Session 1, ***International Perspectives****, chair Professor Brit Salbu*

Nuclear Events in the Past

Secretary General *Malcolm Crick*, UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) www.unscear.org

Based on a series of nuclear events, and in particular the health injuries following the Hiroshima and Nagasaki bombing, Crick discussed the dose-health impact relationship. At high dose exposures, above the 1 Sv (Sievert) threshold, deterministic health effects such as visible burns, radiation sickness and eventually death will occur. Following chronic exposures between 1000 mSv and 100 mSv, stochastic effects such as cancer may occur, where the risk of cancer increases with dose, observable in disease statistics. For chronic exposure of less than 100 mSv health effects are plausible, but below the statistical limit of epidemiology. The average annual doses from natural background radiation vary in general between 1 to 5 mSv world-wide.

The nuclear bombs at Hiroshima and Nagasaki gave more than 100 000 immediate deaths. The surviving 86 500 people is a primary source of information on radiation risks, showing 440 cases of cancer above the population average by 1999. The atmospheric nuclear weapons test from 1952 to 1962 was the largest man-made release of radioactive materials to the environment, giving a total of 32 mill man Sv (collective dose to the population). The highest world average doses from atmospheric tests occurred in 1963. Individuals living near to the test sites may have received high exposure doses. The Chernobyl accident, the worst accident in civil nuclear history, released about 0.6 mill man Sv. AMAP (Arctic Monitoring and Assessment Program) has reported a sharp peak in the radioactivity of reindeer meat and in the body of reindeer herders (4500 Bq/kg) in 1965 and a smaller peak in 1986 as an effect of the Chernobyl accident.

Evaluating risks from exposure to radiation sources, one must not forget accidents associated with orphan sources or with sources for medical applications, said mr Crick. He reminded us about the Goiânia accident in Brazil, September 1987, where a medical therapy unit containing 93 g of CsCl was accidentally opened and the CsCl powder was distributed amongst individuals. Following the exposure, there were four fatalities, eight with Acute Radiation Syndrome (ARS) and total of 70 with observable injuries. About 112 800 individuals were surveyed and 271 persons found contaminated. Mr Crick expressed also concern about the rapid increase in radiography and computer tomography. Damage and fatalities caused by radiotherapy is under-reported, said Mr Crick, summing up as follows

- Atmospheric nuclear weapons testing was by far the largest man-made contributor to collective dose world-wide
- Chernobyl was by far the worst nuclear accident
- Number of criticality accidents seems to have diminished with time
- Number of accidents involving orphan sources is prominent and increasing
- Civilian transport has never lead to radiation injury
- Medical accidents are significant, and probably underreported and are becoming more frequent

Consequences of the Chernobyl Accident based on Chernobyl Forum

Professor *Mikhail Balonov*. Institute of Radiation Hygiene, St. Petersburg, scientific secretary to the Chernobyl Forum and consultant for UNSCEAR.

Professor Balov gave a comprehensive resume of the Chernobyl accident and the efforts to reduce the damage to people, fauna and flora. Consequences of the accident have been assessed by a number of international bodies, last by the Chernobyl Forum 2003 – 2005, where IAEA, FAO, WHO, as well as representatives from Ukraine, Belarus, and Russia, including a series of highly competent experts were involved in the assessment summing up the knowledge gained 20 years after the accident.

The Forums main conclusions are:

- The accident at the Chernobyl NPP in 1986 was the most severe in the history of the world nuclear industry
- Due to the vast release of radionuclides it became the first large magnitude radiological accident that required substantial countermeasures in Europe.
- In the course of the years since the accident, the most significant problems have become the social and economic depression of the affected Belarusian, Russian and Ukrainian regions and the associated serious psychological problems of the general pubic and emergency workers
- The majority of the 600 000 emergency workers and the 5 million residents received only minor radiation doses, comparable with natural background levels. This is also the case for other European countries. This level of exposure did not result in any observable radiation-induced health effects.
- An exception is a cohort of early emergency workers who received up to 20 gray (Gy)
- two persons were killed

