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The International Atomic Energy Agency – 35 Years Promotion of Nuclear Energy

A critical documentation of the Agency's Policy

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Content

This is the summary of a study which will be available at the end of the year. The study follows the history of the IAEA. It will contain critical discussions of the IAEA's policy and its consequences.

I. Statute, Aims and Members of the International Atomic Energy Agency (IAEA)

The International Atomic Energy Agency is a United Nations organisation. It was founded in 1957. 57 states ratified the Agency's statute in 1957, today the IAEA has 116 members. The IAEA promotes the use of atomic power for several applications in medicine, agriculture and energy production. Only one fourth of the member states use nuclear energy for electricity generation.

Starting point to the foundation of the IAEA was a speach held by U.S. president Eisenhower before the United Nations in 1953. Eisenhower declared the USA are willing to share the benefits of nuclear power with all nations of the world. With this "Atoms for Peace" programme the USA hoped the world would forget the horror of Hiroshima and Nagasaki.

"... this greatest of destructive forces can be developed into a great boon for the benefit of all mankind." (1)

Eisenhower proposed the creation of an International Agency to control the use of fissionable material and to develop peaceful applications of atomic energy.

Even at this time it was evident that no agreement and no police-like control can prevent the military use of nuclear technology. The development of nuclear energy for peaceful purposes and the development of atomic bombs are interchangeable and interdependent, stated the Acheson-Lilienthal-Report in 1946 (a study of an US governmental commission).

Nevertheless the General Assembly of the United Nations voted in 1954 for the "Atoms for Peace" resolution and started a process which ended with the foundation of the IAEA in 1957.

From the outset the IAEA was an international forum for the nuclear industry (firstly for that of USA). This is fully in line with the IAEA's statute, where the aim of the Agency is defined as:

"... to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it ... is not used in such a way as to further any military purpose." (2)

The statute is written in the nearly religious faith of the 50ies and 60ies in the benefits of nuclear power. The risk of widespread contamination and the danger of radioactivity is nearly completely ignored, despite the experiences of Hiroshima and Nagasaki, the uranium-mining and the work with radium.

The first Director General of the IAEA came from USA. He is representative for their interests in the Agency.

Sterling Cole, member of several military commitees in USA, was participating in the revision of US atomic law to make peaceful development of nuclear energy possible. (3)

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1 New York Times 9. 12. 1953

2 IAEA Statute, Article II

3 Mr. Sterling Cole, IAEA's First Director General Leaves Office after Four Years of Service; IAEA Bulletin 4 (1962) Nr. 1

His successor as Director General became Dr. Sigvard Eklund in 1962: Eklund was scientist at the Nobel Institute for Physics and the Research Institute for National Defence in Stockholm. Since 1950 he was working as a manager at the Swedish Atomic Energy Company (AB Atomenergi, Stockholm) (4). Eklund is a typical representative of nuclear industry. In his inaugural speach he expressed its interest in the IAEA:

"The time available before we need atomic energy before other energy sources are exhausted should be used to perform extensive research and development work including the construction of reactor prototypes, to make the still missing 'break through' ". (5)

The IAEA is in many respects an unique organization:

It is nearly impossible to fulfill such contradicting duties as to promote nuclear energy and prevent its military application. At the same time the IAEA wants to be responsible for the safety of nuclear facilities and for radiation protection. But if your first goal is to further the application of nuclear energy for various purposes, you will hardly be very critical regarding safety problems.

Moreover the IAEA is the only United Nations organization with a clear mandate concerning energy production - to promote nuclear power. It is evident that atomic energy can not solve world's energy problems. Therefore a United Nations Agency for the promotion of nuclear power is obsolete and counterproductive.

At the beginning there were only very few industrialized countries which had atomic power stations and an industry which was able to develop and construct nuclear facilities. Today they are some more, but the majority of the IAEA's member states does not have a nuclear industry or nuclear power plants.

II. IAEA Safeguards and the Proliferation of Nuclear Weapons

"Considering the devastion that would be visited upon all mankind by a nuclear war and the consequent need to make every effort to avert the danger of such a war and to take measures to safeguard the security of peoples.., " (6)

After discovering the nuclear fission and its applications the United States first tried to keep this frightening knowledge secret, and then changed towards "Atoms for Peace". With the spread of nuclear technology attempts began to reach an international agreement against the proliferation of atomic weapons which led to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). It entered into force on 5 March 1970. There are now 147 countries parties to the NPT including 4 of the 5 "declared" nuclear-weapon States. Although the international non-proliferation regime nowadays encloses many different elements the NPT is still central.

The NPT sets out six main obligations: Fixing the number of nuclear-weapon states to five; undertaking of the non-nuclear-weapon states not to aquire nuclear weapons; controlling the civilian use of atomic energy by IAEA safeguards; encouraging of civilian atomic cooperation; undertaking to make available the benefits of so-called peaceful nuclear explosions; promoting nuclear disarmament.

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4 Dr. Sigvard Eklund Takes Office as Director General of IAEA; IAEA Bulletin 4 (1962) Nr. 1
5 ibid.
6 Preamble of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)

The NPT has not reached its goals. An Indian critic states it harshly:

"Indeed, the proliferation control system formulated and evolved so painstakingly under the IAEA/NPT prescriptions have been exposed as meaningless, hollow, and ineffective (...)."

The reasons for this are the critical gaps in the safeguards regime:

— Encouraging the use of nuclear power and the fictional distinction between civilian and military use of nuclear energy are fundamental. A treaty built on this, however, cannot serve as an efficient instrument of non-proliferation of nuclear weapons. A most recent example for this is the development in Iraq - a country which concluded a full-scope safeguards agreement with the IAEA.

— The possibilities of IAEA safeguards are very limited: IAEA's task is only to ascertain whether fissile material from the civilian sector has been diverted, but not to verify whether the non-nuclear-weapon member countries in fact do not manufacture nuclear weapons.

— Only the non-nuclear-weapon states parties to the NPT are obliged to accept full-scope-safeguards on all of their nuclear activities. Nuclear-weapon states are not obliged to do so. Above all, the nuclear-weapon states were and are not willing to accept a control over their atomic weapon arsenals. This is not only regarded as a discrimination by many countries, but it is harmful to the reputation of the IAEA, too.

— The amounts of fissile material are not under control at all. A comparison between the amounts safeguarded in 1990 and the estimated quantities existing worldwide shows: Only about one half of the plutonium in irradiated fuel, less than a third of separated civilian plutonium in store, and only about six per cent of the total estimated civilian and military separated plutonium inventory are subject to safeguards. Of the world's (military) inventory of highly enriched uranium only one per cent is under control.

— The civilian stockpiles of separated plutonium will increase considerably in the near future; one can expect that in 2000 the inventory will equal or even exceed the military inventory today! This situation *"poses a major political and security problem worldwide"*, as IAEA Deputy Director General William Dircks warned in April 1992. Through promoting reprocessing of spent reactor fuel the IAEA is responsible for this situation, too.

— Not all countries which are militarily significant and/or which run well-developed nuclear programmes are party to the NPT and thus subjected to full-scope safeguards. India, Israel and Pakistan for example are only having facility- or material-oriented safeguards agreements in force. These safeguards are of minor importance for the prevention of proliferation, because those states are hardly dependent on diversion of fissile material from the safeguarded sector.

— Even full-scope safeguards do not allow comprehensive controls. Hidden activities (clandestine facilities, undeclared material) cannot be controlled; unannounced inspection of facilities is not possible.

Two main aims of the NPT - to stop horizontal and vertical proliferation - have not been reached. Since its coming into force more than the five acknowledged nuclear-weapon states have become a de facto nuclear weapon state or are able to manufacture nuclear weapons in a short time. Some countries of concern are India, Pakistan, Israel, Iraq, North Korea, maybe South Africa (newly safeguarded), Argentina, Brazil. The list may be prolonged to Taiwan, Lybia, Iran. Suitable conditions exist in well developed countries like Germany, Japan, Canada, Italy, Sweden with appropriate facilities and know-how.

The development in the so-called developing countries was only possible with assistance and supply by countries which possess nuclear technology and whose economic interests far outweigh their desire to prevent proliferation.

The NPT did not prevent vertical proliferation, either. On the contrary: the number of atomic weapons and their technological sophistication in the arsenals of the five declared nuclear-weapon states have increased steadily at least until recently from about 1000 estimated nuclear devices in 1952 to more than 40,000 in 1967 and to 55,600 in 1989.

