Nuclear Disarmament, Non-Proliferation and Development
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Views on Non-Proliferation and Verification

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Since its establishment in 1957 the International Atomic Energy Agency (IAEA) has worked to bring the benefits of nuclear technology to humankind, while at the same time minimizing its risks. When we look at the projections for the coming decades we see considerable growth in the use of nuclear energy and nuclear technology. And while this will help to bring greater prosperity to different parts of the world, it will also carry proliferation risks. Without the appropriate control measures, States could misuse nuclear material and technology to build nuclear weapons. This, in turn, could lead to a major failure in the non-proliferation control regime – the security, social and economic consequences of which would be enormous.

So, when we look at the future of the safeguards verification regime, we do so in the context of this expansion of nuclear energy, accompanied by the development of new reactors and fuel cycle technologies. At the same time, we can expect changes in the proliferation landscape – for instance, there may be further cases of non-compliance or even a State, or States, withdrawing from the NPT.

What is certain is that we will need to develop new verification technologies and approaches to keep abreast of this changing environment.

Nuclear Renaissance

As I have already said, projections by different international organizations indicate significant growth in the future use of nuclear power. Today's capacity is 372 GW(e). The Agency's own projections indicate a nuclear electrical generating capacity of between 437 and 542 GW(e) by 2020 and between 473 and 748 GW(e) by 2030 (Figure 1). In other

words, in twenty years time we are facing an increase of anywhere between 25 and 100%.[1]

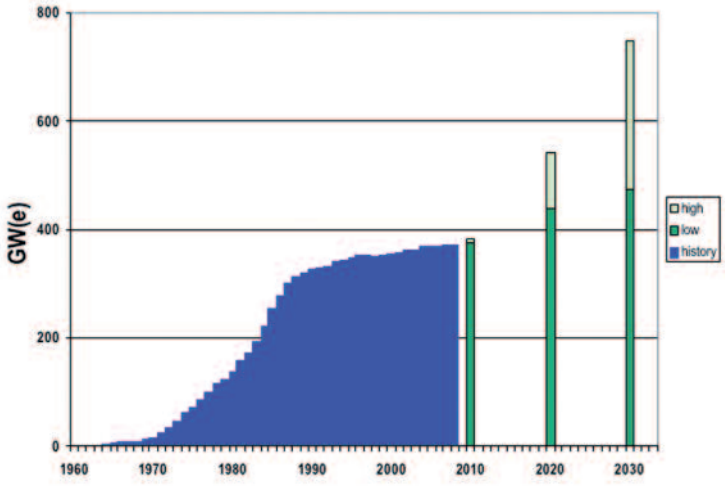

Figure 1. IAEA high and low projections for nuclear power growth by 2030.

Figure 2 shows that the greatest expansion of nuclear capacity in absolute terms is projected for the Far East, under both the low and high projections. Eastern Europe will also grow strongly under both projections. Compared to current capacity, a significant expansion is also projected for the Middle East and South Asia (a region that includes India). North American capacity will also grow. The region with the greatest uncertainty, i.e. the greatest difference between the low and high projections, is Western Europe. Here, nuclear generating capacity could either fall below the current level or grow.

[1] By 2020, the comparable percentages will be 16-45% higher.

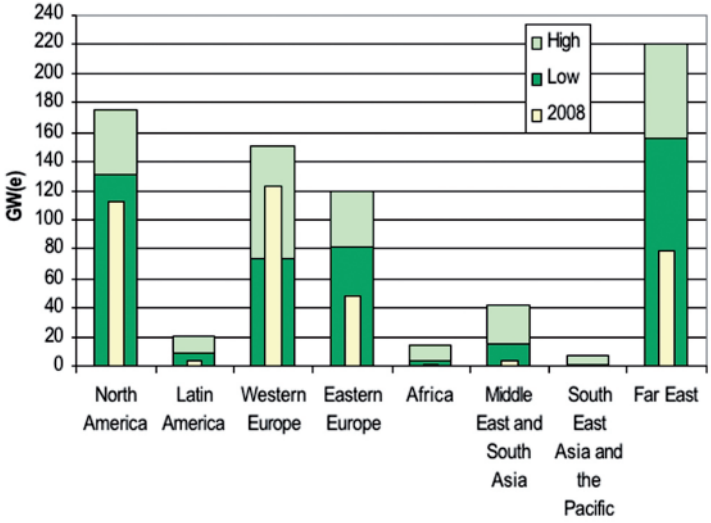

Figure 2. Current and projected nuclear electricity generating capacity by region by 2030.