- 134 suffered from Acute Radiation Sickness (ARS), 37 of these died by 2004
- A cohort of children and adolescents in Belarus, Russia and Ukraine were given milk contaminated with radioiodine. About 6000 developed thyroid cancer. More than 99 % successfully medically treated, but 15 were dead by 2004.
- Thus, 54 mortalities are so far directly linked to the Chernobyl accidents
- A doubling of leukaemia morbidity in workers exposed to more than 150 mGy, 5 % increase in solid cancer and cardiovascular diseases and some increases in cataracts.
- For the residents of the contaminated areas there are no reliable data on increases in any somatic diseases, except for thyroid cancer, as reported above.
- According to biostatistical forecasts, detectable increase in radiation-induced morbidity is unlikely to occur.
- Radiation levels are reduced by a factor of several hundreds due to countermeasures. Therefore the majority of contaminated land is safe for life and economic activities.
- The Exclusion Zone and some other limited areas should be restricted for decades to come
- Particularly high ^{137}Cs activity is found in mushrooms, berries, game, reindeer and fish at specific sites within semi-natural and natural ecosystems. These levels have persisted for two decades and are expected to continue to stay high for several decades.

- The biodiversity of the contaminated areas has increased during the years due to the evacuation of a large number of people
- Government countermeasures were on the whole timely and adequate. Now, social and economic restoration must be a priority.

Nuclear Risks, Safety and Security

Dr. *Deniz Yüksel-Beten*, Head, Threats & Challenges Section, Science Peace Program, NATO gave an overview of the new NATO SPS Committee & Program.

The support of science by NATO was initiated in the early 1950s by Canada, Norway and Italy, to allow scientist to have a dialogue across the "iron curtain". At the end of the Cold War in 1992, new NATO Partners were established, including the Russian Federation. Following the enlargement of NATO, the organisation included in total 26 countries. In 2002, the NATO Science for peace joined the Environment and Security Initiative – ENVSEC- together with UNDP, UNEP and OSCE, with the aim is to initiate and co-ordinate projects in environmental security, mainly in Central Asia and the Caucasus region.

The Science for Peace and Security (SPS) was established on 28 June 200 6, and is the primary NATO body over a programme for enhancing cooperation with all partnerships based on science and innovation. SPS conducts activities aligned with NATO's Strategic Objectives - especially Partnership and has a 'horizon-scanning' role in identifying future threats, raising awareness and finding solutions. In addition four advisory scientific panels are established and Expert groups will be established within high priority areas. The Nuclear Expert Group (NEG) with focus on radiological risks was established in 2007.

The main objective of SPS is to establish civilian cooperation between NATO countries and Partner countries and Mediterranean Dialogue countries and thereby contribute to solving problems effecting large societies in Partner and MD countries, to contribute to stability and peace by promoting regional co-operation. Participation by 56 countries: 26 NATO countries, 26 Partner countries and 7 MD-countries.

SPS has two Key Priorities:

- Defence against terrorism
- Scientific collaboration to counter other threats to security,

where nuclear risks are relevant for both areas. To support the joint collaboration within these areas NATO provides several mechanisms to:

- Small research groups:

  Collaborative Linkage Grants (CLGs) - Working together for security.

- Large groups of experts:

  Workshops (ATC- ARW) - Studies on security-related priorities.

- Institutions:

    Science for Peace Projects - Conduct joint security R&D and upgrade Partner laboratories.

- Societies at large:

    Projects - NATO support to solve problems affecting societies.

Although the focus areas for NATO are Central Asia, Caucasus, Balkan and the Mediterranean dialogue countries, other areas may also be of relevance to NATO.

Session 2 ***Nordic Perspectives****, Chair: Kjell Bendiksen*

Long-term Radioactive Wast Management in the UK

Dr. *Elisabeth Atherton*, Nuclear Decommissioning Authority, NDA

The NDA is a non-departmental Public body, established in April 2005 with the following objective:

To deliver safe, sustainable and publicly acceptable solutions to the challenge of nuclear clean-up and waste management.

The UK has been producing nuclear waste for more than 50 years. Significant amount of waste is stored intermediate for instance at Sellafield. There is a need to solve the problem with long term storage of nuclear waste, and geological disposal of the waste is now a key option in UK. The Government is responsible for the waste management policy and the selection of site for long term geological disposal of nuclear waste. The planning and development of geological waste disposal site are based on partnership with the host community, while NDA is responsible for the implementation. The process is supposed to be transparent and based on ethical principles.

We are dealing with the waste now, not leaving it to future generations, said Dr Atherton.

Radioactive Contamination in the Arctic.
Secretry General *Lars-Otto Reiersen*, AMAP, Arctic Monotoring and Assessment Program

AMAP is one of six bodies under the Arctic Council, with a geographic coverage extending to South of the Polar Circle, monitoring:

- Persistent Organic Pollutants (POPs)
- Heavy Metals
- Radionuclides

- Petroleum Hydrocarbons
- Climate Change and UV

by collecting samples of air, water, snow, ice, sediments, plankton, invertebrates, fish, mammals, birds and humans.