Peaceful nuclear explosions (PNE)

"If peaceful uses of nuclear explosions become possible they could offer dramatic benefits." (7)

If you cannot get rid of atomic bombs, so try to make something beneficial out of them.

"It is hoped that (...) nuclear weapon technology can be converted into a valuable (...) tool for the benefit of all mankind." (8)

The IAEA was very impressed by first tries: *"... a large explosion could, in fact, demolish a Pacific Atoll and, indeed, leave a cavity where an island had been."* (9) – It must be acknowledged that, in fact, indeed, this sort of benefits for all mankind is a striking argument for PNEs.

Some applications discussed by PNE true believers and the IAEA are as follows: underground gas or oil tanks; gas and oil mining; gas fire extinguishing; creating cavities for undergroud leaching of minerals; conventional mining and rock crushing; geographical alterations such as the building of harbours, canals and the division of waterways, geological research; radioactive waste repositories (liquid HLW to be poured into the cavity).

In the USSR several underground natural gas tanks have been made by using nuclear explosions, radioactive fission product traces of which can still be found in Russian gas which is used in Western Europe.

Despite the IAEA's efforts the interest in PNEs was still very limited. After several years of fruitless effort to foster the use of PNE (including a total of 5 conferences, bibliographies, guidelines and tons of paperwork) the IAEA eventually suspended its PNE work in the late seventies.

One reason for the suspension of PNE activities may have been that obviously some technical and safety related questions have never been solved.

The main political concern of PNEs is, of course, that they can jeopardize the efforts of preventing nuclear weapon proliferation; the IAEA was aware of the problem. But nevertheless the promotion of PNEs is part of the NPT itself.

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7 B.I. Spinrad: Possibilities for peaceful nuclear explosives IAEA Bulletin Vol. 11, 3 (1969) 3;
8 The Third Conference - A Summing up IAEA Bulletin Vol. 6, 4 (1964) 15;
9 B. I. Spinrad: Possibilities for peaceful nuclear explosives IAEA Bulletin Vol. 11, 3 (1969) 3;

For the IAEA, the genious solution of this contradiction was to present itself as the authority which could both provide technical know-how for PNEs and control its use; to offer *''international service for nuclear explosions under appropriate international control.''* (10) – *''as one of the ways of fulfilling its statutory mission of furthering all peaceful uses of nuclear energy''* (11).

The fact that the non-peaceful parents of the PNEs still exist is counterproductive to the PNE business and the related benefits for all mankind look suspicious under these circumstances. Therefore, the IAEA would like to see a complete military test ban treaty.

Extension of the NPT – it's time for a change!

In 1995 the parties of the NPT are to hold the so-called extention conference in order to decide on the future of the Treaty. Despite all critique we think the NPT should be extended after 1995 since otherwise an important limitation to nuclear armament would be cancelled and even an incomplete international control of bomb material would not take place any more. But the NPT and therefore the role of the IAEA has to be changed and defined in a new way. Our claims are:

— Establishing of the IAEA as an organization for the effective and comprehensive control of fissile material – both civilian and military – and extension of its related possibilites and competencies.
— Deletion of Article IV of the NPT (Promotion of atomic energy for peaceful applications)
— Deletion of Article V of the NPT (Promotion of peaceful nuclear explosions).
— Stop of civilian and military separation of plutonium.

For us a central point is the disposition of plutonium already existing and arising in the future. Plutonium in warheads must be dealt with in such a way that it cannot be used for weapons again and that mankind and nature are protected against highly toxic radioactive material. In order to stop the increasing surpluses of separated civilian plutonium the only way is to stop reprocessing of spent fuel.

III. Promotion of the Use of Atomic Energy

''The technical co-operation programme is the IAEA's primary vehicle for promoting the peaceful uses of nuclear energy in developing countries.'' (12)

According to her statute one of the main tasks of the IAEA is to promote and support the use of atomic energy throughout the world. This has been done during the last 35 years by providing "technical assistance" and "technical co-operation", respectively, especially to the so-called developing countries. The promotion programme covers the application of isotopes and radiation for industrial, medical, agricultural and other purposes as well as the generation of electricity. One main reason for this policy has been and still is to give a positive image to a technology which from the very beginning is connected with death and devastation.

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10 The Year of the Non-Nuclear Weapon States IAEA Bulletin Vol. 11, 5 (1969) 4;
11 B. I. Spinrad: Possibilities for peaceful Nuclear explosives IAEA Bulletin Vol. 11, 3 (1969) 11;
12 N.b. Muslim: Challenges of technical co-operation IAEA Bulletin Vol. 29, 1 (1987)

Almost 500 million dollars have been spent from the beginning of the technical co-operation programme in 1958 until the end of 1990. It is interesting to note that the overwhelming part of the money comes from the highly industrialized countries and goes to the so-called developing countries. Since the mid-1970ies about one half of the money has been spent for the transfer of equipment like gamma machines or material.

Radiation is a hazardous agent: Exposures to low levels may cause long term health damage, and exposure to an unshielded strong radiation source can lead to severe injuries and death. Many accidents and incidents have occured in the past and have affected radiation workers, the public and the environment. The overwhelming part of all radiation accidents is the result of "misadventures" with radiation devices like radiography sources for medical treatment, seed or food irradiators and instrument sterilizers. Some of these "horrible experiences" have threatened the world, for example 1983/84 in Ciudad Juarez, Mexico, 1984 in Morocco, and 1987 in Goiania, Brazil. The number of deaths has increased, especially due to an accident in a hospital in Zaragoza, Spain, in 1990, in which 11 people died.

Severe accidents leading to very dangerous levels of radiation are, however, only the tip of the iceberg. Hazards are present at any stage of using radiation sources and radioisotopes.

Although hazards connected with the use of nuclear techniques are by no means excluded in countries with an existing radiation protection system, there are special and severe problems in developing countries. It should be incumbent upon the promotors to ensure that an adequate radiation protection infrastructure exists as a precondition for the introduction of nuclear techniques, but unfortunately this had not been the case at all.

In 1984, the IAEA created the Radiation Protection Advisory Team (RAPAT)-missions. In an interim report M. Rosen, Director of the IAEA Division of Nuclear Safety, states in 1987:

"The RAPAT experience so far unambiguously establishes that many developing countries simply lack the necessary infrastructure to implement a radiation protection policy based on international standards."

By now, there have been 52 missions, but the picture has not substantially changed. To give two examples: In one country 3000 X-ray machines run without licencing or inspection, and in several countries sophisticated particle accelerators and neutron generators run without adequate operational procedures or monitoring.

The same is true considering management of radioactive wastes generated from use in medicine, industry, mining, (research) reactors and so forth. In 1987, the IAEA initiated the so-called Waste Management Advisory Programme (WAMAP). The results clearly show the huge deficits. For example: Although spent radiation sources are a major waste problem in most developing countries, no comprehensive and reliable information is available regarding the number and type of the spent sources.

The IAEA has contributed to this situation for several reasons. The IAEA has failed to assure that a country really needs sophisticated nuclear techniques for certain purposes, and that an adequate radiation protection infrastructure exists. Thus ambitious projects have been encouraged and initiated in many developing countries which lack even basic radiation protection infrastructure. It is not only absurd but dangerous to provide these countries with irradiation machines.

It is obvious that the IAEA has ignored the problems for many years. Not until the mid-1980ies RAPAT-missions tried to analyse the situation and to suggest practical long term actions. One gets the impression that for the IAEA activities in radiation protection and safety are means to increase public acceptance of nuclear power rather than a basic precondition for the introduction of this hazardous technology.

Most of the IAEA's promotion has been given away to large-scale projects (e.g. radiation vulcanization of natural rubber latex or the Sterile Insect Technique), radiation techniques which require huge capital investments and thus are (economically) only acceptable as high-capacity facilities. Often these are rather prestigious projects, which would otherwise have been without any chance of competitiveness on the market. These large scale projects, however, are frequently not adapted to the specific needs of developing countries.

Food Irradiation

Serious research on food irradiation began in the 1940's. The USA started their research shortly after World War II had ended. At this time the food industry didn't show any interest in treatment of food with ionizing radiation. It was the Army who wanted to advance a new method to keep food fresh for a long time without refrigeration.

