in nuclear technology received new impetus following Eisenhower's introduction of the Atoms for Peace initiative, which created hopes of new opportunities for international nuclear cooperation and nuclear trade. In November 1954, the American scientific attaché at the American embassy in Paris reported home that "there [seems] to have been a rather radical increase in Norwegian horizons concerning atomic energy."[72] This evaluation was based upon talks with Randers. It seems reasonable to link Randers's heightened ambitions—he was never a modest person in the first place—with the change introduced in the American nuclear policy. The revision of the McMahon Act clearly made him hope that in the future it would be possible to cooperate with the Anglo-American powers in the spread of nuclear technology all over the world, starting in Europe. Randers was eager to partake in the feast. He apparently envisaged embarking on a program of providing Europe with heavy water and enriched uranium. In other words, he planned to create a nuclear materials and non-nuclear materials industry based on the exploitation of Norway's hydropower resources. At the same time, it was obvious that Norway would not be able to build such an industry on its own for want of money as well as uranium.[73] Randers apparently had hopes that the new American policy would permit the British a wider scope of action in the field. If this were the case, it must soon have dawned on him that Britain was not prepared to put its relationship with the United States at risk. Britain's military program was dependent upon enriched uranium provided by the Americans.

The Norwegians were soon to discover that, contrary to expectations, the new American policy had quite detrimental effects on the Norwegian plans. As shown above, its first victim was the Dutch-Norwegian cooperative venture. More were soon to follow. The foundation of the Norwegian position in the nuclear research field had been indigenous heavy water production. In the early 1950s, the rate of production was increased because of a growing demand. When the Americans changed their policy, U.S. heavy water was suddenly available on the international market. The asking price was less than one-third of the Norwegian price ($28 per pound compared to $95). The decision to release American heavy water on the market was probably made early in 1955. It was partly connected with an Indian request for 10 tons of heavy water for use in CIRUS, the heavy water reactor provided to India by the Canadians as a kind of development aid.[74] The annual American production amounted to hundreds of tons of heavy water, while the Norwegian production was around 30 tons.[75] The Americans argued that the low price reflected a desire to help countries on the nuclear energy path. The Atomic Energy Commission was conscious that the costs of nuclear materials and non-nuclear materials would affect the length of time during which nuclear power would remain noncompetitive with power from conventional sources.[76]

This consideration was perhaps not the only or even the main reason for the low price, however. The British scientist J.V. Dunworth reported to Sir John Cockcroft that lowering the price of the heavy water was one way of "[fixing] Randers in Norway."[77] The Americans were undoubtedly very upset by his behavior in connection with the 1955 Geneva Conference on the Peaceful Uses of Atomic Energy. At the time of the conference preparation, Hammerschöld appointed Randers his personal adviser in nuclear matters. Randers immediately intervened in the preparations in a way that did not suit American interests. The American preparatory commission and its chairman Isadore Rabi undoubtedly resented his unwelcome initiatives, and they may have feared his ambitions. However, the U.S. State Department was worried about the effect the sale of heavy water might have on U.S. relations with Norway. It considered the new situation regarding heavy water as "a severe blow" to the Norwegians,[78] and Philip Farley felt that the Americans were presented with "a fairly serious problem in regard to Norway."[79] The diplomats furthermore thought it unfortunate that this "blow" would follow so closely on the U.S.-Netherlands nuclear cooperation agreement, which they also considered to be detrimental to Norwegian interests.[80] It was therefore decided to prepare the Norwegians for the forthcoming "blow," so that they would not be taken by surprise. A later decision in 1956 to furnish the reactor under construction at Halden with cheap American heavy water may have been a further way of softening the Norwegian reaction to the new situation.

On the whole, the major developments in 1955 clearly indicated the extent to which Norway's relatively strong position in the early 1950s in the nuclear research field had been a consequence of America's absence from the nuclear market. Once American industry appeared in the international market, it was difficult for any other country to compete.