Three major sources contribute to widespread radioactive contamination of the Arctic:

- Fallout from atmospheric testing of nuclear weapons
- Routine releases from western European processing plants (Sellafield)
- Fallout from the Chernobyl accident.

Radionuclides are also transported by the rivers Ob and Yenisey, and nuclear waste is dumped in the Kara Sea

The critical food chain with respect to radionuclides in the Arctic is found in the terrestrial ecosystem, in particular the reindeer –lichen – man chain. Thus, reindeer herdsmen and their families represent the critical group.

Nuclear Risks in the Arctic

Professor *Brit Salbu*, Norwegian University of Life Sciences (UMB)

There is a series of nuclear sources that potentially can release radionuclides to the Arctic in the future. Site specific risks (probability of an event multiplied with the concequences, p x c) can be calculated for well known installations, while the probability of unforeseen events is impossible to evaluate. We have to ask who will do the harm? And replace probability with the intention and capacity of the harm-doer. Thus, qualitative statements (high-moderate-low risk) rather than quantitative (probability estimates) have to be applied.

Salbu gave an overview of nuclear sources in Europe which potentially can affect the Arctic: nuclear weapons, nuclear power reactors, reactor driven submarines, civilian reactor-powered icebreakers, storage of nuclear waste as well as dumped nuclear waste in the Kara Sea. Following decommission of submarine reactors, the concentrations of spent fuel and radioactive wastes in Andreeva Bay, 50 km from the Norwegian boarder, and Gremikha at the Kola Penoinsula are very high. The Northwest Russia represents today a site with the largest arsenal of nuclear weapons, nuclear reactors, and spent nuclear fuel world -wide. Based on IAEA threat categories, the conclusion is quite simple: The treat is real. The question is - are we sufficiently prepared?

Emergency Preparedness – Handling future nuclear events.

General director *Ole Harbitz*, Norwegian Radiation Protection Authority

Lessons learned from major releases of radioactive fallout:

- Lack of information and withheld information from the public: increased levels of anxiety
- Lack of coordination
- Lack of emergency preparedness and response

Harbitz gave an overview of sources representing main concerns: nuclear weapons, reprocessing plants, nuclear power plants, naval installations, accidents, dumping sites, visiting harbours, transport routes for spent nuclear fuel, dirty bombs, forming the basis for threat assessment, probabilities and consequences.

Presentation of the Nuclear Emergency Preparedness Organisation - Royal Decree of 17 February 2006 - the Crisis Committee, mandate and actions during an acute phase.

Presentation of Radnett, Automatic Measurement Network and other monitoring systems.

Need for international cooperation, exercises and real life experience.

Security aspects influencing nuclear risks in the Arctic.

Special advisor *Sverre Lodgaard*, Norwegian Institute of International Affairs

In the High North, the probability of the military postures causing nuclear damage is highest with respect to accidents at sea, with nuclear propulsion systems more than with nuclear weapons. The probability of terrorist theft of nuclear weapons and materials is lower. Actual use of nuclear weapons can never be excluded, but seems very unlikely. The consequences – the seriousness of the damage inflicted - are inversely related to the probabilities.

Session 3 ***International Perspectives on Nuclear Energy****, Chair: professor Jan S. Vaagen*

Opening words by professor *Sissel Rogne*, President of the Norwegian Polytechnic Society.

Introduction by State secretary *Liv Monica Stubholt*, Ministry of Foreign Affairs (as of 21 September 2007, 1200 hours: State secretary, Ministry of Oil end Energy):

Ms Stubholt commented on the Norwegian Governments official position along the following headlines:

- The international energy and environment setting
- Climate change and energy
- The renaissance of nuclear energy
- Norway and nuclear energy
- IAEA, nuclear safety and security, non-proliferation
- Nuclear safety in our neighbourhood: the case of Northwest Russia

There may be a renaissance for nuclear power in conceptual terms, but any great expansion of nuclear power is still far off, said Ms Stubholt.

Norway fully supports the right to peaceful use of nuclear power.

In Norway, large-scale efforts will be made over the next decades to curb CO_2 emissions, but reverting to a nuclear energy is, luckily I must say, not one of the options nearest at hand here.

Future Energy Supply – Nuclear Power in a Climate Perspective.

Managing director *Kjell Bendiksen*, IFE, Institute for Energy Technology, Norway.