And it was the Atomic Energy Commission who wanted to make use of the fission by-products (Cs-137). *"In about 1950, the Unites States Atomic Energy Commission (USAEC) began to support a coordinated research program on the use of ionizing energy for food preservation. This program was particularly directed, at first, towardes the utilization of the fission by-products."* (13)

Can food irradiation solve the world food problem?

But another argument became soon more important for praising the new technology (maybe because the term "use of the by-products" was not so successful): the solving of the world food problem. The main argument is that about 30% of the harvest in developing countries are lost because of insect pests or the climate and therefore it is necessary to find new food preservation techniques, of course with the use of nuclear technology.

Dick de Zeeuw from the Ministry of Agriculture and Fisheries in the Netherlands realized:

"Just as other commodities, food is not distributed on the basis of need but on the basis of purchased power." (14)

It's necessary to ask if application of nuclear technology can clear away this problem.

In 1966 it was already realized that *"Unfortunately the economics, as with all kinds of foodstuffs, are against irradiation methods in those parts of the world where they are most desperately needed. Grain irradiation plants are large, expensive installations and can only be operated economically if backed by a well-developed transport system, allowing a throughput*

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13 S. A. Goldblith: "Historical Development of Food Irradiation" in Food Irradiation. Proceedings of a Symposium, Karlsruhe 1966; IAEA Vienna 1966

14 de Zeeuw: "Use of Nuclear Energy to Preserve Man's Food" in: IAEA Bulletin Vol. 18 (1976) / Supplement

of large quantities. In addition, a truly economical use of such plant could probably only be achieved if more than one commodity were involved, assuming a continous utilization over most of the year. " (15)

In 1990, just six developing countries had irradiation facilities for commercial use, but 14 developed countries had some.

Consumer's acceptance

It is quite evident that the consumers must be convinced that the new technology is necessary. And not only the consumers: the governments also hesitate to clear irradiated products. This fact is often complained about as one of the major problems in getting acceptance for irradiation.

"The consumer's greatest prejudice is in the word 'irradiated', falsely associated with negative terms such as cancer, death, sterilisation and radioactivity. Hence the Dutch have tried to avoid the word and introduced an irradiated food symbol which could also be used internationally for exports. " (16)

For the IAEA this problem could be solved with another terminology:

"A company in California has already proposed the name 'picowave processing' as a substitute for food irradiation ... Unfortunately, the picowave process does not cover electrons which can also be used to preserve food ... The Agency was therefore requested to appoint a group of experts including marketing specialists to evaluate the terminology and facilitate acceptance by the consumer. " (17)

The Wholesomeness of irradiated food

IAEA and WHO established a Joint Expert Committee on Wholesomeness of Irradiated Food. A great number of regional and international projects on the subject of food irradiation were started, for example the "International Food Irradiation Project" (IFIP) which was carried out in Karlsruhe, FRG, to test the wholesomeness of some irradiated products. The result of all these studies was that an expert committee decided in 1980 in Geneva that irradiation of foodstuff in general up to 10 Kilogray does not imply toxicological hazard for human consumption.

It is not undisputed that consumption of irradiated food is really wholesome. There have been some research results which proved several negative health-effects. For example, in India an increase of polyploidie was found after feeding some malnourished children with a diet containing irradiated wheat. But other institutes were not able to confirm these results.

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15 "Food Preservation by Irradiation" in: IAEA Bulletin Vol. 8 (1966) / 3
16 "Ulmann, Round-Table Discussion of Food Irradiation" in: IAEA Bulletin Vol.15 (1973) / 1
17 Conference Report: "Preserving Food in Asia and the Pacific Region" in: IAEA Bulletin Vol. 24 (1982) / 1

The microbiological effects of irradiation are also an important argument for the IAEA. Irradiation is seen as the only way to reduce/kill microorganisms in foodstuff. But infections and intoxications by microorganisms like Salmonella originate mainly from incomplete hygienics in animal-breeding and in the kitchen. Keeping cooked food warm for a long time or using heating temperatures which are too low to destroy the microorganisms are major reasons for contamination of food. Post-process-contamination also can be found very often. Contamination of food, especially poultry, usually do not arise from food industry manufacturing (only about 4 %). The main part of contamination with microorganisms happens afterwards.

Food irradiation is not the big success that the IAEA hoped it would become. And its contribution to the solving of the world food problem is very doubtful.

Atomic Energy for Developing Countries ?

From the first years on the IAEA had several missions in Asian, African and Latinamerican countries to find possibilities to install nuclear power stations. In spite of several technical obstacles (e.g. small grids) and the lack of electricity requirement the IAEA was very optimistic regarding the possibilities to install nuclear power plants in these countries:

"It envisages that the Agency's main role during the next few years will be, on the one hand, to assist in preparing Member States for the introduction of atomic energy in its various peaceful uses, especially in the production of power .. The long-term programme is based on the conviction that promotion of nuclear power will be the Agency's most important contribution to economy and general welfare. (18)

The IAEA's programmes to develop NPPs which could be used for energy production in developing countries failed:

First of all NPPs were produced in and for the industrialized countries which had big electrical grids. NPPs were growing bigger and bigger in their capacity to reduce the investment costs per unit (factor of scale).

Developing countries had not (and many of them have not even today) big electrical networks. Therefore it is impossible to install big plants. (For technical reasons one single plant should not exceed 10% of the grids' capacity.)

The IAEA made efforts to stimulate nuclear industry to develop small NPPs. These reactors should be simpler and not so expensive. But the nuclear industry was not interested. In 1973 the IAEA made a market survey on developing countries's for small and medium reactors. The study was substantially supported by cash contributions from FRG, USA, the Inter-American Development Bank and the International Bank for Reconstruction and Development.

The market for small reactors turned out to be very small. The biggest share had medium reactors (about 600 MWe). (19, 20)

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18 A Long-Term Programme for IAEA; IAEA Bulletin 5 (1963) Nr. 4
19 O.B. Falls Jr.: A Survey of Nuclear Power in Developing Countries; IAEA Bulletin 15 (1973) Nr. 5
20 G. Woite: The Potential Role of Nuclear Power in Developing Countries; IAEA Bulletin 17 (1975) Nr. 3

These results responded to the interests of nuclear industry, because there were no small reactors available. Up to now this situation has not changed substantially.

Several NPP producers have started to design so-called advanced or inherent-safe reactors. These reactors shall be simpler in construction, with a reduced amount of active safety features and costly parts. But no prototype of such a plant has been built and up to now no "advanced" reactor has been commissioned by the regulatory body of the producers' countries.

Another IAEA programme was to further the application of nuclear reactors as heat sources or dual purpose facilities (heat and electricity generation), especially for the desalination of water.

In the 60ies nuclear managers promised cheap energy and fresh water for developing countries. The combination of electricity production with energy-intensive processes (as desalination) should make it possible to use reactors with greater capacities without extensive networks. This programme failed, nuclear desalination is to expensive for developing countries. Even today there exists only one nuclear desalting plant – in the former USSR.

Despite of all IAEA's efforts nuclear power is expensive. So the IAEA could not help reducing the gap between industrialized and less developed countries.

Do developing countries need nuclear energy?

"I am sure all experts would agree that if there is any single yardstick to measure economic development of a country, it is the per capita consumption of power ..." (21), said Dr. Usmani/ Pakistan at the IAEA's General Conference in 1963.

Based on this opinion one could believe that nuclear power is a necessary contribution to development. And that has often been repeated by IAEA representatives. This view is based on the idea development could be achieved by industrialization in the way of western countries and with the help of their technology.

In the last 30 years it has turned out that this development policy has not improved the living conditions for the majority of people living in developing countries. It has widened the gap between the small group participating in industrial development and the majority living in agricultural regions or in the slums of big cities.

This industrial way of development has ruined the traditional agriculture and economy. Nuclear power fits in this developing strategy, where consumption of energy is believed to be development. But nobody needs energy itself. What is needed is heat for cooking, a warm house in the winter, light, transport, mechanical motion ... A high rate of energy consumption does not mean that the needs of population are satisfied. An example for such situations is Eastern Europe. (high energy consumption per capita due to an old and energy wasting industry)

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21 Some National Atomic Programmes; IAEA Bulletin 5 (1963) Nr. 1

There is no doubt that people in developing countries need energy – but can they use nuclear power?