However, it seems doubtful whether Randers acknowledged the extent to which the Norwegian position had become weaker due to the changed international situation. Others may have grasped it. The amount of money spent on nuclear energy development in Norway was again questioned in the mid-1950s, and again the severest critics were university-based scientists.[81] However, the political support continued unabated. Until the mid-1960s, the Institute for Atomic Energy still received two-thirds of the annual grants distributed by the Research Council for Science and Technology. Randers's and the government's continuous optimism led to new investments, and, in particular, to the creation of Noratom, a company specializing in the export of nuclear technology, nuclear materials (plutonium), and heavy water.[82] It was Noratom that handled the export of 20 tons of heavy water to Israel in 1959.

Noratom did realize its founders' dreams of creating a new, important export industry, however. After a while, Norway had problems penetrating the European market. The fact that Norway remained outside Euratom became an impediment to gaining access to this important market.[83] Several negotiations of sales to Third World countries were stopped for political reasons. Norwegian technology very soon became outdated. And new developments in Norway did not appear. In 1965, the ship propulsion project was cancelled because nuclear power could not compete in price with petroleum.[84] When the government introduced plans for the construction of nuclear power plants in the early 1970s, these plans were stopped by the mobilization of a strong anti-nuclear movement.[85] Eventually, the Institute for Atomic Energy was to change its name and adapt its research and production to meet the demands of the budding petroleum industry exploiting the North Sea gas and petroleum reserves. These reserves made the development of a Norwegian nuclear power industry seem even more unnecessary.

Norway's nuclear energy industry fizzled out due to a lack of domestic need and its inability to be competitive on the international market. Moreover, the downward trend was also indicative of the direction that Norway's defense policy took from the mid-1950s onwards.

THE ISSUE OF NUCLEAR DEFENSE OR NONPROLIFERATION

During the planning of the first Kjeller reactor, the possibility of a Norwegian bomb was clearly touched upon by the planners. At the time, the production of nuclear bombs was considered too expensive, as well as too demanding, to be a realistic aim in the foreseeable future. If some of the principal actors had harbored hopes about bomb production being made possible by changed circumstances, they must surely have been disappointed. If anything, political developments would later serve to take Norway further away from any plans of an indigenous nuclear arsenal.

The first important step in this process was Norway's membership in NATO, which meant that Norwegian defense became an integral part of the alliance's defense plans from 1954 onwards. Its membership implied that Norway was protected by the American nuclear umbrella, and that there were no legitimate military reasons to have indigenous nuclear bombs. This view was voiced by then-Chief of the Defense Staff Ole Berg in 1954 when it became known through a report issued by the Swedish Ministry of Defense that Sweden's defense plans had been enlarged to include nuclear weapons. Commenting upon this piece of news, Berg stated that Norway's military situation was quite different from Sweden's. While Sweden was a neutral country, Norway was protected through NATO. He furthermore emphasized that Norway had not developed the capability of producing nuclear weapons.[86]

The second step was contained in a statement made by Prime Minister Einar Gerhardsen in 1957. Speaking at a NATO summit meeting in Paris in December 1957, he declared that Norway had decided to refuse the deployment of nuclear arms and the storage of nuclear ammunition on its territory in peacetime.[87] His "No Nukes in Peacetime Declaration" came as a total surprise, especially to his foreign minister, who had wanted more careful wording. No one knows exactly what prompted Gerhardsen's decision, but several factors probably played a role. Gerhardsen's action may well have been an indication that he had not quite relinquished early post-war ambitions of Norway acting as a "bridge-builder" between the East and the West. Another likely factor influencing his decision was internal party strategies.

It is important to bear in mind that the Labour Party was the dominant force in Norwegian political life throughout the post-war period, and Gerhardsen was its leading light for the first 20 years of this period. Since the 1940s, the Labour Party had a strong left wing to contend with. The left wing opposed the security policy of the party. The first big issue was the question of NATO membership, which created a huge split within the party. The arming of NATO with nuclear weapons and the implementation of this policy in Norway was the second issue that threatened to split the party. Gerhardsen's declaration at the NATO summit conformed with a resolution made at the Labour Party convention earlier in the year. Based on grass roots intervention, the convention decided as part of its next four-year program that nuclear weapons should not be stationed on Norwegian territory. That spring, Gerhardsen also had assured the Soviet Union that Norway would not allow American special troops to supervise nuclear charges in Norway.[88] Gerhardsen's summit declaration may therefore be interpreted both as a concession to internal opposition, and as a reassurance to the Russians.

