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When the title of this lecture uses the term "the spread" it refers to a spread beyond the US, the UK, the USSR, France and China, which was the last of the permanent members of the Security Council and became a nuclear-weapon State in 1964. There is no further acknowledged nuclear-weapon State nor any further State that claims to have nuclear weapons. India set off what was termed a "peaceful nuclear explosion" in 1974; Israel has declared itself capable of assembling a nuclear weapon in a very short time; Pakistan has said that although it would be able to make a nuclear weapon, it has no intention of doing so. South Africa has stated that it has the capability to make weapons, but is at present contemplating adhering to the Non-Proliferation Treaty. Argentina and Brazil have denied any intention of making nuclear weapons.

This is not to say that a spread of nuclear weapons to further countries could not happen. The risk exists and considerable efforts are devoted to prevent that risk from becoming reality. I shall describe some of those efforts. Before I do so, however, I should in fairness point out that while "horizontal proliferation" is a risk, "vertical proliferation" is a reality. It is calculated that the stockpiles in the nuclear-weapon States contain some 50 000 nuclear warheads and the technology race, including testing, continues even today. When I am not addressing this awesome issue, it is because the IAEA has no role in nuclear disarmament but is playing an important role as responsible for safeguards verification under the non-proliferation regime.

The nuclear-weapon States, especially the superpowers, are very active to prevent further proliferation. There is perhaps something paradoxical about nuclear-weapon States desperately urging non-nuclear-weapon States not to do what they, themselves, seem to find indispensable to continue doing, namely develop nuclear weapons.

However, the unanimity which exists on this matter between the five permanent members of the Security Council does give special strength to the non-proliferation stance. There is also a broad and strong body of government and world opinion behind this policy, which is based on the premise that five

nuclear-weapon States is already more than enough and that the world would become even more dangerous if additional countries were to acquire nuclear weapons.

For the policy of non-proliferation to become successful it is not enough, however, that all are agreed that the world as a whole would become more dangerous, if new nuclear-weapon States appeared. Individual countries must also be convinced that for them the world would be less safe or at least not more safe if they had nuclear weapons. It is a little like family planning. It is not enough that a country is convinced that its population growth must stagnate; for such a policy to succeed individual couples must also be convinced that it is in their own interest to have few children.

It is fair to say that the efforts to prevent horizontal proliferation have been successful. While President Kennedy expressed the fear in 1962 that 20-30 States would acquire nuclear weapons, the number of acknowledged nuclear-weapon States remains the same today as it was in 1964, when China joined the club. What are the reasons for this success and what are the present and future risks of proliferation?

We sometimes hear it said by opponents of nuclear power that nuclear weapons and nuclear power are Siamese twins - one cannot promote nuclear power without at the same time making it easier to make nuclear weapons. A more appropriate image would be a tree with a trunk of basic nuclear physics and two major branches, one with the technology of explosives, the other with the technology of controlled chain reactions harnessed for power generation.

One cannot completely disregard the risk that a State intending to make a nuclear weapon for some time might hide its intention in a civilian nuclear programme. However, it should be remembered that going for nuclear weapons through nuclear power is a very roundabout way. All the five nuclear-weapon States actually went first for nuclear weapons and only subsequently built nuclear power stations. In fact, China, a nuclear-weapon State since 1964, has not yet put its first nuclear power plant into operation.

There is little doubt that today any State with some industrial infrastructure and trained personnel could develop a nuclear weapon if it were determined to do so and were willing to spend the resources necessary. It is mainly a question of political will. To be sure there exist severe restrictions on the export of sensitive technology, e.g. for enrichment and reprocessing. Moreover, any country which has not pledged itself to non-proliferation - and indeed even some whose pledges are not completely relied upon - find that there are limitations in their possibility of importing even non-sensitive technology and hardware. All these restrictions may well raise difficulties for a State determined to make nuclear weapons and cause delay which may give time for political action.

The political will and determination of the individual State not to acquire nuclear weapons is the first and fundamental barrier to proliferation. Hence, such conditions need to be created and maintained that no inclination arises to acquire these weapons. The will of the State is influenced by several different factors, but most important is certainly the security situation of the State. A general or regional climate of detente will reduce the perceived need for armaments, including nuclear arms. Latin America is an area of relatively little conflict between nations. This has probably convinced many Latin American States that they have nothing to lose but a good deal to gain by committing themselves to non-proliferation. Brazil's, Argentina's and Cuba's unwillingness so far to commit themselves has hardly its grounds in intra Latin-American relations. India's refusal to accept NPT, we know, had its roots in its conflict with China - a nuclear-weapon State - and Pakistan's stance is related to India's position. Israel's position of calculated ambiguity is based on what it perceives to be its need to dispose of a strong deterrent.