Energy for the majority in developing countries has to be very cheap. This aim can be achieved only by technologies which use locally available resources (not only regarding energy resources itself, but also regarding workforce and technical know-how). Electricity, especially if it is produced in big centralized power stations – is the most expensive energy. It requires not only high investment costs for the installation, but also large transmission lines. Such electrical networks are too expensive for most developing countries.

In India, which has a high degree of supply with electricity, in 1979 44% of the villages had electricity. But in these villages only 14% of households had a connection. In Brazilia 35% of all households in 1980 had no electricity at all, 56% of electricity is used by industry and only 12% in rural districts. Brazilia as well as India are countries with nuclear power stations and other big electrical capacities. These examples prove that nuclear energy is too expensive to contribute to the energy supply of rural districts in developing countries.

But there are options for developing countries: renewable energies such as bioenergy, solar energy, wind and waterpower – in small scale installations. People in rural districts can use these energies with simple technologies, in facilities which can be produced in local factories and repaired by themselves. Technology transfer from industrialized countries should further this development.

Most developing countries which use nuclear power had to buy turn-key plants. At best some construction work or non-nuclear equipment were made by local firms. India and partly Argentina are the only developing countries which tried to set up an own nuclear industry. Most developing countries which use nuclear power need the support of construction firms for the maintenance of their NPPs and they have to import any spare part they need. So nuclear industry makes profit not only once, when the plant is built, but all over its lifetime. The transfer of modern technology from industrialized countries to the "less developed" as promised by representatives of the IAEA did not take place.

Nuclear power requires high investment costs, which cannot be paid by developing countries. These expenses lead to a higher indeptedness. The benefits of these credits remains mainly to foreign firms. To meet their liabilities governments often have cut social programmes.

Nuclear power can not solve environmental problems!

Nuclear power did not prevent that big dams for power stations ruin hole regions. Often NPPs and big dams are built in the same country (e.g. Brazilia), mostly the same construction firms participate in both. And always western firms are participating in such gigantic projects.

Nuclear power for developing countries can not reduce the global CO_2 emissions substantially either:

The biggest part of these emissions is produced by industrialized countries. E.g. in 1981 11% of oil was burned in developing countries and only one third of it was used for electricity production. So if it is our goal to reduce the global CO_2 output, we have to do it here in the industrialized world. We also have the possibility to achieve this goal. Industrialized countries are wasting energy. We have to increase the efficiency of generation and consumption of energy (in factories, transport and households).

Two examples shall demonstrate the possibilities:

In Austria it would be possible to save about 50% of electricity by renewing old equipment and lighting in factories, public buildings and households. (22)

20% decrease of oil consumption in the FRG would save as much oil as 680 million Indian people use together (figures from 1981). (23)

Special problems with export of NPPs to developing countries

There are only few suppliers in industrialized countries which export NPPs. Countries starting nuclear programmes are therefore limited to a few nuclear systems. Only reactors 1000 MW or larger have been ordered in the industrialized countries. In contrast the export reactors are smaller in the range of 600 to 900 MW. It is common practice to reference an exported reactor to a similarly sized plant in the country of origin. Thus most of the exported plants have not undergone a rigorous regulatory review, and modifications that might have been required are not available for consideration.

Comparisons of exported nuclear plants with the corresponding domestic model point up major causes for differences in the fully constructed plants. These differences are due to the usually lower power of the export reactor, dissimilar site characteristics, balance of plant considerations, and the continuous evolution in design and safety requirements within the supplier state.

The last item is the most important aspect of the non-standard and unreviewed nuclear power plant export. The regulatory process mostly results in a myriad of changes including major modifications in, for example, structural supports or automatic actuation systems. Within most of the supplier countries, all domestic nuclear facilities have undergone many required modifications and changes as a result of the regulatory review process. However, these changes are not necessarily incorporated into the exported plants. (24)

Thus the design of exported NPPs is mostly 10 or more years old. Backfitting is not only a question of regulatory bodies but also a question of costs. Developing countries are not able to go to great expense for the safety of NPPs. Therefore promoting the use of NPPs for developing countries increases the risk for reactor accidents.

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22 H. Haberl, A. Höttl: Energie für die Slowakei: Handlungsoptionen für eine umweltorientierte Politik; Österreichisches Ökologie Institut, Wien 1992

23 C. Eisenbart (Hg): Kernenergie und Dritte Welt; Texte und Materialien der Forschungsstätte der evangelischen Studiengemeinschaft; BRD 1984

24 M. Rosen: The Critical Issue of Nuclear Power Plant Safety in Developing Countries / IAEA Bulletin 19 (1977) Nr. 2 /

IV. The Consequences of the Chernobyl Disaster and the IAEA's Recommendations for the Future

The main aim of the IAEA's policy after the Chernobyl disaster was to avoid restrictions in the use of nuclear energy. Therefore the IAEA helped to cover up the consequences of the disaster to people's health, environment and agriculture.

In 1986 the IAEA praised the emergency operations in Chernobyl, despite the fact that many of these had nothing to do with radiation protection. The secrecy of the accident delayed the evacuation. The poor equipment of the decontamination workers caused a lot of diseases due to radiation. In the following years the IAEA backed the efforts of the Soviet authorities to gloss over the consequences of the Chernobyl disaster.

An important attempt to disprove the alarming reports in the Soviet media was the IAEA's International Chernobyl Project (ICP) (despite all the important information the ICP team worked out). The ICP-team concluded no deviations in people's health were detectable and that the observed diseases could not be caused by radiation. But the conclusions of the ICP are based mainly on Soviet data and the medical examinations of the ICP-team are to be criticized in several points. First of all the study was limited to the population still living in heavily contaminated regions. The two groups, which received the highest radiation exposure, the decontamination workers and the evacuees, were not subject of the study. The examined groups were small and the time for the examination was very short. Based on such a limited study it is irresponsible to reassure the people that there will be no health effects due to radiation.

Based on the ICP's measurements, on the IAEA's recommandations for emergency situations and on cost-benefit analyses the experts concluded, that the Soviet efforts to relocate people from contaminated areas are too restrictive:

"The relocation and foodstuff restrictions should have been less extensive. These measures are not justified on radiological protection grounds ... The cautious approuch ... was inappropriate ... and contradictory to the fundamental objectives of intervention ... In view of the scale of the accident, the extent over which restrictions were needed and the shortcomings in food supply and distribution in the areas concerned, higher values of intervention levels would have been justifiable." (25)

The bigger an accident, the higher the limits! This very simple strategy IAEA experts recommend for the future. In the application of intervention levels the IAEA demands "realism" (in contradiction to a "cautious" or "conservative" approach). Since the Chernobyl disaster the IAEA has tried to achieve a unification of such "realistic" intervention limits. The aim of these efforts is to get public acceptance in case of another accident and to avoid restrictions in the international trade.

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25 The International Chernobyl Project – An Overview; IAEA, Vienna 1991

V. Nuclear Power is a Hazard to Environment and People!

The risk of severe accidents is inseparable from the use of nuclear power. Reactor cores contain large amounts of radioactive substances and heat. Even if the energy production by fission itself is stopped, there is still the decay heat, which has to be removed from the core. The regulation, control and safety of NPPs depend on very complex systems and there is no guarantee that these safety systems never fail. Maybe the probability is very small but it is impossible to exclude the hazard of severe radioactive contamination due to a reactor accident. The consequences - as can be seen in Chernobyl - are so severe, that it is very doubtful to argue with small probabilities.

At the first UN conferences on peaceful use of atomic energy (1955 and 1958), the safety of NPPs was no special issue.

The first severe reactor accident happened in 1957 in Windscale/GB. But Windscale was no commercial plant and the atomic industry argued that new NPPs were more advanced than the Windscale reactor with more safety features and a better containment.

The biggest danger was seen in the melting of some fuel rods and the emission of some radioactive iodine and strontium. But it was assumed that such an accident would not be catastrophic and an evacuation of people would be necessary only in the immediate vicinity of the plant.

Nuclear industry managers regarded too many safety features as an obstacle for the development. So they hoped that the IAEA would supply them to remove what they thought were undue restrictions to NPPs:

"... there is a double standard in safety requirements by which nuclear undertakings are compelled to be safer than all others ... and that this imposes an economic penalty on nuclear power... " (26)

There are more then 400 reactors operating in the world. The design of all of them is based on decades-old safety principles. Most of these safety concepts were established in the early 60ies with a priority on design features: controlling the chain reaction, cooling the core and containing the radioactive material.