Fossile fuels cover 80%+ of the present global energy demand, and their share increases. Renewable energy amounts to less than 10 % and is mainly hydropower, amounting to 89 % of the total for renewables, with bioenergy at 7 % in second place. Wind and solar contributes each 2 % of the renewable energy.

This picture will not change much by 2030, said Bendixen. Fossil fuels will still dominate. The contribution from renewables will barely upheld its share, but wind power will increase. Hydro will however still be at 69 % and wind at 15 % of the total for renewables.

Contribution from nuclear power is about the same as from renewables. Nuclear´s share of electricity production in 2005 is 16 %. This may increase to 18 % in 2030, equivalent to a doubling in production capacity.

Ordinary spent reactor fuel must be stored for 250 000 years before the radiation level is reduced to that of natural uranium ore. Removing plutonium reduces the time to 15 000 years. Removing the minor actinides further reduces necessary storage time to 250 years.

Nuclear energy has definitely become safer, said Bendiksen. A new Chernobyl accident is near impossible, but existing plants and old designs are not fool-proof.

Nuclear energy is the only available large scale power source with negligible GHG on the market.

Equipping existing fossil-fuel fired power-plants with capture and storage-systems means deploying 2 – 4000 CCS plants and safely to take care of 15 to 20 gigatons of CO_2 annually before 2050.

GHG-emissions from nuclear plants are close to zero.

Power availability for nuclear plants has risen from 74% to 84%. New technologies may reduce the waste storage problem and at the same time extend fuel supply to thousands of years.

Public acceptance remains crucial.

Nuclear Energy – The Finnish Solution and Position

Professor *Rainer Salomaa*, Helsinki University of Technology.

Finland has four nuclear power-plants providing 18% of the total fuel consumption. The total electricity consumption in 2005 was 85 TWh of which 20% was import, 16% hydro-power and 26% nuclear. From 1995 to 2003 the electricity consumption has increased by 22%, while the production capacity only has grown 15%.

The Finnish economy depends on the power consuming export industry, and its competitiveness depends on low and stable energy prices.

A comparison of electricity generation costs, with emission trading, shows that a nuclear power plant with 8000 operating hours/year gives lower prices than both Elspot, wind, gas, coal, peat and wood. Furthermore choosing nuclear enables Finland to meet its Kyoto commitments

The public acceptance for nuclear power in Finland has increased from 24% in 1982 to 50% in 2006, while the negative fraction is reduced from 38% to 20%.

Building of the 5^{th} reactor, Olkiluoto 3, started in 2004 and it is expected to go in commercial operation after 2011. Planning and construction will give a total of 30 000 man-years, a peak workforce at the site of 2500, and engage 1600 subcontractors in 28 countries.

The spent fuel from Finland's five NPP´s will be stored in an underground, bedrock repository at Posiva. Construction started in 2005 with local consent.

Public opinion in Finland is pro nuclear power. A poll in 2006 showed 63% in favour and 33% against. Environmental Impact Assessments for a 6th NPP are under way for several locations in Finland.

Professor Salomaa emphasized that nuclear power means long-time commitment. The life-time for a modern NPP is 60 years and the plans for operation of the repository at Posiva extends to year 2140.

Fourth Generation Nuclear Power Plants

By Jaques Bochard, Chariman of the Generation IV International forum (GIF)

Presented by Sunil Felix, Assistant to Jaques Bouchard

The Generation IV International Forum, GIF, was chartered in July 2001 to lead the collaborative efforts of the world's leading nuclear technology nations to develop next generation nuclear energy systems to meet the world's future energy needs. www.gen-4.org/

By the end of 2002, the work resulted in a description of the six most promising systems and their associated R&D needs. The six systems feature increased safety, improved economics for electricity production and new products such as hydrogen for transportation applications, reduced nuclear wastes for disposal, and increased proliferation resistance.

Gen IV reactors can be made with closed fuel cycle where plutonium and actinides are consumed, reducing the volume and necessary storage time for spent fuel, and at the same time give a 70 to 100 times better utilization of the energy content in the fuel, compared to the once-through fuel cycle used today.

Gen IV gas cooled reactors can produce hydrogen by a thermochemical process, bypassing generation of electricity and electrolysis and they are suited for desalination of seawater.

Gen IV reactors should reach maturity by 2030, said Mr Felix

From waste to value – Accelerator-based Inherently Safe Nuclear Power

Dr *Yachine Kadi*, Nuclear Scientist, CERN

A major innovation is needed to replace the expected "decay" of traditional energy sources.