A number of countries feel their security is adequately protected against nuclear threats by their being members of military alliances. They have a nuclear umbrella held by someone else and have not felt the need of nuclear weapons of their own. But two members of the Western alliance, the UK and France, have continued to feel they must have an independent nuclear weapon capacity.

Some other countries, like Sweden and Switzerland, which are not protected by umbrellas, have come to the conclusion that it might be more dangerous for them to have than not to have nuclear weapons. It is hard to know whether they have placed any faith in the declarations made by the nuclear-weapon States that

these would not use nuclear weapons against States which have committed themselves to be without such weapons.

For a large group of developing countries, the nuclear weapon option has seemed so distant both for themselves and for neighbouring potential enemies, that to renounce these weapons has not been felt to be any sacrifice in terms of security. These States may also have been influenced by advantages which could accrue from a renunciation. This brings me to discuss the famous "Atoms for Peace" programme which was presented by the United States in 1953 and which was designed precisely to create a motivation for non-proliferation.

It should be recalled that until this period the United States policy in nuclear matters had been one of secrecy. It was increasingly realized, however, that once it was shown that the technology of nuclear bombs and nuclear power could be mastered, other States would make efforts to develop both. This insight prompted the idea that the US would offer freely to share nuclear material (enriched uranium), hardware, technology and know-how for peaceful purposes but on condition that a pledge of exclusively peaceful use was given and the principle of on-site verification was accepted. Acceptance of the offer would obviate costly research and development work. It was a carrot to forego the military option and it certainly had some effect.

The Non-Proliferation Treaty (NPT) is based upon the same concept of promising to facilitate transfers. In return it requires not only that the particular object transferred be committed to an exclusively peaceful use, but also that the recipient country's whole nuclear programme be exclusively peaceful and be verified as such by the IAEA.

The NPT has 140 parties today. It can by no means be said that 137 non-nuclear-weapon States parties are all States that either would have no ability in the foreseeable future to make nuclear weapons or States that could not plausibly have any motivation to acquire them. Egypt is an NPT party, so are Libya, Turkey, Iraq, Syria, Saudi Arabia, Iran, Indonesia, Viet Nam, Republic of Korea and Democratic People's Republic of Korea. The most important non-parties are the group of States which I mentioned at the beginning. It should be noted that among the non-parties South Africa has declared it is considering adhering to the treaty and

that among the parties the Democratic People's Republic of Korea still has no full-scope safeguards agreement.

What is the real effect of a treaty of this kind? How reliable are the pledges? The world has certainly experienced States repudiating treaty obligations. When we consider the security value of the treaty, we cannot just say "pacta sunt servanda" and leave it at that. In my view the voluntary and motivated acceptance of the treaty - for that matter any treaty - by the States parties remains the most important factor for reliability. Thus, if any significant factor were to disappear which had induced a State to adhere to the treaty, then its continued acceptance of the treaty could be weakened. However, States fortunately are reluctant to disavow legal commitments which they have entered, even if with time they have become unhappy with some of these commitments. Renunciation of valid treaty obligations, they know, affects a State's standing and reputation. A treaty obligation thus creates a legal threshold which a State does not like to transgress, except for strong and preferably legally plausible reasons. This may be said to constitute a second barrier.

The NPT contains a denunciation clause in Article X which would allow a State to leave the treaty if it decides that extraordinary events, related to the subject matter of the Treaty, have jeopardized the supreme interests of its country. So far no party has availed itself of this clause. It may be assumed that any indication of any party intending to do so would trigger considerable diplomatic activity among other States, perhaps including economic or other measures as well. For States which are dependent for their nuclear power industry on import of fuel, a cut- off of further fuel supply could be such a measure.

Thus, if there exist incentives for a State to join the NPT, there also exist incentives for States not to renounce it. However, one can imagine factors which would constitute powerful counterincentives, some of which would have the seriousness to legitimately qualify under Article X, e.g. if a neighbour of a party breaches its obligation and starts making nuclear weapons.

We should also note that even though parties to the treaty some States are nevertheless looked upon by some other parties with a degree of suspicion. Adherence to the treaty raises a presumption of a determination not to acquire nuclear weapons, but the presumption may be weakened and is rebuttable.