"... the concept of the `worst conceivable accident` gave way to another one known as the `maximum credible accident`. .. defined as `the most serious accident which one can conceive without implying any clearly impossible circumstance`." (27)

It was thought that the maximum credible accident would most likely arise from a rupture of primary piping or failure of electric power supply. Such initiating events have given the design basis for the existing reactors. But it is more or less arbitrary what was assumed as "maximum credible". So the sudden rupture of the pressure vessel itself was deemed incredible and no containment is able to withstand such a failure. But also more probable accidents as small leaks in piping were not seen as special safety problems.

Each accident showed safety lacks in NPPs and led to changes in the design rules, and partially to improvements of working power plants.

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26 IAEA's Director General S.Eklund at the Symposium on Reactor Safety and Hazards Evaluation Techniques, Vienna May 1962 in / Safety of Nuclear Reactors / IAEA Bulletin 4 (1962) No. 3 /

27 Safety of Nuclear Reactors /IAEA Bulletin 4 (1962) No. 3 /

An accident with a melt-out of fuel in Browns Ferry/USA teached the nuclear industry that fire protection was a safety relevant issue. And the Three Miles Island/TMI accident (1979, USA) convinced the nuclear industry that it was not enough if safety systems are designed to control and to mitigate the consequences of most severe accidents (design basis accidents). None of the accidents which have occured have followed the course of these design basis accidents. And TMI has demonstrated that several apparently minor events when combined with deficiencies in instrumentation and operator error, can lead to serious accidents. (28) Another lesson nuclear managers derived from the TMI accident was to pay more attention to the human elements.

In the aftermath of the TMI accident there were a lot of discussions about reactor safety in the Agency. But all these activities did not really enlarge the safety of NPPs. Otherwise a disaster like that in Chernobyl might not have happened.

The Chernobyl reactor is a type constructed and used only in the former SU. But this reactor was not unknown to IAEA experts. The SU was not only a member of the IAEA, their representatives were working in leading positions. One of them, Mr. Semenov, praised the advantages of RBMK reactors in an IAEA publication in 1983, especially because of their saftey features. Mr. Semenov was just at that time Head of the Agency's Department of Nuclear Energy and Safety. (29) There was no inquiry or discussion about the design faults of these reactors neither before nor in the first years after the Chernobyl disaster in the IAEA.

All experts agreed on the cause of the biggest accident in the history of nuclear power: it was the operators' fault and neglect of operation rules. IAEA experts hurried to assert that such a big disaster can not happen in all other reactor types. Their main concern was not to help the victims, but to avoid consequences for the atomic industry.

Just after another accident in an RBMK type reactor IAEA experts started an inquiry on its safety lacks: this was the accident at Sosnovy Bor/CIS in March 1992, which fortunately had no severe consequences.

But it is not only the Chernobyl reactor which has insufficient safety equipment. There are other reactors working which also have safety lacks.

Safety regulations

In the 70ies more and more NPP projects were started. To simplify international trade with equipment and service the IAEA made efforts to harmonize differing national regulations. Therefore the Agency started to elaborate Safety Codes and Guides for NPPs. These should define the minimum standard for the safety of NPPs.

"... the standards should be general enough without too many details so that the criteria they express may have a longer validity. NUSS represents a reasonable compromise ..." (30)

The standards had to be very general, so every country could agree to them. The result is harmonization at the minimum safety level. Even the oldest NPPs (e.g. WWER 440/V230 without containment and emergency core cooling system) come up to these guides. Therefore NUSS (Nuclear Safety Standards) did not at all increase the safety of NPPs.

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28 M. Rosen, R. Schmidt: Current Nuclear Power Plant Safety Issues - Preview of an International Conference / IAEA Bulletin 22 (1980) No.1

29 IAEA Bulletin 25 (1983) No.2

30 E. Iansiti: Top safety issues: NUSS reviewed / IAEA-Bulletin 27 (1985) No.1 /-

Since the 80ies and especially since the Chernobyl disaster the IAEA has made inquiries to prove the safety of specific plants, if a member asks for it. But these missions do not review the overall safety of the plant. They are restricted to certain aspects and rules. According to the limited tasks of such reviews the results are limited, too. The following two examples shall highlight that:

1. IAEA's report of ASSET mission to Greifswald nuclear plant:

"While the team found the overall operational status of the four units to be acceptable, it urged improvements in fire detection and... feedback to plant staff about operational events..." (31)

Only a few month later this plant (all four units) were shut down by the German government because of their safety lacks.

2. IAEA's report of a design review in Bulgaria, Czechoslovakia and the SU where the experts studied plants of the same design as in Greifswald:

"Overall, it was found that the plant systems fullfil the basic design criteria for the selected design basis accident." (32)

– But there was no critizism of the design itself which is based on small leaks only!

It looks like IAEA experts are evaluating NPPs safety with different standards: strong requirements for rich industrial countries and a greater possible risk for the poor ones. So if there is an accident in one of these plants the IAEA will also be responsible for it.

Recently one could read in the IAEA publications that there are a lot of upgradings and improvements necessary if these (and other soviet reactors) should stay further in operation.

Is probability a reliable criterion for licensing NPPs?

Probabilistic Safety Assessment (PSA) is a method to determine the probability of severe accidents with the aid of complex mathematical models. On a technical level PSA is a useful tool to identify design or operational weakness of a NPP. But it is impossible to attest the safety of a certain plant by PSA.

"... PSA should not be used as to evaluate ... the absolute value of the risk of a given NPP, since the uncertainty of this absolute value is too high ..." (33),

said one of IAEA's experts responsible for safety problems in 1984. A few years later IAEA is promoting the widespread use of PSA. In 1988 the IAEA recommended probabilistic safety targets for NPPs: for existing NPPs the probability of severe core damage should be below 10^{-4} (1 : 10,000) per plant operating year. The probability of large off-site releases should be lower by a factor of ten.

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31 ASSET mission to Greifswald /IAEA Bulletin 32 (1990) No.1

32 L. Lederman: Design review of WWER 440/230 nuclear plants /IAEA Bulletin 33 (1991) No.1

33 E. Iansiti: Top safety issues: NUSS reviewed /IAEA-Bulletin 27 (1985) No.1 /

The result of PSA is not an accurate estimate. Due to the complexity of the system under study completeness can never be guaranteed. Another problem is that all input values of a PSA are random variables. Their uncertainty margins propagate through the analysis of the complex safety systems. Hence the results are beset with a considerable bandwidth of uncertainty. There are other issues which cannot be included in PSAs and are thus omitted from numerical analyses as complex forms of human errors, unexpected plant defects or unexpected physical phenomena ... Nevertheless the IAEA proposes the use of PSAs as a tool for licensing processes. (34)

Advanced reactors

Over the years NPPs had increased in power capacities . Decay heat levels were getting higher, more engineered safety features had to be added and the designs had become more complicated. Further addition of safety systems at best will bring marginal improvements.

"Advanced" was at any time the nuclear industry's acronym for their latest designs. In the history of IAEA we have found a lot of "advanced" reactors. The latest development are so-called inherently safe reactors.

The designs of conventional light water reactors were based on "defense in depth" concept (multiple elements to prevent and mitigate accidents). Advanced reactors rely on one ore more assertedly "passive" systems to perform essential safety functions (passive systems are systems working on the basis of natural laws). "Passive" safety features are claimed by IAEA experts to make reactors "inherently safe". But there is nothing "inherently" safe about a nuclear reactor. There is always something that could be done (or not done) to render the reactor dangerous. The degree to which this is true varies from design to design, but there is always the hazard of a severe accident. (35)

Advanced reactors shall be equiped with enhanced accident prevention capabilities, but capabilities for accident mitigation will be reduced. In essence, some of the advanced reactors are being proposed without containments.

Life extension

Increasing problems to build new power plants in western industrial countries enhanced the IAEA's efforts for life extension of operating plants. Life extension causes new safety problems due to materials ageing effects.

"Redundancy (coupled with diversity) is the principal means of guarding against the consequences of random failures of equipment and providing assurance that at least one complete chain of safety systems is functional at all times .. The required protection would not be provided if equipment ageing degrades the functional capability to the point where the increase in stress levels associated with a design basis event could cause simultaneous failure of redundant systems." (36)

Life extension (as upgrading of Eastern NPPs) is a profitable branch for a nuclear industry which can not achieve orders for new plants. IAEA's efforts are helping to fill the order books of NPP producers.