Verification Requirements

Today, the Department carries out inspections at 196 nuclear power reactors in 24 non-nuclear-weapon States which have comprehensive safeguards agreements (based on INFCIRC/153) with the Agency. Depending on how the Agency's projections materialize, by 2030 the Department may be carrying out verification inspections at anywhere between 209 and 347 nuclear reactors – in other words, up to 75% more than today.

Today the Agency verifies 133 major Nuclear Fuel Cycle facilities globally.[2] Of these, 121 are in non-nuclear-weapon States and 12 either in nuclear-weapon States or States that are not party to the NPT. Based

[2] The facilities accounted for in the graph are those facilities where PDIs exceed 10 days per year.

on currently available information, the Agency may be safeguarding 160 such facilities by 2030 – an increase of 20%. Figure 3 shows the breakdown between the various facility types.

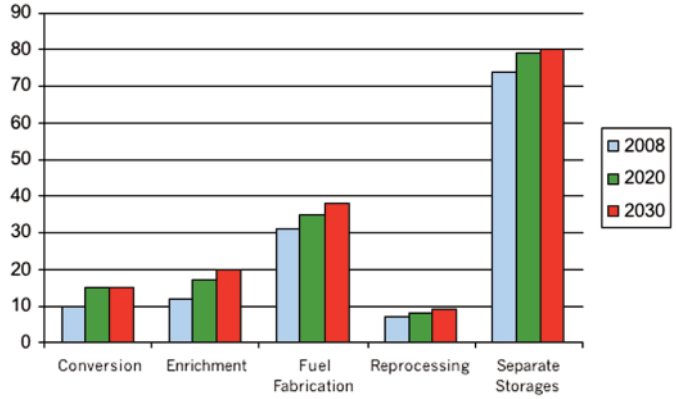

Figure 3. Projections of NFC facilities under safeguards by 2030.

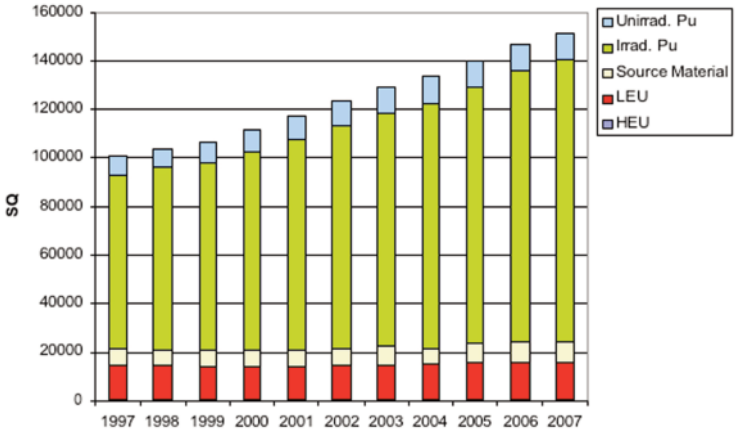

Figure 4. Significant quantities of nuclear material under safeguards 1997-2007.[3]

[3] Safeguards Implementation Reports 1997-2007.

The potential nuclear expansion will also drive an increase in the quantities of other nuclear material under safeguards. There will be more nuclear material present – and requiring to be safeguarded – in each stage of the nuclear fuel cycle. Increases in mining, enrichment, fuel fabrication and reprocessing capacity will influence the quantity of source material, low-enriched uranium and un-irradiated plutonium. Some stages, such as enrichment and reprocessing, are more proliferation sensitive than others. But in general terms we can say that nuclear material will be present in a higher number of facilities, locations and countries.

New Demands: Disarmament?

I should also point out that in the future the IAEA may also be called on to take on new roles, such as the verification of nuclear materials released from military programmes. In doing so, it would be contributing not only to non proliferation but also to disarmament.

How to Cope with the Challenges?

