

Still Waiting for *Glasnost*

Notes on NGO Relations with the Nuclear Establishment in Sweden and the Baltic Sea Area

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"Certainty is totalitarian. It forecloses all thinking."
— David Malone, mathematician and
documentary film-maker

I Introduction

This paper is problem-oriented. We whose experience the contents reflect are active within MILKAS, a joint organization made up of *Friends of the Earth Sweden* and the *Swedish Anti-Nuclear Movement* for the express purpose of participating in consultations about plans for storage of domestically produced high-level nuclear waste (irradiated fuel, etc.) in Sweden. The paper also draws extensively on input from participants in the international conference, "Coping with Nuclear Waste", arranged by MILKAS in Stockholm in April 2007.¹

Problems common to many countries ...

Nuclear energy is a spin-off from the technology developed to produce nuclear bombs. Unfortunately, the civilian uses of the technology seem to have inherited the culture of secrecy that surrounded the military research and development (R&D) that parented it. That may not be the whole explanation, but the fact is that in most countries nuclear energy is not debated as freely as other hazardous technologies. Nor is it regulated by the same laws. Somehow, governments around the world have found it reasonable to accord nuclear energy a privileged status: economically as well as in regulatory terms.²

Neither is the pollution produced by nuclear energy part of the general environmental agenda in most European countries. Even environmental protection authorities (EPAs) know little about radiation. It is not part of their remit. This flaw in the regulatory apparatus has far-reaching consequences (cf. the discussion of the Baltic Sea below).

A sad consequence of this situation today is that it leaves ample leeway for the industry to claim that nuclear energy is "clean". The companies know it is not clean, but they also know that few people are aware of the kinds of pollution nuclear energy entails. (The regulatory

¹ The author is particularly grateful for post-conference input from Per Hegelund, MILKAS, but bears full responsibility for the interpretation of his and others' information. For notes from the proceedings of MILKAS' conference, see www.milkas.se.

² Using the Swedish situation as an example, the economic 'favors' that nuclear energy enjoys are principally three: credit terms far under market rates, a cap on third-party liability, and low taxation of electricity compared to other sources of energy. Remarkably, the favors are condoned by the European Commission. In addition, state-owned power companies (e.g., Vattenfall) pay very low dividends. In regulatory terms, the principal privilege is special legislation that exempts nuclear energy from the requirements of modern environmental law. Both the UN agency, IAEA and the Euratom Treaty, one of three constitutional laws in the EU (never amended in all its 50 years), combine promotion of nuclear technology with regulatory duties.

agencies remain silent.) And, as all manipulators of opinion — from Macchiavelli to George W Bush — know, a lie, repeated often enough, will acquire the ring of truth.

Issues relating to nuclear waste management are, by contrast, universally controversial, the main reason being that no credibly environmentally sound solution has been presented. The time frame for the hazards involved is staggering; nuclear waste will pose a hazard to hundreds of generations. And then, there is the NIMBY ("Not-In-My-Back-Yard") factor: In repeated EU opinion polls 80-90 per cent of the respondents say they would not want a waste repository near their home. This, regardless of the person's views on nuclear energy.

Another, more general problem that hinders communication about nuclear energy is a frequently prevalent cultural conflict between engineers and laymen. Gustaf Östberg, a Swedish writer (and engineer) who makes a strong case for better communication between engineers and policy-makers,³ notes that many engineers are instinctively hostile to people who voice doubts. Many engineers, he writes, associate doubt with weakness. (On a crasser level, giving in to doubt may mean costly delays.) Many of us in the environmental movement are sceptics by nature; we are the proverbial "doubting Thomases and Tomasinas". Little wonder, then, if our attempts at dialogue on nuclear issues often derail?

Stalemate in Sweden

In addition to the foregoing, we in Sweden suffer a number of problems which may or may not be unique. A sort of prolonged ceasefire prevails between two well-defined camps, pro and contra nuclear.

The Swedish nuclear energy program was started in secrecy, closely coupled to the development of a Swedish nuclear bomb. Swedish desire for the bomb in the early postwar years was long denied; rumors were first confirmed in 1995 in a 50-year anniversary publication from the Swedish Defence Research Agency (FOA), an unimpeachable source. After that, the story unraveled, bit by bit. Secrecy around the bomb was compact. Even certain members of the Cabinet were kept in the dark. Much of the civilian program was planned before Sweden abandoned her military ambitions -- that is, without broad consultation.

The animosity surrounding nuclear power as an issue in Sweden is also a legacy of a fudged referendum on the future of the nuclear power program in 1980. The accident at the Three Mile Island nuclear power plant (Harrisburg) forced the Social Democratic government to give in to popular demand for a referendum.

The Social Democratic government feared, however, that a majority of the people would vote to scrap the program. Their strategy was to introduce a third alternative, between "Yes, continue" and "No, stop the program and phase-out the existing six reactors". This third alternative proposed to build the remaining six reactors in the program, and then to phase out all twelve as alternative sources of energy became available. In short, a sort of "Yes-but-No".

³ Östberg, *G Att tycka sig förstå*, [To feel you understand] Stockholm: Carlssons, 1991.

As policy, the third alternative was ludicrous. It was simply a way to avoid an unwelcome show-down, one which seemed likely to end in defeat. The "Yes-but-No" alternative received most votes, closely followed by "No". Only 18 per cent of the electorate supported the "Yes" alternative.

It should be noted that Swedish referenda are advisory, not binding. Nonetheless, the referendum has had lasting repercussions. The emotions and strife surrounding the campaign continue to inflame the issue and polarize opinion. One very serious consequence of the referendum is that it made it clear to all that the divide, pro vs con, cuts through every party. All the Swedish parties know this, and therefore all avoid raising the issue.

Twenty-five years of Social Democratic double-talk have hardly helped. Successive governments have talked of "sustainability", yet there has been no commitment to decommissioning reactors. Ten of twelve reactors are still in operation, and several are currently undergoing upgrading, so that Sweden's output of nuclear energy will be greater than ever.

Next to nothing has been done to encourage conversion to renewable sources of energy. The government has not even used its authority as owner, either to steer Vattenfall away from investing in coal (in Germany), or to urge the company into 'green' electricity production.

A relationship of mutual respect?

A cozy relationship prevails between regulator and regulated in the nuclear branch. A certain collegiality is to be expected; after all, most of the experts have sat on the same school benches. But in Sweden the relationship goes further: As one exasperated 'dissident' reactor safety expert put it recently: "*It is remarkable how the authorities choose not to criticize, even when it's warranted, for fear of disturbing production. It's as though they were part of the companies' PR departments.*" His comment came in the aftermath of a near meltdown due to a power outage and design error at a Forsmark reactor in the summer of 2006.⁴

⁴ The Reactor Safety Authority first dismissed the incident. Only when a whistle-blower went public and described in detail what had happened was the public informed. Still, the Authority continued to refer to the incident's rating on the INES scale, a scale that rates the ultimate outcome, not what *very nearly* happened.