Nuclear energy has the potential to satisfy the demand, at least 15 centuries for fission and infinite for fusion.

Can nuclear fission be exploited in a way that reduces the risk for accidents and eliminates proliferation of plutonium?

The idea of a accelerator-driven, sub-critical reactor had been around for a long time, said Dr Kadi.

Such reactors accept fuels that are not acceptable in critical reactors, such as minor actinides and high Pu-content and give much greater operational safety margins

The main objective is to reduce the production of nuclear waste. Fast neutrons allow a more efficient use by allowing an extended burn-up. The strategy is to use the hardest possible neutron flux, so that actinides can fission instead of accumulating as waste. The radiotoxicity of spent fuel reaches the level of coal ashes in 500 years, similar to what is predicted for future, hypothetical fusion systems.

When and where will the demo-plant be built?

Thorium as an alternative fuel.

Professor *Egil Lillestøl*, CERN & University of Bergen

The world number one problem is the increasing global energy consumtion, growing at more than 3% per year, corresponding to a doubling in 20 years. Only massive use of nuclear power, combined with rapid development of direct conversion of solar heat may alleviate the problem.

Thorium is not fissile but fertile and can be transmuted to 233U which is fissile. This can be done in conventional nuclear power plants.

Thorium is much more abundant than the uranium and the thorium ore does not require the separation process necessary to enrich uranium.

Thorium has been tested for 40 years in nuclear reactors, with large efforts in India since 1995.

The road to commercialization of critical reactors based on the Th - 233U-cycle is long and costly.

However the Thorium-cycle for an accelerator-driven reactor is much simpler and could be developed fast.

Norway should build a pilot project, using existing technologies, with thorium from India, accelerator from Switzerland, reactor core from Russia and fuel processing for the US.

Session 4 ***Norwegian Perspectives of Nuclear Energy****, Chair Reidun Sirevåg*

The occurrence of Thorium Minerals in Norway

Professor *Arne Bjørlykke*, Norwegian Gological Survey, NGU

Results from air-surveys have showed that the Fens area in Norway may have large reserves of thorium.

USGS estimates that Australia may have 300 000 tons reserves, India 290 000 tons and Norway 170 000 tons, with a a world total of 1200 000 tons

Professor Bjørlykke pointed out that thorium from beach sand with monazites probably will be the main resource of thorium for many decades, because it is:

- Easy and cheap to mine
- Easy to make a mineral concentrate
- There is a simple process of desolving monazite in sulphuric acid and precipitate Th-oxide

Thorium in Norway is found in bed-rock. Professor Bjørlykke concluded:

- There may be a possibility for thorium from carbonatites as a by-product, and a systematic study of the Fen area is recommended.
- There may be several reasons why Norway should invest in research on Th as an alternative future nuclear fuel. Norwegian resources of Th is for the moment not one of these reasons.

Radiation Protection Aspects

Director *Per Strand*, Norwegian Radiation Protection Authority (NRPA)

Mr Strand presented an overview of radiation protection aspects throughout the nuclear fuel cycle, international commitments and recommendations as well as Norwegian laws and regulations.

The Norwegian radiation protection Law 2000 includes the radiation protection not only of man, but also of the environment. Today, the regulation of the radiation protection of the environment is still a problem, as there are no international standards for non-human organisms. The Norwegian Atom energy law, regulating the operation of the Kjeller and Halden reactors will need to be updated, if Norway were to develop a nuclear power industry.

IAEA safety standards would be useful resources in such a work process

Possible Industrialization of Norwegian Thorium Resources

Director *Svein Sundsbø*, Federation of Norwegian Industries.

The industry consumes about 40% of the total electrical energy used in Norway. There is an increasing lack of generating power in Norway, and the power balance for the Nordic countries is negative. This basic problem must be solved by installing new generation capacity.

The prices for electric power offered to the industry are no longer competitive. We have a dysfunctional energy market. Prices for oil and gas show large variations. The emission trading system reduces competitiveness with countries outside of the trading system. Dependency on energy from Russia gives uncertainty. Will industry manage to reduce its dependence on fossil based energy, while at the same time uphold its competitiveness relative to third countries not subject to obligations to mitigate their carbon footprint?

New renewable energy is a positive asset, but will not solve the fundamental challenges because of insufficient and unstable production, to costly without subsidies, environmentally controversial.

Carbon capture and sequestration will be necessary for fossil based power, but it is a costly solution.