So, how is the IAEA going to rise to these challenges and to meet the expectations of the international community in this changing environment? I believe the answer lies through innovation and adaption.

The safeguards system is aimed at detecting the diversion of nuclear material. Projecting future quantities of nuclear materials to be safeguarded – and their impact – is complex. This depends on the physical form of the material, the stage of the nuclear fuel cycle where the material is present, the type of facility involved – conversion, enrichment, fuel fabrication or reprocessing – and the size of the process. It also depends whether the facility is in a non-nuclear-weapon State, a nuclear-weapon State or a State that is not a party to the NPT.

New thinking is required in order to provide the IAEA's safeguards systems with the legal authority, technical capabilities, and financial and human resources to do the job effectively in tomorrow's world.

Many of the new nuclear facilities established will be in States that have limited or no previous nuclear experience. And many of these States have yet to establish – let alone bring up to standard – the nuclear

regulatory bodies needed to ensure effective State Systems of Accountancy and Control (SSAC).

An additional challenge is the emergence of an illicit trade in nuclear technology, facilitated through covert trade networks, the activities of which span the globe. These traders conceal their clandestine shipments within legitimate trade, often taking advantage of weaknesses in export control systems.

The further advancement of science and technology will offer both challenges and opportunities for the Department. Undoubtedly, the Agency will need to safeguard new types of reactors and fuel cycle facilities. Scientific and technological progress, combined with the increased availability of information through the internet and States' own information gathering methods, may also make it easier to access sensitive nuclear technologies. If so, proliferation risks would be heightened. On the other side of the coin, advances in science and technology should also continue to offer new ways and means of countering proliferation threats.

I believe we will also need to pay attention to future cases of non-compliance with the NPT and other non-proliferation obligations: cases which, if not resolved in a timely manner, will erode the credibility of the verification system. In a similar vein, how do we deal with States that withdraw from the NPT?

I did mention earlier that we need to assess our strengths and weaknesses: where we have been good and where we have either failed or performed below expectations. When we look back at the proliferation cases of the last one or two decades, it is clear that there has been practically no diversion of nuclear material that has been declared to the IAEA. Most of these cases have involved *undeclared* nuclear material at *undeclared* facilities. It is important, therefore, to further strengthen our capabilities to overcome the challenge of undeclared activities – while at the same time not weakening our capability to deal with declared activities. A chain is only as strong as its weakest link.

A strengthened system of safeguards has been instituted that incorporates the additional protocol, State-level approaches to safeguards, and a move towards information driven safeguards. A review of the IAEA's legal authority and resources is required, as well as ensuring that the IAEA has state-of-the-art verification technology.

The IAEA will need to move with the times in order to strengthen existing detection capabilities and remote monitoring, particularly for the detection of clandestine nuclear activities. In certain cases it might even be advantageous to conduct remote inspections.

Having the capacity to commission R&D in safeguards technology, be it in cooperation with Member States or tapping into the commercial markets, would be a great advantage to the IAEA.

New types of nuclear reactors and associated nuclear fuel cycle technologies will emerge, requiring the IAEA to develop and prepare dedicated safeguards approaches and techniques well in advance.

The IAEA will also work with States, facility providers and operators to design and operate "safeguards friendly" nuclear installations to facilitate efficient and effective verification.

It is vital to remember that the challenges posed to the safeguards community arise not only from developments in the peaceful use of nuclear energy, non-proliferation and disarmament, but also from the need to develop and implement corresponding verification tools and methods.

In Summary

A resilient safeguards verification system that provides necessary assurances is the ultimate stamp of confidence that promotes the peaceful uses of nuclear energy. This is a continuous journey for which the support of Member States is essential. We need to have a strong and durable worldwide nuclear order – and for that we need the NPT and the IAEA as its cornerstones.