See further reports in *WISE-NIRS Nuclear Monitor* 649 (6 Sep 2006) and 652 (8 Feb 2007).
www.wisemaster.antenna.nl.

Aftermath: The events at Forsmark were embarrassing for the Reactor Safety Authority (SKI) in a number of respects. SKI long explained their soft approach to regulation in terms of maintaining an atmosphere of openness. But investigations following the incident revealed that Forsmark (a subsidiary of Vattenfall) had failed to report a long list of irregularities to the Authority, some of which had bearing on the crucial event. Secondly, it became clear to the press that the Authority had lied to them when the story broke.

Sweden has had a change of government since the incident. One of the first initiatives of the new bourgeois government was to propose to fuse the two regulators, the Reactor Safety Authority and the Radiation Protection Institute (SSI) into one. The proposal has been circulated for comment; a decision is expected soon.

Coziness is less pronounced at Sweden's second regulatory body, the Radiation Protection Authority (SSI). Their "mission" after the Chernobyl disaster and its fallout over Scandinavia was to prevent panic – particularly in the regions hardest hit. SSIs "not to worry"-messages damaged the Institute's credibility among environmentalists, but in the decades since, some note a swing toward more stringency at SSI. Indeed, one department there is working to bring regulation of nuclear technology on a par with regulation of other hazardous technologies.⁵

Any number of examples could be given — but this is not the place. Suffice it to say that it is not surprising if we environmentalists sometimes find ourselves at odds with the regulatory authorities and often wonder what portions of the truth they are withholding.

And then we have the tactics spokespersons for the nuclear power industry have used against the few expert engineers, physicians and natural scientists who have dared to criticize them. The engineer who blew the whistle at Forsmark was subjected to a campaign of lies – with Forsmark AB's chief legal counsel going so far as to claim that the safety engineer did not have the credentials he claimed to have (these, of course, were a matter of record, which only made matters worse for Forsmark). A professor of Geology who questions the assumptions behind the KBS3 storage scheme is publicly belittled and scorned by the industry. When colleagues abroad verified his criticism, the industry (via SKB AB) changed their tune -- but only temporarily. Again, the examples are more than can be included here.

The silence of the academic community in these cases is worrying.

Perhaps it is abundantly clear by now — but it should perhaps be stated outright: The "glasnost" we in Sweden are waiting for is not the Russian, but a Swedish variety. Unfortunately, the atmosphere that surrounds nuclear issues warrants the analogy.

□

II. Case: Ongoing nuclear pollution of the Baltic Sea

The Baltic Sea is radioactive. In fact, according to HELCOM-MORS: "*The levels of anthropogenic radionuclides are higher in the Baltic Sea than in any other water bodies around the world.*"⁶

Responsibility for the Baltic Sea is acknowledged by nine national governments and parliaments, the Council of the Baltic Sea States, the Nordic Council (through the Helsinki Commission), and numerous NGOs, including Friends of the Earth and Greenpeace. The

⁵ For information about the work at SSI to further develop Swedish National Environmental Goals in English see [www.naturvardsverket.se/ Documents/publikationer/620-1260-6.pdf](http://www.naturvardsverket.se/Documents/publikationer/620-1260-6.pdf).

⁶ Helsinki Commission, Monitoring of Radioactive Substances, cited by Per Hegelund in "Østersøen: stop for nye atomanlæg er nødvendigt". *Miljøsk* 2007 (web-magazine of NOAH/Friends of the Earth Denmark), www.noah.dk.

Convention for the Protection of the Marine Environment of the Baltic Sea Area (a.k.a. The Helsinki Convention, 1992) is a thoroughly modern document that even admonishes signatories to follow the precautionary principle in all that affects/might affect the Sea. Its definition of "hazardous" materials (Article 2) would appear to include the products of nuclear activities.^{7, 8} Given all these good intentions, one is tempted to ask, how could things go so wrong?

How, indeed! The reasons are several.

First of all, the Baltic Sea is essentially landlocked, the exchange of water between the Baltic and the North Atlantic being no more than an estimated 1-2 per cent each year. Such a low renewal rate means that a considerable amount of the radioactivity that is introduced into the Sea will not be dispersed, but accumulate. (Cesium, for example, has a halflife of 30 years; or, in plain English: *half* of the radioactivity remains 30 years after the cesium is produced.)

Some of the radioactivity comes from historical events like the atmospheric bomb tests conducted in the northwestern Soviet Union in the 1950s and 1960s, and the nuclear disaster at Chernobyl in 1986. Radioactivity released from the burning reactor rained down over the Baltic Sea's catchment area. Rivers and streams continue to flush (mainly) cesium from Chernobyl into the Sea.

There is not much that can be done about these sources. The events cannot be undone. Containment of the radioactivity is not an option.

Past events are not the whole story, however. Unfortunately, they are not even the main story. Research findings point to presently ongoing pollution from other sources, particularly nuclear power facilities — especially the Swedish units⁹ — and nuclear recycling facilities. The Russian environmentalist organization, Green World counts seventeen units in operation in five countries around the Baltic Sea and Skagerrak. Finland is currently building a fifth

⁷ See www.helcom.fi/Convention/en_GB/convention/.

⁸ Additional pro-active agreements to which governments in the region adhere provide for public consultation (1) when a proposed activity is likely to have a "significant, adverse transboundary impact" (the Espoo Convention) and (2) in the planning of installations for the processing, storage or final disposal of irradiated nuclear fuel or radioactive waste (the Aarhus Convention).

⁹ Sven P Nielsen, Senior researcher at Risoe National Laboratories, Denmark, and head of HELCOM-MORS.

reactor, which will bring the total up to eighteen.¹⁰

Reactors pollute. Every nuclear reactor regularly releases radioactive gases and liquids -- about four to five times a year, assuming that German reactors are typical. The gases and liquids, byproducts of the reaction itself, cannot be contained indefinitely. The releases are planned and legal. The various national authorities consider the Sea "an appropriate recipient", to quote the Swedish SSI.

Waste repositories pollute. In addition to nuclear power reactors several countries have storage facilities for nuclear waste. Permanent repositories for waste of low and intermediate activity, interim facilities for high-level waste (irradiated fuel rods, etc.). All these facilities are coastal, and they leak.¹¹

Both Finland and Sweden are currently projecting geological repositories for high-level waste on the shores of the Baltic. (More about the Swedish project in our next "case".)