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34 International Nuclear Reactor Hazard Study - Summary Update; Gruppe Ökologie Hannover 1986/1992

35 MHB Technical Associates: Advanced reactor study; San Jose, California 1990

36 St. Novak und M. Podest: Nuclear power plant ageing and life extension: Safety aspects / IAEA Bulletin 29 (1987) No. 4 /

VI. Uranium Mining & Milling & Marketing

Even the atomic age needs fuel. It is called uranium and has to be dug out of the ground like every ordinary fossil fuel. Accordingly, uranium mining and milling is quite a prosaic and dirty job, in general not suitable for atomic age fantasy literature (unless it is about the heroic efforts of uranium exploration engineers in jungles and deserts).

The uranium market

To the IAEA, uranium mining and milling is of concern mainly in respect of supply security. Although fuel costs are a minor factor in atomic power generation (compared to fossil fuel power) instabilities in the uranium market can have an impact on the atomic energy industry as a whole.

In fact it turned out that the uranium market was instable due to, by turns, (real) oversupply and (anticipated) shortage of uranium, wrong forecasts about future uranium needs (in turn due to wrong atomic power growth forecasts) and unforeseen uranium production cost rises. The uranium market mess resulted in ridiculously low and high uranium prices, large stockpiles, abandonned mines and mills, decommissioning problems and financial losses. Free market economy was, in this case, clearly negatively biased against the IAEA's statute to foster atomic energy.

Low prices mean low investment of the uranium industry and low exploration activity. In the late sixties (low uranium price) the IAEA was afraid of the possibility of a uranium supply shortage and urged for harder exploration efforts. It saw its role, first, in being a mediator between uranium suppliers and users and second, in providing exploration know-how particularly to developing countries. There was still optimism about the uranium market in the early 1970s:

"The rapid growth of nuclear power provides the uranium mining industry, for the first time in its history, with a stable and promising commercial market on which firm plans for exploration and production can be based." (37)

Shortages and supply troubles were forecasted for before 1980 or, later, for around 1990. However, due to the stagnation of nuclear power, the growth of which had been vastly overestimated in the past, the request for uranium happened to be much lower than previously predicted (by the IAEA and others).

The *"large exploration effort in the 1970s* (promoted by the IAEA !) *in response to rising uranium prices resulted in over-production and a consequence drop in prices. Current prices are too low even to sustain many producers."* (38)

Uranium producing developing countries are particularly affected by the unpleasant situation - an effect of IAEA development aid.

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37 The IAEA: its promotional role; IAEA Bulletin Vol. 14, 1 (1972) 2
38 IAEA Bulletin Vol. 24,4(1982)16

In the early 1970s: *"The discovery of economically workable deposits of uranium ore could be an important source of export earnings for the developing countries."* (Eklund) (39); *"The Agency has always encouraged developing countries in their efforts to locate economicaly workable deposits of uranium"* (40). Almost 20 years later: *"Especially painful has been the reduction of revenues for the developing countries Gabon and Niger. Niger's economy depends to a large part on the revenues from uranium exports."* (41).

Uranium exploration

The IAEA has permanently promoted uranium exploration all over the world, also when the uranium market had bad times and hence there was no economic incentive for exploration: we have to be prepared for a atomic energy revival. Furthermore, the IAEA fears that technical know-how and man power may be lost if the current poor condition of the uranium industry persists. Therefore, a certain level should be maintained even if it doesn't make economic sense.

When searching for promising regions for exploration it turned out that they comprise more or less the whole world.

"Although coral islands and recent volcanic areas might be excluded, it is dangerous to be dogmatic about parts of the world unfavourable for uranium occurence." (42)

To the IAEA, the world should obviously be converted into a large uranium mine.

The developing countries are admonished to better contribute to the atomic age:

"Vast areas in their territories have not yet been adequately explored (...)" (43)

Due to high uranium prices exploration got to a record level in 1978. Also developing countries showed increasing interest in uranium mining since the mid seventies (high uranium prices). They are supported by the IAEA and the UN development program.

Radiation protection

Also from the beginning, but in a much smaller extent, the IAEA was aware and subsequently concerned about radiological and environmental impacts of uranium mining and milling. The IAEA knew about the poor radiation protection standards in early uranium mining and also the radon problem started to be taken serious at this time.

However the IAEA does not forget about its mission to promote atomic energy and avoid competition losses because safety standards could be too strict. In the eighties the uranium industry came into economic troubles due to oversupply. Thus, stricter safety standards as recommended by the ICRP in Nov. 1990 might kill some uranium companies. The IAEA warns that *"the consequences of this development (...) may threaten the world's future uranium supply."* (44). It should be added that the ICRP is certainly not known for rash decisions nor are they particular anti-nukes.

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39 Harnessing nuclear energy; IAEA Bulletin Vol. 12, 4 (1970) 4
40 The IAEA: its promotional role; IAEA Bulletin Vol. 14, 1 (1972) 8
41 E. Müller-Kahle: Uranium market conditions and their impact on trends in uranium exploration and resource development; IAEA Bulletin Vol. 32, 3 (1990) 29
42 Making the yellow cake go round; IAEA Bulletin Vol. 11, 2 (1969) 6
43 Significant years for uranium; IAEA Bulletin Vol. 12, 3 (1970) 11
44 Impacts on uranium production costs; IAEA Bulletin Vol. 34, 1 (1992) 49

However, only in 1978 and later in 1984 there was a more comprehensive mention of radon induced cancer. Working conditions in the uranium industry are better now than they used to be, but there are still problems in developing countries:

"Many do not have their own means of ensuring adequate radiation protection in such activities, nor do they have regulatory controls designed exclusively for the mining and milling of radioactive ores." (45).

In 1989 the radon contribution to atomic energy risk was assessed (46). It turns out, that for the long-term collective dose commitment Radon-exhalation from mill tailings gives the dominant share.

Land right questions

What the IAEA hasn't mentioned a single time in 30-odd years of covering the success story of the atomic age in general and uranium mining and milling and marketing in particular is that it has been and still is based on continuing violation of indigenous land rights. In the trade-off between benefits and costs of the atomic age indigenous peoples were destined to be the loosers. But progress has its price, so, why talk about.

VII. Transport of Radioactive Material and the Role of the IAEA

"Transport of radioactive materials is of vital importance for the full international development of the peaceful uses of atomic energy." (47)

Transports of radioactive material are the links between the single stations of the use of atomic energy. As for stationary facilities, there is no absolute safety (concerning radiation exposure or risk of accident) for transports. This is true for the incident-free transport as well as for accidents. In both cases not only the transport workers are affected but also the people who live along the transport routes.

In its capacity as a UN organization the IAEA issues recommendations worldwide on the transport of radioactive material, in particular the "Regulations for the Safe Transport of Radioactive Material". International and regional transport organizations and the IAEA's member countries adopt these recommendations in their legislation and regulations. The IAEA regulations were issued in 1961 for the first time and have been revised and updated in the subsequent years; the next major revision is planned for 1996.

The IAEA is often presented in the public eye as being the neutral organization with a regulatory and supervisory function in radioactive transport questions. Of course this does not correspond to the facts, because its statute clearly lay down its promoting function concerning the so-called peaceful use of atomic power.

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45 J. U. Ahmed: Radiation protection in mining and milling of radioactive ores; IAEA Bulletin Vol. 26, 1 (1984) 54f.

46 A. J. Gonzalez, J. Anderer: Radiation versus radiation: Nuclear energy in perspective; IAEA Bulletin Vol. 31, 2 (1989) 26f.

47 G. Appleton IAEA Division of Health, Safety and Wast Disposal in / IAEA-Bulletin No.4 1966 /

The basic "Safety Standards" establish (among other things) requirements concerning general principles of radiation protection, activity and fissile material limits for packages, limits for surface contamination and dose rate of packages, and test procedures for packages.