The safeguards inspection system may be said to constitute the third barrier against proliferation. Under the bilateral agreements which the United States concluded under the Atoms for Peace programme, inspection by the US of the peaceful use of exported technology, hardware and material was envisaged and implemented. When the NPT came into operation and all NPT States accepted to subject all their fissionable material to IAEA safeguards, the bilateral arrangements for inspection were suspended and the inspection function transferred to the IAEA.

Today about 95% of all fissionable material and 95% of all nuclear installations outside nuclear-weapon States are under IAEA safeguards. Although some safeguards inspections are performed by the Agency in India, Pakistan, Israel, South Africa, Argentina and Brazil pursuant to agreements which these countries have reached with supplier States, these countries have in addition material and installations which they have created on their own and these are the 5% not inspected by the IAEA. There is no presumption that these installations and material are devoted to military purposes. I have myself been invited to visit non-safeguarded enrichment plants both in Argentina and Brazil, but the Agency pronounces itself only about those installations which it inspects. It may be said as a generality that in the world at large confidence ends where safeguards end.

This brings me to the nature of safeguards and the safeguards system. It consists of two major parts: first an accountancy system under which States inform the Agency of all the movements, burn-ups, and other whereabouts of all fissionable material in their territory. Material comes under safeguards when it has a composition and purity suitable for fuel fabrication or enrichment and it remains under safeguards until it is so burnt up or otherwise treated that recovery of the fissile material is not practicable. This means in practice that yellow cake from uranium mines is not under safeguards and that safeguards can be terminated under certain conditions on wastes when they are disposed of.

For States parties to the NPT, the safeguards are fixed to the fissionable material, not the installations; for non-NPT countries, the safeguards have regard both to installations and material.

The information provided by the States is fed into the computers of the Agency and checked. Figures for import by one country must square with figures

for export of another. Figures for spent fuel must be consonant with fuel inserted and burn-ups, etc.

The other major part of the safeguards system is the inspection. Somewhat like the accountancy system of a bank, figures are checked for consistency, but the existence of the assets is also verified. The bank inspector verifies the existence in the vaults of gold and other assets. The safeguards inspector verifies that the material reported is located where reported and in the quantity and form reported.

There are about 200 inspectors travelling around the world for inspection. In addition, we have some 300 staff in Vienna for the checking of reports, working out procedures, preparing inspections, examining the results of inspections, developing new techniques for safeguards in the future, drafting reports about the results to our member governments and so forth. The whole activity is budgeted in the Agency to about $60 million per year. In addition, especially future development of safeguards is assisted by voluntary programmes of Member States to the tune of some $14 million per year. About 30 staff in our Department of Safeguards are so-called cost-free experts and should be added to the cost of the system as should the harder to calculate costs of the inspected Member States for receiving inspectors.

The system relies also importantly on so-called containment and surveillance measures. There are, for instance, seals applied by inspectors on material containers and pathways, giving evidence that the material has not been touched and that a pathway has not been used for the removal of equipment or material. There are also cameras operating and taking pictures at irregular intervals of strategic pathways to give evidence that no fissionable material or important equipment is moved between inspections. Millions of such pictures are checked in monitoring devices in the Agency. More than 13000 seals are checked each year in the same way.

In the early days of the Agency's safeguards operation there was a good deal of reluctance among governments and industry to accept safeguards. Inspection was often seen as an unwelcome intrusion, costing operators and governments some trouble and expense. Fears also existed that safeguards could hamper nuclear development or lead to leaks of business or technological secrets.

Practically all these concerns have disappeared over the years. First, no one would contend any more that safeguards encroach upon sovereignty. The Agency is invited to perform them by a host State because that State finds the safeguards to be in its interest and the performance occurs in conformity with an agreement freely entered into with the State. Secondly, no one contends that nuclear development is in the least hampered by the inspection. Thirdly, even the fear about leakages of information seem to have largely, though not completely, disappeared. There are, in fact, hardly any secrets connected with ordinary nuclear power stations. The Agency also takes care that what is received as confidential information remains confidential. Computer hacks cannot just hook on to our data bank! However, there do remain sensitive matters. Inspection must be performed on enrichment plants and reprocessing plants under safeguards, but this must be organized in such a way that not even the inspectors learn the secrets of the technological process.