Nuclear "recycling" pollutes. A third source of pollution is processing of radioactive materials for the dual purpose of (1) extracting radioactive elements for re-use and (2) bringing residue waste (concrete, asphalt, plastics, building materials and, especially, metals) down to below so-called clearance levels so that they can be released onto the ordinary market for use in a

¹⁰ Nine reactors have been decommissioned: in Sweden (2), Germany (6) and Lithuania (1). All are monitored, but we have no data as to whether and how much activity they may continue to release.

Green World also monitors the thermal pollution (heat) from reactors around the Baltic Sea – but that problem falls outside the scope of the present paper.

Source: Oleg Bodrov, presentation at the conference, *Coping With Nuclear Waste*, 27-29 April 2007 in Stockholm. See www.milkas.se.

A report from the Swedish Radiation Protection Authority, SSI, covering the period 2002-2004 noted that a research reactor at Studsvik (Sweden), now decommissioned, is by far the greatest source of strontium-90 in the Baltic Sea area. Emissions of strontium are about one-thousand times that of the next-largest source (a Swedish nuclear power plant). The reactor also topped the list of sources of tritium. (Both strontium and tritium are readily stored in the body, if ingested.) Whereas tritium releases would cease when the reactor was taken off line, releases of strontium would continue, as a byproduct of reactor fuel tests at the facility. Concentrations of cesium-137 in sediments in the archipelago outside Studsvik were also found to be higher than near most Swedish nuclear power stations, according to a Swedish public radio news report in January 2006.

Sources: SSI (2005) *Utsläpps- och omgivningskontroll vid de kärntekniska anläggningarna 2002-2004* [Emissions and environmental impacts of Swedish nuclear installations 2002-2004] (M Luning, SSI rapport;19), and Swedish Public Radio: [:www.sr.se/sormland/nyheter/artikel.asp?artikel=764931](http://www.sr.se/sormland/nyheter/artikel.asp?artikel=764931).

¹¹ In the summer of 2005, SFR, a Swedish storage facility for low- and intermediate-level radioactive waste at Forsmark (on the Baltic north of Stockholm) leaked ten times more cesium than *normal* into the Baltic Sea. Still, SSI assured us that the release was only *a small fraction* of the *authorized* releases from the facility. SFR was not *expected* to start leaking until at least fifty years had passed – at which point most of the radioactivity would have dissipated. (The italics in the foregoing show the routine nature of deliberate pollution from the storage facilities.)

wide range of products.¹²

We would have no objection to this kind of recycling – on the contrary – *if* the products released to the market were not radioactive, and *if* the processing did not impact on the environment. Unfortunately, the materials are radioactive, and the process pollutes.

The European Union opened the door to this kind of commerce in trash through a Council Directive, 96/29/Euratom. The directive has been approved and incorporated into most Member States' legislation – in Sweden essentially without debate. The potential market is very large and will grow as the world's aging nuclear power plants and military facilities reach the end of their lives. Tremendous volumes of contaminated waste will have to be treated.

The two principal operators in this highly lucrative branch are *Ecomet* outside St. Petersburg in the Gulf of Finland and the above-mentioned *Studsvik Nuclear* on the coast south of Stockholm. Both companies are in an expansive phase and plan to process radioactive scrap from all over Europe -- and perhaps further afield.

In addition to the polluting installations themselves, each will generate a significant increase in transports of radioactive materials on the high seas and in the Baltic. KIMO International, an organization of coastal communities in the North Atlantic, monitors the standard of vessels used for hazardous transports. Current European regulations for nuclear transports are entirely too lax, KIMO tells us.¹³ We should recall that transports to and from the Baltic Sea area will take place in a northerly climate and in congested sea lanes from the North Atlantic and North Sea, through the Skagerrak and Kattegatt into the Baltic.

In a statement intended to reassure British audiences, □Mark Lyons, the self-confident manager of Studsvik UK, promises to reduce the volume of scrap metal going to the low-level waste repository in West Cambria by 95 per cent -- and to recycle it into the international metal market. Some of the most troublesome materials, material that requires "further treatment," will be sent to Studsvik's plant in Sweden, he assured the Brits.¹⁴

The international trade in highly contaminated radwaste has a long history. Swedish public radio reported in 2005 that Russia had been processing imported irradiated nuclear fuel since 1996. About 60 per cent of the 14 to 15 thousand tons of mainly European fuel delivered to Russia up to 2005 was believed to have stayed in the country — in violation of Russian law. 'Disposal' in Russia is a cheap solution for companies like the French nuclear power giant, Areva (formerly Cogéma) and Urenco, a company owned by German, British and Dutch power companies. The Putin government plans on significant growth in the

¹² Materials are cleared on the basis of their *average* level of radioactivity. In Europe, by the terms of Council Directive 96/29/Euratom, highly active particles (e.g., plutonium) may be present in the cleared material, but if the overall level in the total mass is low enough, the material is pronounced to be "of no radiological concern".

¹³ See www.kimointernational.org/Portals/0/kmpr1106.doc.

¹⁴ See www.businessgazette.co.uk/default.aspx?aid=438159.

trade.¹⁵

No mystery

Given (1) the localization of all these facilities on the shores of "an appropriate recipient"; (2) the generous allowances for releases of radioactive effluents, whether routine or accidental; (3) hazardous transports and (4) the very limited (1-2 per cent) exchange of water between the Baltic and the North Sea, it is hardly a mystery that the Baltic has become perhaps the most radioactive marine environment in the world, or that it is becoming more radioactive day by day.

Our regulatory authorities remain unconcerned, even though a study of radioactivity in Baltic Sea fish found some levels very close to the maximum allowed for human consumption.¹⁶ These findings confirm indications noted in a study by the Swedish FOA in the early 1990s.¹⁷ A modeling study from the National Laboratory at Risoe in Denmark suggests that 94 per cent of the radiation that residents of the Baltic Sea area are exposed to comes from fish.¹⁸

Don't blame the fish!

National radiation protection authorities in the region are aware of the situation – but acquiesce. That they do so is a consequence of their belief that radioactivity under certain threshold levels is "of no radiological concern". This is an outdated view, dating back to research among survivors of the nuclear attack on Hiroshima in the second world war. In recent decades the evaluation of the consequences of low doses of radiation has changed – particularly with respect to the risks associated with eating or inhaling radioactive particles. Medical research on the immune system, genetic studies, epidemiological studies of the incidence of cancers, and ecological findings on the chemical repercussions of ionizing radiation in the environment all indicate that there is no safe level of radiation.¹⁹ But to take full account of these findings would have costly implications – not only for the nuclear power industry.