A third major step in the development of Norway's nuclear policy was an assurance given by the government in 1962 to the effect that Norway had no intention of acquiring nationally controlled nuclear weapons. This policy decision may have been linked to the big issue plaguing NATO during this period, namely: the question of establishing a multilateral nuclear force, which would give the Germans access to nuclear weapons within a supranational setting. This particular issue became a stumbling block in the negotiations of the NPT and effectively prevented any progress in the negotiations for years. The Norwegian attitude on this issue was clear. Norway had no desire to see a multilateral nuclear force being set up and wholeheartedly supported the efforts to arrive at a nonproliferation treaty. Once the negotiations were brought to a successful conclusion, Norway ratified the treaty in 1969.

Norway's efforts to promote nuclear nonproliferation in the 1960s were above all connected with developments within the IAEA and Gunnar Randers's personal involvement in the development of the IAEA safeguards system. The IAEA's efforts to develop a safeguards system did indeed provide Randers with a new outlet for his ambitions and energy. In 1960, he was appointed Norway's representative to the IAEA Board. At the first meeting he attended in January 1960, he was, in his personal capacity, appointed chairman of a safeguards "working group." The Board failed to reach consensus on a draft for a safeguards document, so the working group was set up to produce a new draft taking into consideration comments given by member countries on the Secretariat's draft. The Randers's working group produced a new draft within a month, and, after further deliberations, the final Safeguards Document was agreed upon by a majority decision of the Board in January 1961. Randers's involvement in the development of the IAEA safeguards regime continued throughout the 1960s. For every extension and revision of the first safeguards document, the Randers's working group would come together and prepare a draft. Randers's involvement meant that efforts to strengthen the IAEA's role as the main safeguarding body were actively supported by the Norwegian government. Thus, Norway volunteered to transfer its bilateral nuclear cooperation agreement with the United States to IAEA safeguards and to put all its nuclear activities under IAEA safeguards at an early stage. However, the full implementation of this policy was delayed for years due to Euratom's refusal to let the IAEA inspect the Eurochemic plant in Belgium.[89]

CONCLUSIONS

Norway's nuclear history is important because of the lessons it holds for international nonproliferation policy. The fact that one of the early leaders in the nuclear field eventually did not develop a bomb or, indeed, develop a nuclear power industry, provides important evidence that proliferation is not inevitable. At the same time, however, the Norwegian case highlights the importance of safeguards and export controls on stemming proliferation.

Norway contributed in a significant way to the development of the French and Israeli nuclear programs. In the 1940s and 1950s, Norway had no scruples about exporting heavy water to friendly countries. International nuclear trade was not officially regulated at that time, and what control measures did exist were solely directed at preventing heavy water from reaching the Soviet bloc. To a large extent, Norway shared the French resentment regarding American efforts to prevent other countries from developing a nuclear industry. Randers always felt certain that the Americans would sooner or later be forced to relinquish their monopolistic policy, and the Atoms for Peace initiative seemed to fulfill his dreams. His somewhat megalomaniac plans for a Norwegian nuclear materials and heavy water industry bear witness to the euphoria created by the change in the American policy. However, it soon became evident that it was based on a gross miscalculation not only of Norway's potential in the field, but of the prospects for nuclear developments in the world at large. Still, the Norwegian investment in the building up of a nuclear industry was considerable. It had its background in the early successes of the Institute for Atomic Energy and was based upon the Labour government's consistent support until the mid-1960s. The sale to Israel, at least in part, must be seen in light of past ambitions for creating a nuclear exports industry. The negotiations with Israel showed Norway's willingness to go far in the direction of treating nuclear trade like any other trade. This case also seems to indicate a growing awareness of the political implications of such trade in the Foreign Ministry. However, it is striking to what extent the handling of trade in the nuclear field seems to have been left to the technocrats for a long time.