Host States and host operators now almost universally see safeguards for what they are: confidence-building measures. It is reassuring for a non-nuclear-weapon State to have it verified that its neighbour uses nuclear material only for peaceful purposes. The Agency and the inspectors are no nuclear police ready to intervene and stop any diversion of fissionable material. They are observers whose only power is to report. This may seem toothless, but a little reflection will show that any international inspection - also in disarmament - will be limited to observation and reporting. The international community does not possess any brigades to inflict sanctions against uncooperative parties: the sanctions lie elsewhere. They lie in the reactions of those who have economic and military power: the States.

If an inspector were to discover a diversion of fissionable material or military use of an installation, he would immediately report this to the Head of the Safeguards Department and the Director General. The Board of Governors would be convoked and could take some action, including the submission of a report to the Security Council of the UN. The IAEA is the only member of the UN family that has direct access to the Security Council and that reports - annually - to the General Assembly rather than to the ECOSOC. No report of diversion has ever been made to the Security Council, for none has ever been found, but the Agency did report directly to the Council after the Israeli bombing of the Iraqi research reactor in 1981.

I have described the formal procedure in a hypothetical diversion case. It is not a very likely scenario. It has been stated that the purpose of safeguards is to "deter from diversion by risk of early detection". This is a somewhat big brotherish definition. The many States which have accepted safeguards and routinely receive them have not invited this operation to deter themselves from any temptation to misuse nuclear material or installations. They have invited safeguards to create maximum confidence among their own citizens, among neighbours and in the world at large that they are using nuclear material and installations only for peaceful purposes. Self-declaration and self-inspection could not create such confidence. Only the continued presence of an outside, impartial, professional inspection mechanism can achieve this. To have maximum credibility the inspections must be so thorough and the risk of detection so high that it would function as a deterrence against misuse of material or installations, should a State be tempted to do so.

The sensitivity of the system is set at a risk of detection of about 85-95%. To strive for 100% detection would both be very costly and impractical. Moreover there would be a great many false alarms which would irritate everybody. It is a little like security checks at airports. To attain 100% detection would be costly and impractical. A high detection probability is deemed sufficient.

If a State were to decide that it would go for a nuclear weapon it is more likely that it would denounce the NPT and safeguards on some ground or that it would find some pretext to stop inspectors entering. To be caught red-handed must be such an embarrassing prospect that States would be unlikely to take the risk. The chances are therefore that some signs of lack of co-operation with the safeguards system would appear first. Any such signs are taken very seriously by the Agency and, indeed, by Member States.

The Agency has not under the some 30 years of the operation of the safeguards system discovered any diversion of fissionable material or misuse of installations for military purposes and I am convinced it is because none has occurred. It is not a perfect system, but it is well tried out and it is often studied by governments to give ideas as to how inspection can be organized in connection with disarmament measures.

What are the shortcomings of the safeguards system?

- It can only report what it sees here and now. It is like a radar that scans the horizon. It does not read intentions.

- It does not roam the territory of a State in search of clandestine installations or even to check an installation deemed suspicious. While the Tlatelolco Treaty has provisions about verification by challenge, the NPT does not. It is conceivable therefore that a State could build undeclared nuclear installations. However, imports of uranium or construction of major facilities are not likely to go unnoticed. Moreover, safeguards are not the only system that observes States. Satellites and intelligence are naturally also providing some governments with data.

- A problem is the increasing complexity of some modern nuclear installations handling growing volumes of plutonium and enriched uranium. Efforts must be made so that safeguards keep abreast with the evolution. Governments can facilitate the task by designing the installations in a "safeguards friendly" way! It is, in fact, in their own interest to do so.

- The financing of the system has until recently not been a problem, but the rigidity with which the greatest payer States hold on to zero growth in budgets of international organizations, makes the safeguards task more problematic. To satisfactorily safeguard increasing quantities of nuclear material in a continuously expanding number of nuclear installations, of which some are highly complex, with no growth in resources is difficult. We risk a gradual erosion in coverage or quality.

A special and peculiar feature of the safeguards system requires some comment. The Agency is invited by all five nuclear-weapon States to perform inspection on peaceful nuclear installations in these States.