Authorities in the European Union and national authorities in the Member States continue to regard the Sea as a convenient waste bin for nuclear installations. Russia appears to do likewise.

¹⁵ Sveriges Radio/Ekot, 3 augusti 2005, Jesper Lindau, Moskva. [Newscast of Swedish public radio, story filed by Moscow correspondent, 3 August 2005].

¹⁶ Helsinki Commission (HELCOM), www.helcom.fi/environment2/ifs/ifs2004/en_GB/C-137fish/.

¹⁷ "Radioactive sources of main radiological concern in the Kola-Barents region", Stockholm: FRN, 1998.

¹⁸ Sven P Nielsen, "Modelling and assessment of doses to man. Risoe National Laboratory, Roskilde, Denmark (1998) and European Communities (2000). See www.iael.it/inpp_en.asp?lang=1.

¹⁹ For more on the medical and epidemiological research on this subject visit www.llrc.org. The genetic research referred to here includes the work of Yuri Dubrova at the University of Leicester (UK), cited in the article, "Testing Times" in *Economist*, 11 Sep 2004.

It should be clear by now that the nuclear pollution of the Baltic Sea, like all other forms of pollution of the Sea, is an international problem that requires an international solution.

Operation Save the Baltic

In 2002 the European Commission launched an ambitious program known as the Cleaner Seas Strategy. National and regional programs to implement the program have since been announced — they, too, with high levels of ambition.²⁰ In April 2007, for example, two Cabinet members, the Minister for the Environment and the Minister for EU Affairs, announced the Swedish program in an article in the country's leading newspaper under a headline guaranteed to impress: "We are investing a half billion to clean up our seas".²¹ The currency in question is Swedish crowns, about 9 to the euro, and the total sum refers to the period, 2008-2010. Forty million will be allocated in the remainder of the current budget year. The marine environment will, furthermore, be made a standard post in the national budget — a first.

Besides inventories, clean-up operations and research, the ministers pledge to intensify collaboration with the Baltic Sea States and the European Union. They note that "*a better understanding of the environmental threats and the effectiveness and economic efficiency of various measures is absolutely essential to the success of future policy-making, for more effective measures, and to generate support for the effort among actors in the region*". The program features:

- political economic analysis of the cost of pollution, analogous to the Stern report on climate change;
- prognostic modelling for algae and other scenarios;
- inventories of the sea bed
- continuation of the program to reduce contributions of nitrogen and sulphur oxides to the Sea; and
- a focus on measures to reduce releases of phosphorus to the Sea.

The article concludes: "*A holistic view of the Baltic Sea and the Skagerrak, that develops the seas as a resource and brings different interested parties together to preserve the marine ecosystems, is called for. Starting with the Spring budget bill, the Government is laying the foundation for a new, comprehensive marine policy.*"

Holistic, comprehensive ... yet there is no mention of radioactivity!

At the start of this paper we noted how little many national environmental protection agencies know about radioactivity. Evidently the gap remains. It is a situation that must be remedied. As MILKAS wrote in solicited comment to the Swedish SSI this past June:

²⁰ For excellent monitoring of these and other initiatives (with links to documentation) see the Helsinki Commission's website, www.helcom.fi.

²¹ *Dagens Nyheter*, 11 April 2007; www.dn.se/DNet/jsp/polpoly.jsp?d=572&a=637751.

*"For nearly half a century nuclear technology has been separate from the rest of environmental conservation policy. MILKAS finds this artificial division of labor a crucial systems error, a fatal flaw. The Baltic Sea may well become its next victim."*²²

Jonas Ebbesson, Professor of Environmental Law at Stockholm University, points out the significance of EU expansion.²³ Since 2004, all the countries in the Baltic Sea area, except for Russia, are members of the Union. Ebbesson appreciates the principles set out in the Helsinki Convention and its institution, the Helsinki Commission, but at the same time points out that *"Helcom has no power to make binding policy; its role is to monitor [de facto voluntary] compliance on the part of the countries that adhere to the Convention. It is an international [not supranational] body that, despite noble ambitions, is toothless"* (p 189).

The European Commission, by contrast, has "teeth". Its directives are binding; effective institutions are in place to police and enforce compliance. Ebbesson sets out the principal features of EU law pertaining to the environment:

"Member states are obliged to require environmental impact statements for new projects, plans and programs that may have environmental impacts, to integrate environmental assessments for major facilities, to minimize atmospheric pollution (like, for example, nitrous oxides), to provide legal protection of valuable natural environments and to ensure public participation in planning processes that have environmental consequences"(p. 194, unauthorized translations).

All these provisions, Ebbesson notes, have implications for the Baltic Sea.

There is only one problem. They do not apply to radiological hazards. To repeat: Nuclear technology is governed, not by EU environmental laws, but by the Euratom Treaty and Euratom directives. Euratom, a state within the state!

To sum up

We conclude this 'case' with a list of objectives for our continued work:

The sources of cumulative nuclear pollution in the Baltic Sea are international, and the problem requires an international solution. The environmental consequences of nuclear technology remain essentially national, however, each country suboptimizing and turning a blind eye to them as perceived national interest requires. But as long as the Euratom Treaty remains in force and its institutions have their present mandate, coordination of policy in this area under EU auspices is totally unacceptable to environmentalists.

Our objectives — the order does not imply priority — are

1. To repeal the portions of the Euratom Treaty that promote nuclear energy and give nuclear technologies privileged status.

²² MILKAS (2007). Comments on the Draft evaluation of the national environmental quality objective, Safe Radiological Environment. SSI Dnr 2006/1070-41, 27 June.

²³Ebbesson, Jonas (2006) EU är Östersjöns chans [The EU is the Baltic Sea's big chance]. In *Östersjön – hot och hopp*. Stockholm: Formas. Pp 189-201.

2. *¶¶¶ We urge regulatory and environmental protection agencies to put nuclear technology on an equal footing with other hazardous technologies. The "fatal flaw" that keeps environmental protection agencies in the dark about the pollution from nuclear facilities must be eliminated.*

3. *¶¶¶ We urge radiation protection authorities in our countries and throughout Europe to update their knowledge with respect to low-level radiation. Political expediency has no place in agencies charged to protect human health.*

4. *¶¶¶ No one has questioned the validity of the findings that arouse our concern. The criticisms raised mainly have to do with the fact that the findings are sporadic and non-comparable. We agree that the evidence is spotty, but it is hardly because we have been selective in our choice of data. It is because there is little (published) research, and no standardization of the methods used. We call for standardized measures of relevant parameters throughout the Baltic Sea area and the creation of an open longitudinal data base.*

5. *¶¶¶ We demand -- and continue to work for -- a moratorium on building nuclear facilities that impact on, or may be expected to impact on the Baltic Sea.*

In compiling this paper we are reminded of the benefits of networking. While we are aware that several of our objectives run directly counter to perceived national interest, we are convinced that "time is on our side". In all these efforts we seek collaboration with environmentalist colleagues abroad, we welcome input from international research communities, and initiatives on the part of parliamentarians and governments, particularly those in non-nuclear EU Member States (e.g., Denmark, Poland, Latvia, Austria).