The Norwegian attitude towards the handling of nuclear trade gradually changed during the 1960s. In the early 1960s, the Norwegian efforts in the nuclear field went into decline, and Randers personally found a new role as a promoter of IAEA safeguards, which meant that Norway very early on accepted IAEA control of its activities. However, the Euratom countries' refusal to accept IAEA control of the Eurochemic plant hampered full IAEA control of Norwegian activities for years. This was part of a general problem that was not solved until the IAEA and Euratom reached agreement for the application of IAEA, as well as Euratom, safeguards on all nuclear materials in the non-weapon states of the European Community.

The history of Norway's nuclear odyssey shows how research on the early nuclear age helps illuminate current proliferation problems. Events taking place during this early period shaped perceptions and influenced the politics of later periods. Indeed, several aspects of the nuclear period deserve to be researched more thoroughly.

For instance, there is probably a great deal more to be learned about patterns in international nuclear relations during the 1940s and 1950s, when—in the absence of taboos or effective controls—numerous countries actively took part in nuclear research and development. One interesting question is how the two European powers, France and the United Kingdom, compensated for the American refusal to provide their nuclear programs with assistance. To take but one example, we know that the United Kingdom only reluctantly accepted President Eisenhower's Atoms for Peace initiative.[90] At the time of the launching of this program, the British felt that they had finally managed to put their nuclear house in order: they had gotten the bomb and established close relations with Australia and South Africa, two of the major uranium-producing countries in the world. But do we know all there is to know about the contents of this cooperation?

Another potentially interesting field of research suggested by the Norwegian case is the plutonium production which took place in the 1950s and 1960s, and especially the role that Eurochemic played in the distribution of plutonium. More information on the way Eurochemic influenced the spread of IAEA safeguards in the pre-NPT period would be especially valuable to the nonproliferation field.

[1] An earlier version of this paper was presented at a workshop on "Nonproliferation Decisions: Lessons from Lesser Known Cases" held at the Monterey Institute of International Studies, August, 19-29, 1996. I would like to thank David Fischer and Lars van Dassen for comments on that first version of the paper.

[2] Bertrand Goldschmidt, "The supplies of Norwegian heavy water to France and the early development of atomic energy," *IFS Info,* No. 4 (1995), pp. 24-26.

[3] Astrid Forland, "Norsk atomenergipolitikk, 1945-1951" (Master's thesis in history, University of Bergen, 1985), pp. 54-55; Tor Arne Eilertsen, "Fra FOTU til FFI. Grunnleggingen av norsk forsvarsteknologisk forskning, 1942-1946" (Master's thesis, University of Bergen, 1987).

[4] Astrid Forland, "Atomer for krig eller fred? Etableringa av Institutt for atomenergi, 1945-48," *Forsvarsstudier*, No. 2 (1988), p. 13.

[5] Gunnar Randers, *Lysaar* (Oslo: Gyldendal, 1975), pp. 88 and 106.

[6] Forland, "Norsk atomenergipolitikk," pp. 52-53; Forland, "Atomer," pp. 11-12.

[7] The White Paper is printed in the Records of the Storting, published on an annual basis.

[8] Gunnar Randers, *Atomkraften. Verdens håp eller undergang* (Oslo: J.W. Cappelens forlag, 1946), p. 5.

[9] *Ibid*., pp. 217-218.

[10] Norwegian Defense Research Establishment's archives, file 70, 1946, letter from Randers to the Secretariat and the research directors, dated October 10, 1946.

[11] Randers's private papers, file entitled "IFA, 1946-1951," "Kort oversikt over fysikkavdelingen 1946/47" ("A short overview of the Physics division 1946/47").

[12] National Archives (Oslo), "Tekniske utredninger til Forsvarskommisjonen av 1946" ("Technical Reports to the Defense Commission of 1946").

[13] Jakob Sverdrup, *Inn i storpolitikken 1940-1949* (Oslo: Universitetsforlaget, 1996), pp. 223-234.