Transports of radioactive material hold their own problems, as the hazard is not linked to a particular place, packages cannot be constructed at any weight and transports often lead through highly populated areas. The aim of the IAEA recommendations is to restrict the dangers to the lowest "acceptable" level. The underlying "safety philosophy" in principle comes down to two points: The transport safety is based on the packaging of the material and the sort of packaging must be appropriate to the hazardousness of the material being transported – that is to say the packaging is central to all deliberations on transport safety. Depending on the hazard, its design should either prevent a release of radioacitvity after an accident (Type B packages) or the release should be so restricted, by limiting the radioactive content in connection with the package design, that adherence to the dose limits for the general public is guaranteed.

First of all there are some general problems linked with the IAEA recommendations:

— The regulatory network covering the transport of radioactive material is a jungle; the system is complex and opaque - even for experts who know it from inside. This leads to problems.

— Central to the "safety philosophy" is the transport package. Other issues are not affected, for example the manner of transportation or the transport vehicle itself. Requirements concerning the transport route are missing: dangerous material can be shipped through (or above) highly populated areas.

— The IAEA regulations are directed to the individual transport, seen in isolation. A look at the whole system of shipments, however, is lacking. This is important insofar as in certain regions an accumulation of dangerous shipments occurs, for example in the vicinity of final dispositories for atomic waste.

The radiation protection regulation for accident-free transports and with accidents is inadequate. The basis of IAEA's radiation protection concept – the ALARA principle – means that economically favourable safety regulations are of primary interest.

The dose limits for transport workers are oriented on ICRP recommendations and hence are wholly inadequate. Workers are designated as "radiation workers" only if the annual dose is expected to exceed 5 mSv; in the light of today's knowledge of the harmful effects of ionizing radiation this does not guarantee the necessary industrial safety provisions. The limit of 50 mSv per year is associated with an unacceptable risk for the employees.

The so-called secondary limits, i.e. the dose rate on and close to the surface of packages and vehicles are of heightened importance. Just dealing with a few transports can lead to high exposure of transport workers like goods station workers or truck drivers: Remaining 10 hours at a distance of one metre from a freight container can cause a dose of 2 mSv, for example.

The IAEA recommends a limit of 1 mSv (100 mrem) per year for the exposition of members of the public through incident-free transport. This limit is too high and exceeds even some national dose limits set for the operation of nuclear plants.

In 1990 the ICRP has recommended to lower the dose limit for radiation workers to 20 mSv per year (averages over 5 years). Although we criticize this as an insufficient protection against hazardous ionizing radiation, we claim that the ICRP recommendation is going to be implemented into the IAEA regulations as fast as possible – as a first step to the improvment of radiaton protection.

The activity inventory of Type B packages is not restricted. The IAEA certainly assumes that the package design makes sizeable releases very unlikely. But the IAEA regards serious accidents with these packages as possible. Therefore the Agency recommends emergency response planning for transport accidents as being necessary.

It must be stressed that it is impossible to protect people effectively against severe transport accidents.

Every package type in which radioactive material is to be transported requires a licence. For this licence to be issued by the national authorities the IAEA recommends regulations for adherence to certain requirements with regard to the integrity of the packages. The core of these regulations are tests which are intended to give proof that the requirements are fulfilled. The requirement for the packages depend on the material's hazard potential. Only the test conditions for Type B packages claim to guarantee the integrity of the package after an accident. But severe accidents with release of radioactive material cannot be excluded, even if the package is of type B.

The IAEA-Regulations are thoughtless with regard to transportation of uranium hexafluoride (UF_6). It is transported in packages which are not appropriate to the hazardousness of this material. Apart from radiological hazards UF_6 also exhibits severe chemical toxicity. Especially the latter must be taken into account for construction of the package. In IAEA-Regulations this fact is inadequately considered. Only criteria of activity are important for the decision on which package type must be used according to IAEA.

The shipments of plutonium from Europe to Japan, which are scheduled to start in autumn of this year, illustrate the present situation concerning radioactive transports, i.e. highly toxic and fissile material is transported from one end of the world to the other and back again.

Japan is one of the main customers of the commercial reprocessing plants in Europe, Cogema in France and BNFL in the UK. During the next years about 40 to 50 tonnes of separated plutonium must be sent back to Japan. It will be shipped by the transport vessel "Pacific Crane", only escorted by the relatively small, lightly armed vessel "Shikishima" on a route of about 17,000 nautic miles. These transports are dangerous for at least two reasons:

It is doubtful whether the physical protection of the fissile material can be warranted, may be in case of an act of sabotage or terrorism on the seas, maybe if the transport vessel has to run for a harbour. And it is open to question whether the transport casks will withstand severe accident conditions, especially fire, immersion, and crush exceeding IAEA test conditions.

Transports of radioactive material and thus the risk for major radiation hazards to people or the environment have increased steadily in the recent decades. Those transports are not limited, neither in number nor in distance or by the hazardousness of the material. The IAEA has contributed to this situation through promoting the use of nuclear energy worldwide. Its role is to ensure a smooth-running trade not restricted by attempts to minimize or to avoid transports.

VIII. Radioactive Waste Management

"The technical problems of the fuel cycle (...) have been solved for each step of the fuel cycle." (48) (Director General Eklund)

Radioactive waste is a nuisance both physically and ideologically. One of the atomic age's appeals was cleanness: we are facing a future of abundance and endless benefits through a new source of virtually inexhaustible and clean power - but all technical effort was not able to make a real cycle out of nuclear fuel management rather than only a word. So, we face a fuel cycle with numerous outlets the effluents of which getting more and more ennoying and even troublesome. In fact, recycling has never existed in an industrial scale; ironically, the fuel cycle merely consists of open ends.

The perception of the problem

Basically, all radioactive waste activities of the IAEA are subject to the premise that atomic energy is beneficial. Radioactive waste belongs to the drawbacks of the benefits, which have to be handled in a way that progress of atomic energy is not hampered.

The IAEA's attitude towards solutions (or sometimes rather would-be solutions) of radioactive waste management problems follows its general perception of the problem: any solution reported is an appropriate one, even hair-raising ones, like injecting high-level waste into the ground. However, later it may turn out that the once so called solutions are not as satisfying as they were supposed to be.

It is true, however, that the IAEA has been aware of the existence of a radioactive waste problem from the beginning:

"Safe disposal of the increasing amounts of radioactive waste produced in atomic operations is a problem of first magnitude." (49),

though obviously not of its very extent. Although considered important, the problems were seen as easily manageable (or that they could even be turned into benefits, for example by using radioactive waste as raw material) and generally underestimated.

In the seventies the IAEA was first confronted with what is called lack of acceptance of atomic energy. It adapted to the situation by changing its stylistic pattern:

"I do not pretend for a moment that we have, now, long-term solutions for all of these problems..." (Eklund) (50). It was realized that *"public and political concerns regarding this question can no longer be ignored."* (51)

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48 Renewed Confidence in Nuclear Power; IAEA Bulletin Vol. 19, 3 (1977) 6
49 Radiactive Waste Disposal into the sea; IAEA Bulletin Vol. 2, 3 (1960) 14
50 Stockholm: The Promise of nuclear power; IAEA Bulletin Vol. 14, 4 (1971) 15
51 Radiactive waste management; IAEA Bulletin Vol. 18, 5/6 (1976) 47

Concentrate or dilute

There are two basic strategies of radioactive waste management: either to concentrate and isolate the wastes from the environment or to dilute them until their specific toxicity is low enough that they can be released into the biosphere according to radiation protection standards. Usually it is reckoned that high level wastes should be concentrated & isolated whereas some low level wastes can be diluted & dispersed.

Dilute

From the beginning, discharge of waste into the sea has been seen as an attractive solution also by the IAEA. It is instructive to learn about the IAEA's perception of the ocean:

"Large areas of the open seas are (...) biological deserts where fishing is not profitable and in which larger amounts of radioactivity might be admitted." (52)

In other words, an area which cannot be exploited with profit is by definition a desert. Obviously, the world consists of 1. profitably exploitable resources and 2. waste disposal sites.

Criticism in sea disposal did not cease although *"so far there is no scientific indication of harm resulting from the discharge of radioactive waste into the sea"* (53) (Eklund).

However even the IAEA started getting bad conscience about dumping: that the Agency provides standards for safe sea disposal

"should not be understood as encouraging such dumping without full consideration of the alternatives ..." (54).

Later, poor practices in sea dumping were revealed and in 1983, an international moratorium on dumping was agreed. Apparently it has not been fostered by the IAEA since the fact that a moratorium exists was mentioned in the Bulletin only some years later and even then it was reported without comment.