We would like to stress one need for collaboration above all others:
The call to repeal the Euratom Treaty and to revoke its status as part of the EU Constitution is a cause that reaches far beyond issues relating to energy supply or even the environment. It is an issue that should engage a much broader sector of civil society.

III. Case: NGO participation in consultations about storage of Swedish irradiated fuel

The process to develop and implement a method for permanent storage of Sweden's irradiated nuclear fuel (a.k.a. "spent fuel" and often referred to as "high-level waste") is in its third decade. Whereas the case of the Baltic Sea is highly international and has a multitude of actors, the project of a geological repository for high-level nuclear waste is essentially national, insular and involves, many would argue, too few institutions.

National: The plan is to store only waste generated in Sweden.

Insular: Responsibility for the research and development is entrusted solely to the nuclear industry, who act through a jointly owned, dedicated subsidiary, Swedish Nuclear Fuel and Waste Management (Svensk Kärnbränslehantering AB, SKB AB).

The regulatory institution that supervises the project and the processes involved is the Swedish Reactor Safety Authority, SKI. SKI has a track record of industry-friendliness in the extreme (see page 4 above). There is also quite some traffic through the 'revolving doors' between industry, the regulators and even municipal authorities, which enhances the community of values relating to the Swedish waste repository project.²⁴

As noted earlier, nuclear technology has long been regulated by two agencies, the Swedish Radiation Protection Authority (SSI) and SKI, in accordance with sector-specific legislation (Lagen om kärnteknisk verksamhet, KTL). □The provisions of KTL are supplemented with more detailed requirements set out and enforced by the two agencies.

In 1999, however, Sweden adopted a modern Environmental Code. Almost immediately it became apparent that the Code and KTL were at odds on important principles. The Code states that it is universal in scope, but the nuclear industry rejected its application to nuclear technology – and SKI has at least once sided with the industry. Within a few years' time a regular "turf war" between the nuclear power industry and SKI, on the one hand, and the environmental courts, set up under the Code, had broken out. (Perhaps needless to say, we in the environmental movement argue that nuclear technology should be subject to the Code.)

There is more at stake for the regulator and the industry than mere prestige. The key factor is that KTL empowers the agencies to grant exemptions from the requirements of the law without consulting any third party. Such dispensations, termed "transitional provisions", are rather many. In sum, the arrangement allows the Swedish Government, SKI and the industry to boast of strict regulations, while the nuclear operators carry on, free to comply with the law as they see fit.²⁵

The two laws differ in other respects, as well. For example, the Code applies standards in terms of "BAT" (best available technology), whereas KTL applies a standard of "good enough". Also, the Code requires that the projector, in this case SKB AB, evaluate its plans compared to alternative technologies and a so-called "zero alternative", i.e., the consequences of not doing anything. Alternative sites should also be considered. SKB AB has largely ignored other solutions than the KBS scheme – with the apparent acquiescence of the regulator, SKI.

Finally, the Environmental Code provides for consultation with "concerned parties", which

²⁴ Elam, M & Sundqvist, G (2006) "Swedish Update", presented at CARL Workshop Troon (29/11/2006). www.carl-research.org/docs.

²⁵ For more on the "turf war" see "Nuclear Challenge to Environmental Code Fails", *WISE-NIRS Nuclear Monitor* 652 (8 Feb 2007). For an illustration of what the Code implies in practice see "Environmental Court Comes Down Hard on Nuclear Energy" *WISE-NIRS Nuclear Monitor* 628. www.wiseamster.antenna.nl.

until 2004 was interpreted strictly, as including only the residents of the immediate area, but not environmental NGOs.

Starting in 2005, we NGOs have been invited to consultations and have received grants from the government to make active participation possible. We have no illusions that we would have been invited to take part, were it not for the Code. (As recently as 1998/99 our request to take part was not even considered worthy a reply.) And even today, we are received grudgingly. We are not, for example, allowed even observer status in separate consultations between SKB AB and the political leadership in the two candidate communities. The industry draws up the agenda. The minutes from the meetings (written by SKB AB, but circulated on the official stationery of the respective regional governments) reveal little of the discussions.

Fig leaf?

The Swedish environmental NGOs continue to participate, despite a nagging sense of futility. There is no true dialogue.²⁶ The questions we ask are answered in few words, the points we raise are politely listened to – and then ignored. Are we simply being used as a "fig leaf"? Is our sole purpose to allow SKB AB to fulfill the letter of the Code -- but hardly its spirit?

All in all, the Swedish environmental movement is agreed that the industry runs the show.

Giving the industry such a free hand in the conduct and evaluation of their R&D efforts – and monopoly status, what is more – has some unfortunate consequences. Unless the authorities are firm, the industry's cost-effectiveness calculations will decide whether or not an alternative method or alternative sitings are worth exploring. Such an arrangement lays the foundation for a result that no one wants, namely, that Swedish irradiated fuel will be stored under conditions that the industry has deemed *optimal*, rather than under conditions that are the *best* that present technology can achieve.

□

Some basic historical context

The nuclear industry began working to develop a storage strategy in the early 1980s. They were under extreme pressure. A "solution" to the problem of what to do with irradiated nuclear fuel had, namely, been made a condition for the continued expansion of Sweden's nuclear power program, and export of waste had been banned.

²⁶ Observations of SKB's "consultations" with local residents and NGOs formed part of Hanna Sofia Johansson's doctoral work at Göteborg University. One chapter in her dissertation records several instances of heated exchanges between SKB spokespersons and critical participants. They were not recorded in the minutes of the meetings. Johansson characterizes one such futile attempt to engage SKB in dialogue as "an example of a monologue held by [a local NGO] within the boundaries of an agenda set beforehand by SKB". At these meetings, Johansson comments, SKB AB successfully retains the role of "speaker" and relegates representatives of the general public to the role of "audience" — no matter how knowledgeable they may be. Johansson, H S (2006) *The Siting of Swedish Nuclear Waste: An Example of Deliberative Democracy?* Göteborg: Section for Science and Technology Studies, Göteborg University.