Evidently such inspection does not have the purpose of verifying non-proliferation, since these States have nuclear weapons and continue to make such weapons. These "voluntary offers" have their roots rather in a criticism voiced

early that the nuclear-weapon States were "rewarded" for having nuclear weapons by being exempt from inspection. The criticism was somewhat linked to the mistaken belief that inspection was a heavy burden. The Agency has been routinely inspecting a few facilities in the US, UK, France and the USSR. With China the agreements are now in place but the actual inspection has not yet started. In the US and the UK the offer has regard to the whole peaceful nuclear sector. In France, the USSR and China it is more limited. The Agency has been making use of the offer to acquire experience of inspection on types of installations that might later be encountered outside nuclear-weapon States. The NPT Review Conference that met in 1985 urged the Agency to make wider use of the offer and spoke of the principle that all peaceful nuclear installations in all States should be under safeguards. Under current budgetary restrictions no such expansion has been possible. Indeed, an offer to safeguard a breeder reactor in the Soviet Union remains unused for budget reasons.

It should perhaps be noticed that this type of inspection could be of use in some disarmament schemes. If, say, an enrichment plant or reprocessing plant were to cease producing for military purposes it could be designated civilian and offered for safeguards. In this way an existing verification mechanism would be readily available.

I should like to conclude with some remarks on the prospects of non-proliferation. In August and September this year another review conference of the NPT is to take place and in 1995 a conference is to determine whether the treaty is to be prolonged for an additional period or additional periods or indefinitely. A good deal of interest is already focusing upon this 1995 conference. One can certainly identify various factors which weaken the attractiveness of the treaty to some parties. First of all, many States feel that they accepted to forego the nuclear weapon option in the expectation that the nuclear-weapon States would embark on substantive disarmament. The contrary happened. There are many more nuclear weapons in the world today than in 1968. Even the INF treaty banning intermediate-range nuclear forces does not dispose of the warheads but only of the carriers.

Another factor that could reduce the attractiveness of the treaty is the feeling among many developing countries that the transfer of nuclear technology - in

spheres of medicine, industry, agriculture and power - the facilitation of which was promised under the Treaty has been much less generous than they feel they were entitled to.

As against these factors, however, there are other more hopeful ones. If nuclear disarmament has not actually got very far yet, nevertheless we may well hope for drastic cuts in the years to come both in nuclear and conventional armaments. Indeed, one might even wonder if the security thinkers of the great powers are not reaching the conclusion that the military - and nuclear - way to security has become too dangerous and too expensive. Such a conclusion, alone, would not, of course, have stopped them earlier from continuing upward in the armaments spiral. Two other momentous developments, however, may now help to stop or slow the race. The first is the attitude of the Soviet leadership, evidenced in action, that all countries should be allowed to seek and develop their own economic and social system without foreign interference. Armed conflicts based on or fuelled by aspiration for ideological supremacy seem more remote. The second development is the new general acceptability of on-site inspection. Only with such inspection will States have enough confidence to lower their military guard. I should like to think that some 30 years experience of safeguards inspection have contributed to paving the way for the new acceptance of far-reaching disarmament inspection schemes.

It is certainly too early to pronounce the demise of military force as a factor in the relations of major military powers, but nuclear weapon doctrines are looking increasingly theoretical and military sufficiency is a very different concept from "massive retaliation". Of course, residuary nuclear forces are likely to be retained as basic mutual deterrence and to deter any maverick State that might succeed to go for nuclear weapons. It would also be naive to think that force will not remain an important factor in regional tensions and, indeed, in internal conflicts. However, a gradual withering of the military option in great power relations could herald the dawning of a new world order. Such an evolution would help to strengthen the non-proliferation treaty. States would see less reason for arms - including nuclear arms - to maintain security.

Another factor that might help to strengthen support for non-proliferation would be more rewards in the form of nuclear technology to those who accept the

treaty. It cannot be doubted that some inconvenience has followed for those countries that so far have determined to stay outside the regime. Carrots, alone, would not bring India and Pakistan, Argentina and Brazil, and even less Israel to join the NPT, but a combination of drastic nuclear disarmament - including all nuclear-weapon States - a general trend away from reliance on the military option in great power relations and some settlement in the Middle East, plus offers of a generous transfer of nuclear technology, might bring about universal adherence to the NPT during the next decade.

Although I know that nuclear power is not the most popular subject in this city of Geneva, I would be less than honest if I did not end by saying that in my view the world is not threatened by the some 430 nuclear power stations but by the - still - some 50 000 nuclear warheads. An expanded use of nuclear power could be - not a panacea - but a significant factor in the necessary efforts to reduce carbon dioxide emissions and the risk of global warming. A new and better world order would transfer enrichment plants and reprocessing plants to the civilian sector and plutonium and enriched uranium from such plants and from dismantled nuclear weapons should, in my optimistic dream of the world, be used to generate electricity.