During the Study Day the author added the following commentary to his paper

Distinguished participants, Father Michael knows that I have been living quite a big part of my life in Asia, in Japan and in South East Asia and there every speech starts with an apology and I have to do it here as well, because yesterday was a day that will stay in my memory for along time and I left the important slides in Vienna. I thought that they were in this USB that I grabbed when I left for the airport but it was the wrong USB so I am here without my slides and the reason for that was actually what took place on Sunday, when President Ahmadinejad informed the international community that they plan to go to 20% enriched uranium and that took me out of sequence for quite some time. And there comes the thanks, because when I came last night to the Residence here I was the happiest man in the world because, first of all, I did not believe I would make it, there was an excellent dinner and then after that dinner I just went to my room and I finally had some time also for myself so I am grateful for this and I will remember this for a long time, as I will remember also the excellent presentations here. But, since I do not have my slides and you have my presentation or intervention in writing, it might be better that I just pick the salient points and try to explain a little bit about the background, and that might benefit you more than my reading through my paper.

When the world leaders in the mid 1950s established IAEA they had a vision. Their vision was that they wanted to share the benefits of nuclear energy and technology with mankind. At the same time they also knew there is a downside for nuclear energy and this is its possible military use for nuclear weapons purposes and the third reason they had was disarmament, and all those three visions are actually enshrined in the statutes of the IAEA. Most of the efforts have certainly been spent for nuclear technology sharing, transfer, education, legislation, etc. In recent years most of the focus has been on non-proliferation issues, verification issues, but disarmament is also there and the statutes say that this work will be done in cooperation with the United Nations. When they established the IAEA in the 1950s this is what I call the rosy dawn of nuclear energy. Everything was beautiful. The world was supposed to be filled by nuclear reactors in the 1960s:

that did not take place. There were several reasons for that. In the end, maybe the most fatal ones were Three Mile Island and then the Chernobyl accident, which slowed tremendously the uses of nuclear energy, but the international community also went and learned from these lessons and today we are facing a very different situation which we sometimes call nuclear renaissance. But at the same time this is a turning point. We have some proliferation cases which have been on the table for quite some time, questions have been raised about the double standards and the applicability of the NPT, we even see one country leaving the NPT so there is a certain stress. Then we have seen the emergence of these clandestine nuclear procurement networks, like A.Q. Khan, as Mr Duarte mentioned, so there are a lot of clouds but, at the same time, this is an opportunity for the international community to get together, establish perhaps a new nuclear order, which will make sure that nuclear energy is only used for peaceful purposes at the same time when its use is spread widely. This spread of nuclear technology also puts additional challenges to the IAEA verification scheme: more nuclear material and more nuclear facilities spread all over the world at the same time as our budgets are limited because of the economic difficulties in our member states. So we also need to think how we will do in the future with our verification system, but again, that is perhaps a crisis and at the same time an opportunity. As Michael said, think outside the box, look at whether you can do things differently. You see in my presentation that we estimate that by 2020 or 2030, let us say, the nuclear energy share, or absolute amount of nuclear energy in the world, can be double compared to today so this means that there will be practically maybe a double amount of nuclear reactors. Today the world has more than 400 nuclear reactors, then we will live in a world which has 7-800. They need fuel, this means more uranium mining, more uranium conversion, more uranium enrichment, because all these new reactor types practically use low enriched uranium. If you look at it from another angle, this is not going to be an even distribution around the world: here in Europe, not so much new nuclear power, but mainly in Eastern Europe, Ukraine, Belarus, then perhaps in Caucasus, Kazakhstan, Russia, this is where the new nuclear power plants are built. The biggest growth will be in the Far

East and South East Asia: India, China, South Korea, Japan. From IAEA verification we have 200 reactors under IAEA safeguards today, about that number. If I remember correctly, 60 are in Japan and about 20 in South Korea. Out of these 450 reactors, which are now worldwide, IAEA verifies only 200, because the rest are in nuclear-weapon states and we do not have very much verification activities there. But I mentioned enrichment; these nuclear power plants mainly need enriched uranium. Today there are about one dozen enrichment plants which are under IAEA safeguards, or totally in the world, not that many under IAEA safeguards. In 2030 we believe that the amount will be double, so there will be two times more enrichment facilities as today. Some of them will be in nuclear-weapon states of most likely not a proliferation concern, but many of them not. Like Professor Rubbia mentioned today, that by adding 40% more centrifuge you can produce highly enriched uranium, 90% you can do it with 80%, actually you can do it also with 60%, so that gets more complicated but it is manageable. But let us look now at the case of Iran, actually, since it is in the focus. This morning they have, by the way, started to feed low-enriched uranium in this pilot plant in Natanz, so they have passed one of the red lines set by some member states. I assume that we are on Chatham House Rules now, when I go from here on.