It was considered appropriate that the task be entrusted to the industry itself. The rationale put forward at the time resembles the philosophy behind the so-called "polluter pays principle". In retrospect, some suspect that it was rather a matter of political expediency for the coalition Government, whose leading party had won votes (and defeated the incumbent Social Democrats) on a "No-to-nuclear" platform.

Rather quickly SKB AB decided on the KBS approach. Very briefly, the method involves storage of irradiated fuel in steel-reinforced copper canisters in bedrock at a depth of about 400-500 meters, which in Sweden means that the surrounding groundwater (in the granite, as well) will be quite mobile. The method does not permit retrieval of the canisters once the access tunnel is sealed.²⁷

Many of the assumptions on which the KBS solution rests have had to be revised. Originally, SKB geologists were looking for dry, solid (no cracks) bedrock. They found that the animal did not exist. Originally, the canisters were to be of pure copper (Steel, when corroded, it was said, could be explosive.) Then, it was found that the scheme would require too much copper. The canisters are now planned to be made of steel-reinforced copper.

Revisions on a grander scale are to be expected. The repository was intended for waste from twelve reactors of 1970s and 1980s vintage that had been online only 25 years. Today, six of the ten remaining reactors are in the process of renewal and upgrading. Their expected lifetime is now 40 years, and they will operate at higher thermal effect. The changes affect the nature of the waste they produce and, of course, the volume, more than 150 per cent of the design capacity of KBS-3. The waste processing plant at Studsvik (see page 7) introduces entirely new kinds of waste into the picture.

When we ask SKB about these changes – and their implications, they reply: "We foresee no problems." So much for "consultations"!²⁸

SKB AB is very aggressive in its marketing of the KBS-3 method. Indeed, outside Sweden word has been spread that "Sweden has solved the problem"—even though many significant issues of safety and environmental impacts remain unresolved. (The many aspects and links in the complex process had not, as late as FUD 04, been integrated and presented as a comprehensive whole.) Inside Sweden, SKB AB has lobbied for government endorsement of the method – which would mean short-cutting the ongoing environmental impact assessments. No endorsement has been given.

Barring unforeseen stumbling blocks, SKB intends to start depositing waste around 2017; the loading process is expected to continue several decades.

Environmental movement not convinced

MILKAS' misgivings about the KBS approach are based on growing doubts that a KBS

²⁷ For details see www.skb.se.

²⁸ The problem is noted by Elam & Sundqvist (see note 24), who ask: "Is the [Swedish] EIA process just a satellite social activity...?"

repository will withstand even the first of perhaps several ice ages that may be expected during its lifetime. Recent geological research findings on the aftermath of the last ice age suggest that the stability of Swedish bedrock has been grossly overestimated.

Secondly, we are worried by SKB AB's decision to postpone so-called "biosphere research" until after the site or sites have been selected. (SSI has also expressed concern on this point.) In our view, the presumed interaction of the repository with the surrounding bedrock and the hydrological mechanisms by which radioactivity might spread to the biosphere should be among the *selection* criteria. That is to say, interest in the ecology of the waste repository has come far too late in the process.

Worse, SKB AB argues that no meaningful safety analysis of the system can be performed until the siting has been planned. This may be a valid argument with regard to site-related aspects, but SKB has used the argument as a reason not to test even other links in the process. Only this past year has a more comprehensive safety analysis been published.

Communication as power game

Another basic cause for misgivings has to do with the rhetoric SKB AB uses in its communications with members of the lay public. Every three years SKB AB is obliged to publish a comprehensive progress report. They form a series, entitled "Research, Development and Demonstration" (abbreviated "FUD").

In a discussion of common communication problems between technical experts and non-expert users of technology Gustaf Östberg treats rhetoric in a power perspective:

"The important thing about linguistic difficulties in the relations between different parties in studies and the like is the power relationships they can give rise to. ... A sheer choice of words can lead a negotiation into areas where one party or the other has the stronger argument, either substantively or formally. ... The trouble with process engineers' language in their relations with end users is ... that it contains terms, the meaning of which the users cannot be expected to understand as well as the engineers, while it leaves out aspects that are important to the user. Even if there is no intention to put the user at a psychological disadvantage, that is likely to be the outcome" (Östberg, op.cit., p. 105f; see note 3 above.)

Östberg was not talking about SKB's reports, but we who are familiar with them find the comment very apt. MILKAS opens its comments on the long-awaited safety report, SR-Can, with a general complaint on exactly this phenomenon (the authors had not read Östberg's book!):

"...By deciding which questions will be discussed with which parties, SKB AB is able to control the discussion and define the topic. Another example of this compartmentalization is the distinction the industry makes between environmental aspects and safety aspects, as though it were a question of one or the other. This artificial dichotomy is not reasonable in the case of nuclear technology, where

*the risk of releasing radioactivity is at once an environmental hazard and a safety hazard. ...*²⁹

Yet another strategy is applied in the FUD reports, which are intended for lay readers. In the most recent report, FUD 04, which is supposed to be a summary of progress to date, the section on safety (SR-Can was not yet published) referred the reader to no fewer than 25 technical reports, most of which were available in English only. In other instances, jargon is as effective a veil as a foreign language.

The comments MILKAS filed on the FUD 04 report, also point out the lack of a unifying strategy -- a complaint also voiced by SSI. But, there was "a method to the FUD's madness", it turns out:

"FUD-program 2004' overwhelms the reader with details, big and trifling, without the logical framework needed to understand and evaluate them, their significance in the project or their importance for goal-fulfillment. ...Without a basis for judging the relevance of the many pieces of information that SKB AB serves up, the reader has to rely on the company's own evaluations. This is not always advisable."

An example is given: The FUD report referred to a previous safety report and noted that SSI had read it. Readers who took the trouble to look up SSI's evaluation of the report found that SSI was harshly critical, virtually tearing the report to shreds. MILKAS comments: "SKBs whitewashing of their work on safety hardly inspires confidence."³⁰ □

All the FUD reports that SKB AB has presented to authorities, politicians and NGOs are overwhelmingly confident. There are no doubts, no worries, no surprises. Values on all the parameters are satisfactory, all the hypotheses and expectations confirmed. Areas that are problematic are either not reported – that is, not spelled out in plain Swedish – or, often, glossed over with the phrase "requires some further work".

Although the rhetoric is obviously intended to impress and reassure, it often does the opposite. Where else in the realms of technology and science do all the pieces so readily fall into place?