[14] This was the concluding chapter, entitled "Sammenfatning og konklusjon" ("Summary and Conclusion").

[15] Technical report no. 9.

[16] Technical report no. 7.

[17] Quoted from Technical report no. 7 (from discussion of air warfare).

[18] *Ibid*, quote from closing remarks.

[19] Randers's private papers, "Opplysninger angående fysikkavdelingens arbeidsprogram" ("Information regarding the work program of the Physics Division"), dated January 22, 1947.

[20] White Paper No. 118 (1947).

[21] Jens Chr. Hauge, interview with author, Oslo, August 26, 1982.

[22] Forland, "Norsk atomenergipolitikk."

[23] Randers, *Lysaar*, pp. 30-45.

[24] Margaret Gowing, *Independence and Deterrence. Britain and Atomic Energy, 1945-1952*, Vol. 1 (London: Macmillan, 1974), p. 341, p. 347; Astrid Forland, "På leiting etter uran. Institutt for atomenergi og internasjonalt samarbeid, 1945-51," *Forsvarsstudier,* No. 3 (1987), pp. 11-12.

[25] Copy of "Gentlemen's Agreement," dated March 9, 1940, in Bertrand Goldschmidt's private papers; copy of letter of March 9, 1940 from Axel Aubert to Jacques Allier, in Bertrand Goldschmidt's private papers.

[26] Copy of report by Jacques Allier entitled "Rapport sur la mise à disposition du Gouvernement francais du stock l'eau lourde de la Société Norvégienne de l'Azote (mars 1940)," dated December 1944, in Bertrand Goldschmidt's private papers.

[27] Bertrand Goldschmidt, "The supplies of heavy water to France and the early development of nuclear energy," *IFS Info* (Norwegian Institute for Defense Studies, Oslo), No. 4 (1995), p. 25.

[28] *Ibid.*

[29] For an account on the development of French nuclear research and its contribution to the war effort, see for instance, Spencer R. Weart, *Scientists in Power* (Cambridge, MA: Harvard University Press, 1979).

[30] Forland, "På leiting," p. 12 ff.

[31] The Institute for Atomic Energy's archives, folder entitled "Oslo arkiv, avd. Kjeller. (L12-9)," report by Odd Dahl from a visit by Dahl and Randers to England, France, and Belgium in January and February 1948.

[32] Forland, "På leiting," p. 14.

[33] Norwegian Ministry of Defense archives, secret files, H-187/1, report by Gunnar Randers entitled "Samtale med professor Joliot-Curie, 20.10.49" ("Conversation with Professor Joliot-Curie..."); Gunnar Randers, *Lysaar* (Oslo: Gyldendal, 1975), pp. 148-149; Bertrand Goldschmidt, *Les Rivalités Atomiques 1939-1966* (Paris: Fayard, 1967), p. 196.

[34] Forland, "På leiting," p. 15.

[35] *Ibid*., pp. 12-17, pp. 20-24.

[36] The Ministry of Defense's archives, secret file (187/1), report by Randers from meeting with Joliot-Curie, October 20, 1949.

[37] Forland, "På leiting," pp. 22-23.

[38] Forland, "Norsk atomenergipolitikk"; Forland, "På leiting," p. 20 ff.; J.M. van Splunter, "Love at first sight. Co-operation between the Netherlands and Norway on the peaceful uses of atomic energy, 1950-1960," *IFS Info* (Norwegian Institute for Defense Research, Oslo), No. 2 (1994).

[39] Gowing, *Independence*, Vol. I, p. 342.

[40] Bertrand Goldschmidt, *Les Rivalités Atomiques, 1939-1966*, p. 197.

[41] van Splunter, "Love...," p. 27.

[42] Among the locations mentioned were a site in the Netherlands; an unused merchant ship; and the reactor site at Kjeller. See *ibid.*

[43] National Archives (Maryland), Department of State, General records, Special Assistant to the Secretary for Energy and Outer Space, Records relating to atomic energy matters 1944-63, Lot-files, 21.69. Country file: Norway, b. Atomic development program, 1955, letter of March 29, 1955, from Howard A. Robinson to Gerard C. Smith.