Concentrate

"Of course, no method can guarantee absolute isolation of the waste from the biosphere." (55)

HLW arises from fuel reprocessing in the form of highly radioactive, heat producing and corrosive liquid. From the beginning in the forties it has been stored in steel tanks which need careful control and active cooling, venting and stirring in order to avoid boiling, hydrogen and criticality explosions. The radiological impact of such accidents is disastrous as the Ural accident in 1957 showed.

In the early years, the technical problems were clearly underestimated. It should be noted that LWR fuel waste vitrification started only in the nineties (in France).

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52 Disposal of radioactive waste; IAEA Bulletin Vol. 2, 1 (1960) 3

53 Radionuclides in the sea; IAEA Bulletin Vol. 13, 1 (1971) 31

54 The IAEA's work for the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter; IAEA Bulletin Vol. 18, 1 (1976) 46, 48

55 V. A. Morozov: Waste Management Practices in Selected European Countries; IAEA Bulletin Vol. 21, 4 (1979) 17

Final underground disposal in deep repositories of solidified HLW is said to be feasable but it is not available. In 1975 IAEA experts had to admit that final repositories are no further than studies - after 20 years of atomic energy use.

However, the first HLW repositories are scheduled for operation only around 2000. As the experience in some of the most advanced projects, Gorleben/FRG and Yucca Mountains/USA has shown, the realization is not as easy as it had been anticipated.

Since no repository is available, interim storage is required.

The strategy of the IAEA is, that from a technical and safety point of view, there is no urgent need for a HLW repository. However, the IAEA got nervous about the fact that no final repository exists since obviously it became a major obstacle against the public acceptance of atomic energy:

The current situation *"(...) does not encourage the public confidence regarding the benefits of nuclear power and certainly provides arguments for those opposed to nuclear power."* (56).

Therefore, they urged that, at least, a demonstration repository be built:

"A HLW disposal demonstration project is of greatest priority." (57)

Until the seventies it was taken for granted that used fuel is being or will be reprocessed to recover plutonium which, as breeder fuel is in fact the base of the long-term use of atomic energy. But:

"Recently, environmental and political considerations have placed the future availability of reprocessing in question,..." (58).

The management of Low- and intermediate-level waste (LILW), which is produced in all steps of the fuel cycle (particularly in uranium mining, reactor operation, reprocessing and decommissioning) was first believed to be easy, compared to HLW management.

The large quantities of this sort of waste (including previously unexpected ones, like decommissioning wastes) gave rise to concerns. And, as with HLW, public acceptance of disposal sites became an issue.

Two particular LILW management problems worth mentioning are, first, management and disposal of radioactive sources (as used in industry and medicine) in, and second, illegal transfer of radioactive waste into developing countries.

Waste production starts with uranium mining & milling:

When uranium is extracted from the ore the same activity of radioactive progeny nuclides like Th-230, Ra-226, Rn-222 and so on is discharged as waste. These uranium mill tailings are usually stored in large ponds.

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56 Management of radioactive wastes; IAEA Bulletin Vol. 17, 4 (1975) 8
57 IAEA Bulletin Vol. 26, 3 (1984) 36
58 J.P. Colton: Spent fuel storage alternatives; IAEA Bulletin Vol. 20, 1 (1978) 35

Uranium mining and milling effluents have been recognized by the IAEA as waste in the early sixties, and it has also been realized that they may form a problem, but not a very severe one. However, some years later, the situation looked different:

"In many mining operations in the past, potential environmental problems (...) have been ignored, (...)." (59)

At least, the radon problem is realized:

"(...) because of radon emanations, uranium mill tailings should not be used either in structural materials or in backfill material in connection with buildings intended for human occupancy (...)" (60)

which in fact has been done in the USA and in Eastern Europe.

The economy of waste management

Often articles dealing with the costs of radioactive waste management begin with the statement that *"Safety, of course, must remain the primary consideration (...)"* (61). This wording yields a "but": the solutions must be practical and economical and standards should not be *"over-rigid (...) originating in emotion (...)"* (62)

Later, cost estimations were carried out, but optimism stayed:

"Though such costs are higher than had been assumed previously, they do not seem likely to have a serious or decisive impact on the use of nuclear power" (63).

The IAEA's idealism succumbed to the harsh reality of capitalism: *"the economic incentive of uranium and plutonium recycling will be high ..."* (64). In the 1990s the plutonium stockpiles are considered a big nuisance and uranium recycling has not even seriously considered by the industry so far.

Only in the mid seventies the decommissioning problem appeared in the considerations of the IAEA. Different estimates about dismantling costs have been reported by the IAEA, varying from a few % up to 20 % of initial investment cost. In the mean time, however, decommissioning is assessed to be as costly as building a NPP.

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59 Radioactive Waste Management: A Status Report. IAEA, STI/PUB/712, Vienna 1985, p. 22
60 Waste Management for nuclear power; IAEA Bulletin Vol. 16, 1/2 (1974) 79
61 High level radioactive wastes; IAEA Bulletin Vol. 5, 1 (1963) 10
62 Radiactive waste disposal: safety achieved, but economy also needed; IAEA Bulletin Vol. 8, 1 (1966) 25f.
63 S. Fareeduddin, J. Hirling: The raioactive waste management conference; IAEA Bulletin Vol. 25, 4 (1983) 4
64 Nuclear power programmes and the nuclear fuel cycle; IAEA Bulletin Vol. 19, 3 (1977) 18

IX. Act Now!

Since 1957, when the IAEA was established, the world and its view of nuclear energy has changed. It is time for a change of the IAEA's functions, too.

The IAEA shall become a purely nuclear control organization without any promotional function, because promotion and control are incompatible. In this sense the Articles II and III of the Agency's Statute have to be changed.

Anti-Atom-International claims:

1. The Disarmament of All Nuclear Weapons!

Necessary steps to achieve this goal are:

Establishing of the IAEA as an organization for the effective and comprehensive control of fissible material – both civilian and military – and extension of its related possibilites and competences.

The application of safeguards to all states without discrimination!

Deletion of Article IV and V of the Non-proliferation Treaty (NPT)!

(These articles concern the promotion of nuclear energy for peaceful applications and the promotion of nuclear explosions for peaceful purposes.)

A complete nuclear test ban treaty!

Stop reprocessing of burnt reactor fuel!

Stop civilian and military separation of plutonium!

2. The Phasing out of Nuclear Power – as soon as possible!

Until this aim is reached there is a lot of work to do for the IAEA:

— improve the safety of existing nuclear power plants and other facilities of the fuel cycle;
— improve radiation protection for workers, environment and the public;
— develop solutions for the problems nuclear industry has created:
  especially for the radioactive waste and decommissioning of nuclear power plants;
— Minimize and avoid transports of nuclear material and waste.

To accelerate the phasing out of nuclear power production the United Nations shall:

— promote the research on, and the development and application of renewable energies especially in small-scale installations;
— take suitable action to cut down the waste of energy.

3. Minimize the Application of Nuclear Energy in Industry, Agriculture and Medicine!

No further nuclear application in industry, agriculture and medicine without proof of requirements and possibilities for non-nuclear methods and techniques!

No application of nuclear technology without appropriate regulations for radiation protection and waste management!

To avoid unneccessary applications of nuclear technology in industry, agriculture and medicine the United Nations shall promote the research on, and the development and application of non-nuclear alternatives.

Glossary

ALARA	As Low as Reasonable Achievable
ASSET	Assessment of Safety Significant Event Team
CIS	Community of Independent States (part of former USSR)
FAO	Food and Agriculture Organization
HLW	High Level (radioactive) Waste
IAEA	International Atomic Energy Agency
ICP	International Chernobyl Project
ICRP	International Commission for Radiation Protection
ILW	Intermediate Level (radioactive) Waste
LILW	Low and Intermediate Level (radioactive) Waste
LLW	Low Level (radioactive) Waste
LWR	Light Water Reactor
NPP	Nuclear Power Plant
NPT	Non-Proliferation Treaty
NUSS	Nuclear Safety Standards
OSART	Operational Safety Review Team
PNE	Peaceful Nuclear Explosions
PSA	Probabilistic Safety Assessment
RAPAT	Radiation Protection Advisory Team
RBMK	Chernobyl type reactor
Sv	Sievert
TMI	Three Mile Island
WAMAP	Waste Managment Advisory Programme
WHO	World Health Organization