So what does it really mean: actually, when you have produced low-enriched uranium it is 4% enriched Uranium-235 and if your plan is to produce high-enriched uranium for nuclear weapons, at the state when you have reached 4% you have done 75% of your separation work. If you go from 4% to 20% you have done 90% of your separation work. So anyone who has enrichment, in my personal view, has a latent capability to take a step forward and fairly easily produce high-enriched uranium, if he so wishes. What can we do? Well, discourage them first. Make them obsolete, that is the easiest way. If not, then try to control them. We have today very robust safeguards approaches so I do not think in any of these places you can produce high-enriched uranium without IAEA detecting it, let us say, in one month's time. But once it is detected, what will the state do, and there we come to the other things like NPT withdrawal, how to deal with those who are

violating the provisions of safeguards agreements, compliances use etc, which are beyond the scope of my presentation but I see particularly this non compliance issue as an erosion to a credible verification system. I do not think we should continue for a very long time along this road because we will see perhaps some other proliferators taking the advantage. Then, when we talk about enrichment, the genie is out of the bottle. The enrichment technology used to be very well guarded technology but with the actions of A.Q. Khan and some others all these designs of centrifuges are now in electronic form, they were distributing this from that shop in Dubai on CDs – we found some of them, regrettably not all of them, we do not know how many they produced – so anyone who has enough funds, I think, can buy them, because I do not think they all disappeared. What was alarming there as well was that these computers, which we then found at a later date, also contained design drawings for nuclear weapons. Luckily, at least those CDs that we got in our hands, did not include a full set of such information but for anyone who is planning to build a nuclear device, he gets a lot of advice and tips with that documentation and his life might be a little bit easier.

Then the other point is what to do with the reprocessing. Today there is actually very little reprocessing and plutonium is recycled in small quantities in the civilian nuclear power reactors. That picture is now changing radically in Japan because from last year they started to introduce mock fuel in their power reactors – in Europe this has, by the way, taken place already in the last twenty years, or maybe even more, thirty years, particularly in Germany, Belgium and in Switzerland but not so much elsewhere in the world. Fast breeder reactors are still far to come so plutonium will be, in the first place, used for light water reactors. The good news in Japan's case is that they do not pile up plutonium anymore, now they start to consume it.

How many additional reprocessing plants? This is probably the most difficult number to predict here, because here we actually have two choices: you take the spent fuel, separate plutonium and recycle it – it is commercially not viable today, but when energy resources are diminishing with time maybe it will become more attractive. Most European countries have, at this point in time, decided just to keep

the spent fuel or do like my home country, Finland and Sweden, encapsulate it and dispose of it and never reprocess it. We also have new reprocessing technologies. The current technology is based on PUREX reprocessing, this is used here in Europe and in Japan but, for example, South Korea is looking at what they call pyroprocessing, which is a technology resource developed in the US in the 1950s. Well, that has got a lot of opponents, particularly in the US non-proliferation community, but if we had to select between bad and worse, let us say pyroprocesses versus PUREX, I would personally pick the pyroprocesses because there you cannot control the process better in such a way that you will see you need to do substantial modifications to the facility in order really to separate plutonium as a metal, so there are some pros. But the overall solution here is perhaps what my former boss ElBaradei has been advocating, it is establishing international reprocessing and enrichment centres. Internationalising these services might be the best way. It has actually taken place here in Europe in terms of the Euranco company.

Then, disarmament. Well, the IAEA has not been in the frontline there but I think there is perhaps a role for us. The first is this one which General Burns mentioned here, it is to turn megatons to megawatts. Take the material from the military programmes, change it to another format and feed to the power reactors. Actually in the US in the last few years we have been verifying the high-enriched uranium which he mentioned came from Russia to the US and then it is downplanted and fed to the light water reactors. 15% of the US light water reactors' electricity actually came from uranium which originated from the Russian weapons programme, so that is the good use and that, I think, is where the IAEA may have a role, since disarmament should also be irreversible, so the materials which come go to the civilian cycle. We have there some two tons of plutonium in the US, stored in one place, and the idea is that that will be also manufactured to mock fuel, and IAEA will be properly safeguarding it to make sure that this military origin plutonium goes for civilian purposes. This is the very easy part, and where the agency can be readily available if the international community so wishes.