"Out of sight, out of mind"

A fundamental doubt of a non-technical nature concerns the daunting task of communicating "DANGER! KEEP OUT!" across dozens upon dozens of generations – 100,000 years, perhaps longer. Humankind today has no living memory that stretches that far back.³¹ □What imagery can be sure to communicate mortal danger over such a span of time? □Especially when, assuming KBS-3 is pursued, already four generations from now

²⁹ MILKAS (2007) Remissutlåtande till SSI och SKI om SKB-rapporten, SR-Can (SKB TR-06-09) [Solicited comment to SSI and SKI on SKBs safety report, SR-Can ...].Augusti.

³⁰ Folkkampanjen mot kärnkraft-kärnvapen, Avfallsutskottet (2005) Utlåtande över SKB ABs FUD-program 2004 [Comments on SKB ABs FUD-report 2004]. Februari.

³¹ The aborigines of Australia are believed to hold the record. Elements in their creation myths have been verified 40,000 years back.

there will be no tradition of guarding the 'treasure trove' we bury deep in the earth.³² As MILKAS notes in connection with SKB's recent safety report: "*Of all the risk factors that need to be taken account of, human curiosity is perhaps the greatest*" (see note 29).

The issue of retrievability poses a couple of dilemmas. A guiding principle that SKB often repeats is that we who enjoy the benefits of nuclear energy should assume responsibility for its waste products and not pass the burden of managing them to coming generations. Therefore, they argue, it is best to bury the waste and then let it be forgotten. There are other advantages, too. Keeping the radioactive materials out of reach ensures that no one will be able to steal them to make a nuclear device. And, not to have to guard the repository is clearly cheaper.

The great disadvantage is that no one will be able to get in and remedy any malfunction that might arise after the vault is sealed. A leaking canister will have to be left to leak. Is such confidence in the infallibility of SKBs engineers a good idea?

Not being able to retrieve the waste also means that it cannot be reprocessed to produce new fuel -- should an environmentally acceptable technique for some form of "transmutation" present itself.

Current public opinion appears to be swinging toward making it possible to retrieve the waste -- which implies an about-face for SKB AB. Exactly how stable this trend proves to be remains to be seen. Meanwhile, the environmental movement is divided, for and against.

On a more detailed level

The comments on FUD that we have filed over the years cover far more pages than this paper. It is not possible to discuss all the points of criticism. □ But we can elaborate on a couple of points that illustrate the kinds of issues we are raising.

1. *SKB has not explored alternatives to KBS-3.* The aspect that has elicited the greatest frustration on the part of NGOs (and, to some extent, the Radiation Protection Authority, SSI) is SKB ABs refusal to explore alternatives to their KBS-3 method. When challenged on this point, SKB say they have considered the alternatives and found them inferior.

The initiative to discussion of the alternatives has been left to us in MILKAS and our colleagues in a larger umbrella organization of NGOs, MKG. Each of us has had the benefit of input from senior geologists who harbor doubts about the KBS-3 scheme.

Professor emeritus Nils-Axel Mörner advocates storage above ground under constant

³² A notice in *New Scientist* (24 Feb 2007) notes that the UN organ for nuclear technology, IAEA, has decided to abandon the traditional warning symbol for radiation. Too many people have been injured because they either ignored or failed to understand the symbol. Field research found that all too many children interpreted the yellow triangles as an ordinary propeller or windmill. □ The IAEA's new symbol, on a red triangular background, features the "windmill" at the top, five wiggly arrows pointing down from it, a smiling (?) skull-and-crossbones and a stick figure-man running in the direction of an arrow pointing right.

surveillance according to the Dry Rock Disposal method (DRD).³³ Mörner's main complaint regarding KBS-3 is his conviction that the repository cannot possibly withstand the forces that will be set in motion by the next ice age, particularly its aftermath. Mörner and his colleagues have documented numerous major earthquakes (7.0 on the Richter scale and higher) in what is now Sweden after the most recent period of glaciation. Not to mention underground explosions of methane gas, as frozen earth and rock thaw. Consequently, Mörner reasons, stores of high-active waste should be accessible so that they can be evacuated to less glaciation-prone regions of the planet. □

Secondly, Mörner et al. argue that the energy potential in the wastes should be kept accessible for possible future use. This motive is controversial. Critics argue that continued dependence on nuclear energy, even if it is "recycled" fuel, means continued environmental risk and pollution, and more waste. Most environmentalists would prefer truly sustainable solutions to coming energy crises. But Mörner's question remains: Is it ethically acceptable to deny future generations access to a potential energy resource?

Speaking of ethics, some people see no reason to worry about the welfare of *Homo sapiens* so far into the future as after the next ice age. What degree of responsibility, they ask, can we possibly have for the individuals who repopulate the Scandinavian-Baltic region? But that is to beg the question. Surely, we have no say about what future inhabitants choose to do or not do after migrating into the region. But, does our responsibility for *what we do today* diminish, only because the consequences of our choices will be felt in a distant future?

The second alternative to KBS-3, that put forward by our colleagues in MKG on the advice of Professor Karl Inge Åhäll at Karlstad University, is to deposit the waste in very deep boreholes, at depths of 3-5 kilometers.³⁴ The capability to drill boreholes that deep is rather new, but proponents of the alternative say it has become viable. □As in the case of KBS-3, retrieval of the waste is ruled out.

The principal advantages of very deep boreholes are two: (1) the heat from the waste will melt adjoining granite, creating an extra, natural barrier, and (2) at such depths there are large regions where the groundwater is totally still and layered according to its salinity. A key to the success of this alternative is the ability to drill holes in the formation without disturbing the stability of the groundwater.

For over twenty years SKB AB has been working to develop KBS-3. To be able to evaluate the alternatives on a par with KBS-3 — i.e., to satisfy the requirements of the Environmental Code — will cost millions, but hardly the thirty years and four thousand-million SEK that

³³ See www.morner.pog.nu. See also Cronhjort, B & Mörner, N-A (2004) A question of dry vs wet: The case for Dry Rock Disposal of nuclear waste. *Radwaste Solutions*, May/June, p 44-47; and Mörner, N-A (2003) *Paleoseismicity of Sweden: A novel paradigm*. A contribution to INQUA from the INQUA Subcommittee on Paleoseismology. 320 p.

³⁴ See Åhäll, K-I (2006) Final deposition of high-level nuclear waste in very deep boreholes. (MKG Report;2). December. The report is available at www.mkg.se.

the industry claims.³⁵ It is indeed unfortunate that SKI, the regulator, has not required serious consideration of the alternatives much earlier.