[44] National Archives, Department of State, General records, Special Assistant to the Secretary for Energy and Outer Space, Records relating to atomic energy matters 1944-63, Lot-files, 21.69. Country file: Norway, d. General, 1956.

[45] National Archives, Department of State, General records, Special Assistant to the Secretary for Energy and Outer Space, Records relating to atomic energy matters 1944-63, Lot-files, 21.69. Country file: Norway, d. General, 1956, letter of December 5, 1955 from Howard A. Robinson to Gerhard C. Smith.

[46] "Intet å skjule om atomhistorien," *Aftenposten* (Oslo), December, 10, 1993, p. 3.

[47] Interview with Torjorn Sikkeland in *Aftenposten* (Oslo), December 9, 1993, p.3.

[48] Statement by Professor Jan Olav Liljenzin quoted in *Aftenposten*, September 8, 1993, p. 3.

[49] "Intet å skjule om atomhistorien," *Aftenposten*, December 10, 1993, p. 3.

[50] van Splunter, "Love...," pp. 39-41.

[51] *Ibid.*

[52] "Sveitsisk atombombegranskning: Norsk plutonium til salgs," *Aftenposten*, June 29, 1996, p. 3.

[53] *Ibid*.

[54] Odd Karsten Tveit, *Alt for Israel. Oslo-Jerusalem, 1948-78* (Oslo: J.W. Cappelens Forlag, 1996), p. 256.

[55] National Archives, Department of State, General records, Special Assistant to the Secretary for Energy and Outer Space, Records relating to atomic energy matters 1944-63, Lot no. 57D688, 21.50 Country file: Israel, f. Reactor, 1961, part 1 of 2, secret report entitled "Implication of the Acquisition by Israel of Nuclear Weapons Capa-