We have also had another experience closer to disarmament, and actually it is dismantlement. We had been working in South Africa

when South Africa disclosed its former nuclear weapons programme in 1992, which it had actually dismantled 7 or 8 years earlier. Technically it was a challenging task to go back and see whether they had really dismantled everything. It was a good lesson also for us to learn how you make sure that the knowledge got somehow taken care of, what happened with the people, what happened with the equipment and I think that, when we go one day to talk about going to zero, some of those experiences could be beneficial for these people who will do the security arrangement at that point of time. We did the same in Iraq, which actually was, from the IAEA point of view, in my view a little bit of an easier task, because everything was present and it was in the very beginning so it was easy to deal with and then in Libya where it was even easier, because they had not yet got that far.

In North Korea our role has been varying, but I think that there are certain things that we can also benefit from if we go to the cut off and monitoring of fissile material stocks. So these are the jobs that we have in the future and then how to cope with these challenges. As Michael said, we need to think outside the box. We cannot continue, just, if there is a double amount of reactors there is a double amount of IAEA safeguards inspectors, when there is a double amount of nuclear material we just double everything and if we get new challenges like disarmament.

Our basic verification concept was created in the 1960s. There was a book, it was almost like a bank account, then there was nuclear material, we went and we checked the book then we saw the list, then we counted nuclear material like the auditor counts the money in the bank and we said yes, no, it is OK. There is nothing any more on paper and books in nuclear installations, it is all in computers, all electronic. Same as with nuclear materials, you cannot go there anymore and count them, they are all hidden in some vaults, plutonium, you cannot even see it, you just know that in the storage position A12 is this and this item. So how to cope with this? The way is to use the modern information technology, to do remote inspections. I was operated on my eye in Vienna two years ago and the medical doctor, who was a very proud young surgeon, showed me all his nice gear and said his dream was one day to do an operation in another country with the computer. I said, for heaven's sake, not on my eye! But this brought us, why don't we do

all these inspections remotely in such a way that all these books that are there we actually bring to Vienna in our computer, we take the remote monitoring signals, put everything together and do our analysis without travelling to the other side of the globe? Yes and no. Yes in the sense that you are perhaps more efficient but it should not come at the price of effectiveness, because if you go back and study the history of the IAEA verification cases in the last 10 or 15 years, they were all based on the operation of clandestine nuclear material most of the time in clandestine places so, if we keep ourselves away from those places and do not go to do the physical verification there, we may jeopardize the credibility of our system, therefore we should do this but at the same time we need to do more unannounced inspections, use our manpower and person-power in a more intelligent way on those site visits, and focus on those places where we are weak.

How to cope with illicit trafficking and clandestine networks: well, this is pretty much an export control thing but IAEA can also do a lot. Today we live in the world of the Internet, information flow, free information laws. You can learn a lot of what happens in nuclear installations in countries just by reading those. Certainly the proliferators know that, but it would be very difficult in the modern open societies to hide this sort of things. Therefore we have come with this new concept which is information-driven safeguards, where you have your basic verification thing like in the past, do it a little bit different, you complement this with this other information, and then you will have overall assurances which are at least as good as today, if not better.

Then we need to deal with those non-compliance cases, in order to avoid the erosion of the very system but the most important thing, from the verification point of view, in each of these schemes, is access to information, access to the facilities, location and sights and therefore, in my view, the norm for non-proliferation standards should be a comprehensive safeguards agreement with additional protocol in force. We should, perhaps, even look at some updating to the additional protocol, but I know that in the foreseeable future it is not possible. I think it is perhaps the time to say that the verification system needs to be robust. We cannot win tomorrow's wars with yesterday's tools, we need to keep updated, we need to be a step ahead of the proliferators, I

think we need a new type of nuclear order, actually, to bring it all together to make sure that the proliferation is blocked, how to deal with terrorists or other non-state actors, because I do not think we should only concentrate on terrorists, and work together, share the information, that is the most important. If you have informant services not used or shared, that information actually has no value at all, it is useless and if the IAEA is an organisation that does not use this information and does not do that job it also becomes useless.