2. *The siting process has serious faults of two contrasting kinds.* Admirably, SKB AB has pledged not to force a repository on an unwilling local government — even though Swedish law would allow it. About a dozen sites were originally listed as having suitable bedrock. Today, all but two local governments have withdrawn from the process. The two remaining communities are coastal and already host nuclear power plants. They were not SKB's geologists' first choices. Thus, it seems that political acceptance has replaced geological suitability as the prime criterion.³⁶

The second point of concern regarding siting has to do with the bedrock formations in the candidate communities. Both localities are zones where groundwater streams away from the repository. From the point of view of containment, zones of influx of groundwater would better deter the spread of radiation to the biosphere. Formations of this kind have been identified far inland, but SKB does not seem inclined to spend time or money on these alternatives. Again, without a firm hand on the part of the regulatory agency, we can expect to find ourselves forced to settle for second-best.

Academic independence?

The problem is national, and the R&D effort has been placed in the hands of the Swedish nuclear power companies. Sweden is a country of only nine million people, but because the Swedish economy has long depended on mining and the manufacturing that mineral wealth supports, the number of bedrock geologists is greater than might be expected. Still, as regards the academic world, we are talking about only a handful of institutions. This, combined with a single source of funding, and a source which likes to be told what it wants to hear, reduces the leeway for freedom of expression and 'second opinions'. The climate for 'dissident science' in Sweden is harsh.

The hegemony of 'received wisdom' is not a problem only in small countries. It has been discussed in Great Britain and even within the EC Commission. recognizing an imbalance in the information that influences law-makers, several British organizations asked: Where do governments get their scientific advice? A survey of MPs and other policy-makers by Green Audit found that industry and commercial interests have significantly more influence than

³⁵ MKG (2007) Skrivelse till KASAM, dat. 28 augusti. (Memorandum to the Swedish National Council for Nuclear Waste [a committee under the Ministry of the Environment] of 28 August).

³⁶ This perception is shared by two sociologists who have studied the siting process in an international perspective. They write: "...[I]t has recently been argued that an authentic EIA process would view 'local acceptance' as something to be negotiated during the course of the consultation process, not as something upon which a site's recognition as a potential site should proceed. ... Voluntarism has served to *lock* the siting process into established nuclear communities in Sweden. ... This convenient process of 'lock-in' may prove harder to defend in face of environmental legislation than the long-established 'lock-in' to KBS-3 as BAT [best available technology]. Physical geology has only assumed a dominant role in the siting of KBS-3 after the commencement of site investigations in 2002. Up until the choice of Oskarshamn and Östhammar as sites for site investigations political geology was the dominant factor" (p 4). Elam and Sundqvist (2005); see note 24 above.

the notion of a 'marketplace of ideas' presumes.

"The official view is that NGOs, industry and independent committees like COMARE [Committee on Medical Aspects of Radiation in the Environment] have equal access to committees of MPs and hence equal influence on the decisions of responsible ministers. But in reality there are filters and pressures which amplify pro-industry views"

A couple of years ago, the EC Commission (Health) asked another British NGO, PINCHE (Policy Interpretation Network on Child Health and the Environment) for their views on the problem. Pointing out that the acquisition of and handling of scientific environmental health data may be biased by the needs of the institution handling and interpreting the data, PINCHE recommended

that scientific advice committees on specific exposure questions be set up at the beginning as discursive or oppositional committees, with institutional funding to include independent scientists to examine issues of environmental health. Reports of these committees' discussions would include all sides of issues where there is some argument as to the health consequences of policies involving these substances or processes. It would then be for the policy makers to decide on the safety of the process that was being suggested or the exposure being evaluated [emphasis added].³⁷

We second the idea and urge others, too, to work to make it a reality.

IV. A personal reflection

I lifted the quote at the start of this paper out of a very stimulating article by mathematician and documentary film-maker David Malone that I ran across in *New Scientist*³⁸ just as I sat down to put the bits and pieces of this paper together.

Malone writes about why he made his film, *Dangerous Knowledge*:

"In a society that is desperate to find certainty, and beset on all sides by people who claim to have it, this seems like a suitable moment to show that the idea of certainty-from-on-high was discredited 100 years ago. ...

□□What is ... striking is how much of 20th-century history has been defined by a disastrous oscillation between two equally hopeless reactions to the perceived loss of certainty. At one extreme, if the things we think are true can't be underpinned with certainty, we declare that nothing can be true and make a bonfire of all certainties. Think of fin-de-siècle Vienna or Weimar Germany or even the postmodernist stance, which becomes the perfect apologists' creed for the status quo.

□□At the other extreme, think of the absurd and deranged certainties of Hitler's Reich and Stalin's

³⁷ For an account of this debate, see "I don't know much about science, but..." and "Trust me, I'm a scientist", *Radioactive Times* 4:2, at www.llrc.org.

³⁸ David Malone (2007) "Can we learn to love uncertainty?" *New Scientist*, 4 Aug. At the time of this writing, a clip of Malone's film, *Dangerous Knowledge*, aired on BBC4, could be viewed at www.becauseyouthink.tv.

five-year plans, or the cold-war doctrine of mutually assured nuclear destruction ..."

Now, Malone is moving in circles far beyond MILKAS', but his thoughts do have a bearing on all of us who ask Established Science to consider ideas, minority views, that challenge the received wisdom.

The possible dangers of relatively low doses of radiation need looking into. Equally, while recognition of recent findings about the aftermath of an ice age will surely upset the apple-cart for a lot of hardworking people at SKB AB, the "certainty" of the assumptions behind so-called clearance levels and the safety of storing high-level waste in wet bedrock at only 400-500 meters underground *need* to be questioned. We are asking, and we think our questions are reasonable and worth looking into.

David Malone's article also revived a personal memory from some years back that I choose to make my 'parting words' for this paper.

On the fiftieth anniversary of the nuclear bomb tests at Bikini atoll in the Marshall Islands I was asked to write an article for a Swedish magazine on the fate of the 167 native inhabitants of the atoll. When I was researching the article I was fortunate to be handed an uncatalogued book that had been gathering dust in the attic of the library of the Royal Technological University in Stockholm. It was a public relations effort of the U.S. Army, published only a year or two after the end of the tests at Bikini. Its tone was exuberant.

What I most vividly recall is a photograph of a handsome goat, one of the animals that had been left tethered on deck on a ship in the lagoon during the last and 'dirtiest' blast. In the photo, said to be taken immediately after the detonation, a young sailor, bare-armed, is giving the goat a big congratulatory hug.

The book doesn't say what happened next. We know what happened to the goat from other sources, but what about the sailor? □□□□

Maybe some laboratory that reported directly to the Pentagon had an inkling of what was in store for the living creatures in that lagoon, but the sailor and the photographer apparently had as little clue as the goat.

My point is that the "certainties" of 1952 have had to be vastly revised. The technology is still young, and there is still much to learn. We have no reason to be shy about questioning the "certainties" on which current nuclear projects are founded.