bility," dated January 31, 1961.
[56] Tveit, *Alt*, p. 263.
[57] See for instance, letter of July 26, 1958, with enclosure from Robert W. Mckinney (U.S. Ambassador to the IAEA) to Foster Dulles, in National Archives (Maryland), State Department, Central files, 398.1901-IAEA/7-2658.
[58] See for instance, letter of May 15, 1958 from the Director General of the IAEA Sterling Cole to President Eisenhower, in *Foreign Relations of the United States, 1958-60*, Vol. VII, part 1, no. 20.
[59] Tveit, *Alt*, p. 262.
[60] *Ibid*., pp. 261-262.
[61] *Ibid*., p.263.
[62] See for instance Allan McKnight, *Atomic Safeguards. A study in international verification* (New York: UNITAR, 1971).
[63] See for instance, records from the first nuclear suppliers discussions in London in February-March 1959 regarding safeguards on nuclear issues, in Public Records Office (Kew), FO 371/140594.
[64] Tveit, *Alt*, p. 262 ff.
[65] *Ibid*., p. 265.
[66] *Ibid*., pp. 264-266.
[67] PRO, FO 371/135517, letter of September 22, 1958 from Atomic Energy Authority to Atomic Energy Office (FO); letter of September 25, 1958 from Foreign Office to Atomic Energy Authority.
[68] Tveit, *Alt*, p. 271.
[69] *Ibid*., pp. 269-274.
[70] *Ibid*., pp. 273-275.
[71] Norway's inspection rights were used. The inspection took place in connection with a visit by Jens Christian Hauge to Israel in 1962. Hauge discovered nothing suspicious, and no more inspections were carried out in Israel by the Norwegians. In the wake of Mordechai Vanunu's revelations of the Israeli nuclear weapons program to the *Sunday Times* in 1986, Gary Milhollin of the Wisconsin Project on Nuclear Arms Control was influential in persuading the Norwegian government to try to exercise its inspection rights in Israel. Having refused an inspection by the IAEA, Israel in 1988 said it would allow Norwegian representatives to inspect about nine tons of heavy water away from the reactor site. Israel claimed that the remaining 12 tons had been lost during operations. Influenced by critical media coverage, the Norwegian government did not accept the Israeli offer. In the end, Norway bought back 10.5 tons of heavy water from the Israeli government in order to avoid further embarrassment. For further details, see Milhollin's numerous publications, including Gary Milhollin, "Who Controls the Israeli Bomb?" *Arbeiderbladet* (Oslo), January 21, 1987; and Gary Milhollin, "Heavy Water Cheaters," *Foreign Policy* (Winter 1987-1988).
[72] Quoted from the letter of November 5, 1954 from Howard A. Robinson (Special Assistant to the Ambassador in Paris) to Gerard C. Smith, Special Assistant to the Secretary, in National Archives, State Department, General Records, Special Assistant to the Secretary for Energy and Outer Space, Records relating to atomic energy matters 1944-63, Lot-files, 21.69. Country file: Norway, d. General, 1956.
[73] *Ibid*.
[74] National Archives, Department of State, General Records, Special Assistant to the Secretary for Energy and Outer Space, Records relating to atomic energy matters 1944-63, 21.69. Country file: Norway, d. General, 1956, letter of June 29, 1954 from Gerard C. Smith to Elbert G. Mathews, counselor of U.S. Embassy, Oslo.
[75] National Archives, Department of State, General Records, Special Assistant to the Secretary for Energy and Outer Space, Records relating to atomic energy matters 1944-63, Lot-files, 21.69. Country file: Norway, b. Atomic development program, 1955, memorandum for the files entitled "Heavy water," dated February 14, 1955.
[76] *Ibid.*
[77] PRO, FO 371/125198, letter of February 2, 1955, from J.V. Dunworth to Sir John Cockcroft.
[78] National Archives, Department of State, General Records, Special Assistant to the Secretary of Energy and Outer Space, Records relating to atomic energy matters 1944-63, Lot-files, 21.69. Country file: Norway, b. Atomic development program, 1955, memorandum of March 11, 1955.
[79] National Archives, Department of State, General Records, Special Assistant to the Secretary of Energy and Outer Space, Records relating to atomic energy matters 1944-63, Lot-files, 21.69. Country file: Norway, b. Atomic development program, 1955, letter of February 18, 1955 from Philip Farley to Howard A. Robinson.
[80] National Archives, Department of State, General Records, Special Assistant to the Secretary of Energy and Outer Space, Records relating to atomic energy matters 1944-63, Lot-files, 21.69. Country file: Norway, b. Atomic development program, 1955, letter of February 24, 1955 from Howard A. Robinson to Philip Farley (Deputy to the Special Assistant to the Secretary).
[81] Odd Viggo Nilsen, "Noratom og drommen om en norsk atomindustri," *TMV Working Paper* (published by the Center for Technology and Human Values, University of Oslo), No. 54 (April 1992), p. 19; Randers, *Lysaar*, pp. 244-249.
[82] Nilsen, "Noratom," p. 18.
[83] *Ibid*., p. 29.
[84] *Ibid*., pp. 30-31.
[85] See for instance, Bjarne Åsgard, *Strilekrigen mot atomkraft. Ei soge om sivil ulydnad* (Knarvik: private edition, 1994).
[86] National Archives, Department of State, General records, Special Assistant to the Secretary for Energy and Outer Space, Records relating to atomic energy matters, Lot-files, 21.69 Country file: Norway, letter of November 5, 1954 from Howard A. Robinson to Gerard C. Smith.
[87] Rolf Tamnes, *The United States and the Cold War in the High North* (Oslo: Ad notam forlag, 1991), p. 164; Berge Furre, *Vårt Hundreår. Norsk historie 1905-1990* (Oslo: Det Norske Samlaget, 1991), p. 287.
[88] Rolf Tamnes, *The United States and the Cold War in the High North* (Oslo: Ad notam forlag, 1991), p. 162.
[89] See for instance, minutes from a debate about this issue in Sweden's National Assembly: Riksdagsdebatterna 1967. Andra kammaren. Nr. 28 (The Debates of the Riksdag. Second Chamber. No. 28).
[90] Astrid Forland, "Hope over Fear. The Establishment of the International Atomic Energy Agency," *Forsvarsstudier*, No. 3 (1995).