Nuclear power based on thorium is CO2-free. What about cost, environmental consequences and political accept?

Sundsbø concluded as follows

Industry's competitiveness must be improved, or at least maintained at present level:

- Industry is committed to global climate efforts
- Industry is in urgent need of increased baseload-production at competitive prices
- Renewable energy will not solve the problem

Norwegian Industries foresee two possible solutions:

- Fossil based power where the costs for CCS is covered by society
- Environmentally acceptable nuclear power

Nuclear energy – regional Needs, Problems and Solutions

Professor *Waclaw Gudowski*, University of Uppsala, Chairman of the Energy Committee in the Royal Swedish Academy of Science, Deputy Executive Director ISTC (http://www.istc.ru/)

Professor Gudowski presented an overview of the vocabulary used to describe the processes in a nuclear reactor and its waste products, as well at the material flow in once-trough and closed-cycle reactors.

1. The regional energy consumption pattern differs, with Asia and Pacific heavily dependent on coal, South&Central America with a large share of hydropower. Nuclear power gives an important contribution only in Europe an the US
2. The world carbon emissions are growing quickly, although the carbon intensity is falling

Comparison of cumulated CO2-emissions from different means of electricity production puts hydro-electricity at the top with 4 g/kWh and nuclear as number two with 6 g/kWh. Coal is at the bottom with 978 g/kWh. Photovoltaic emits 60 – 150 g/kWh, reflecting the energy use for making the systems.

A comparison of landuse for a 1000 MWe powerplant shows that a nuclear powerplant only requires 1 – 4 km^2, while biomass would require 4000 – 6000 km^2

Is nuclear energy the solution? Yes, said professor Godowski. Advanced nuclear cycle adopted regionally, mitigates most of the problems. It is important with a regional nuclear fuel cycle, involving regional actinide management and regional approach to nuclear waste repository. Closed nuclear fuel-cycle and possibly Th-based fuel cycle can also solve the problems of sustainability.

Regional approach can optimize costs of nuclear fuel cycle trough common politics and solutions in the front end and the back end of the fuel cycle.

Think globally – Act regionally:

A Nordic thorium initiative can be a perfect beginning.

Plenary meeting at Gamle festsal, Oslo University, Chair Sverre Lodgaard

Risks from Nuclear sources in the 21 Century

Dr *Hans Blix*, former director of IAEA and chairman the WMD commission.

The world will ask for more energy. If nuclear energy is not used, other sources will be relied on. The various risks that we link to any use of nuclear power should therefore be compared to the risks that would be incurred by the use of alternative sources: economy, assurance of fuel supply, safety in operation, safety in waste disposal and security.

Uranium fuel is inexpensive and the largest mined sources are in stable countries: Australia and Canada. The prices for reactor fuel have increased, but the influence on generating cost is much less than the effect of rising gas and oil prices on fossil fuel power plants.

It has been said that the supply of uranium will only last for 50 years. However only a small part of the energy content in the fuel rods is used in most countries. Some 80 to 100 times more energy can be extracted, at a higher cost.

Much focus is on safe storage of radioactive waste. All waste from nuclear power-plants is collected, concentrated and confined in safe, underground repositories. The waste from fossil fuel plants is diluted and dispersed into the atmosphere. The result is global warming.

The spent nuclear fuel may be retrieved and used for fuel in future nuclear reactors. A wise president of a Swedish commission on waste once said: Waste is what remains when our imagination has run out.

The nuclear accident at Chernobyl happened 20 years ago. Since then we have had no serious accident in civilian nuclear power. It was of a rare type of reactor that lacked containment. Most of the world's light-water reactors have containment that stops any emissions of radioactivity into the environment.

The most severe accidents are in hydropower. When big dams have burst – which has happened so rarely – huge quantities of water has flooded downstream villages and towns with horrendous losses in life.

There is much worry about proliferation, but will a doubling of nuclear power plants in Sweden or in the US increase the risk? Sweden, Finland and Germany have had nuclear power for many years, but have refrained for nuclear weapons. Israel has nuclear weapons but no nuclear power.

We live in a world of some 27 000 nuclear weapons and 9 nuclear weapon states. The genie is out of the bottle. We can not uninvent the atomic bomb, but we can outlaw it. Proliferation is a question of political decisions and of the examples set by the US and Russia.

The window that opened at the end of the Cold War has been allowed to hang flapping in the wind, said Dr Blix. It is high time that it be fully opened and lead to a cooperative security order which eliminates the risk posed by nuclear weapons.