ORGANIZED BY JAPAN, AUSTRALIA AND UNIDIR

WORKSHOP

PROMOTING VERIFICATION IN MULTILATERAL ARMS CONTROL TREATIES

– FUTURE VERIFICATION REGIME, FMCT IN PARTICULAR –

DELEGATION OF JAPAN TO THE CONFERENCE ON DISARMAMENT
MINISTRY OF FOREIGN AFFAIRS, JAPAN
28 MARCH 2003, GENEVA

TABLE OF CONTENTS

Foreword

December 2003

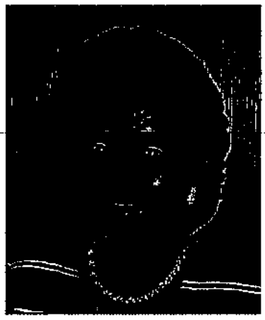
An almost unanimous call for the immediate commencement of negotiations on a treaty to ban the production of fissile material for nuclear weapons and other nuclear explosive devices (FMCT) was made at the United Nations General Assembly. Despite such collective interest from the international community, the Conference on Disarmament did not commence negotiations again this year. As the only nation to have experienced nuclear devastation, it is the strong desire of Japan and its people to witness progress in nuclear disarmament. I have endeavoured to highlight the importance to Japan of FMCT negotiations at every available opportunity, most notably in my recent September address to the Conference on Disarmament.

The strong interest which has been expressed regarding the commencement of FMCT negotiations was also the main thrust for the organization of the workshop entitled "Promoting Verification in Multilateral Arms Control Treaties - Future verification regime, FMCT in particular" on 28 March, in collaboration with the Government of Australia and the United Nations Institute of Disarmament Research. This workshop was organized to help maintain momentum in the lead up to FMCT negotiations, as well as to provide a forum for informative discussion on the issue of verification, which is a core subject in multilateral arms control and disarmament.

I have asked Ambassador Kuniko Inoguchi, Ambassador to the Conference on Disarmament, to issue this collation of all documents presented by the panellists, together with her opening remarks and statement at the Conference. I am confident the documents compiled herein will serve as an invaluable resource to delegations and civil society for further discussions on related issues and future negotiations on the FMCT.

I am most grateful to the panellists for their excellent contributions which indeed enriched the discussions. I would also like to express my sincere appreciation to the two co-organizers, the Government of Australia and the United Nations Institute of Disarmament Research, for their support and cooperation. Finally, my special thanks go to the Secretariat of the Conference on Disarmament for its indispensable logistical assistance extended to our delegation in Geneva.

Yoriko Kawaguchi
Minister for Foreign Affairs



Introduction

December 2003

It is my pleasure to issue this collation of documents made available by panelists at the workshop "Promoting Verification in Multilateral Arms Control Treaties – Future verification regime, FMCT in particular", held in Geneva on 28 March this year.

This workshop was organized by the Government of Japan in collaboration with the Government of Australia and the United Nations Institute of Disarmament Research (UNIDIR). It was my privilege to invite the knowledgeable panelists to this workshop. Their excellent contributions, followed by active discussions with the floor, indeed helped to deepen our knowledge and stimulate our thoughts on this important and sensitive issue in arms control.

The international community has made steady progress in multilateral arms control and disarmament by creating important instruments which constitute an essential foundation for international peace and security. It is, however, increasingly a formidable challenge to preserve confidence. The effective functioning of multilateral verification systems is critical to ensure compliance with these instruments and to maintain their credibility. The workshop dealt with this issue pertinent to the current international security environment.

The workshop also focused on the future verification of a Fissile Material Cut-Off Treaty. I believe that the exchange of views certainly enhanced a knowledge base on this issue. Japan places an urgent priority on the commencement of FMCT negotiations at the Conference on Disarmament. H.E. Mrs. Yoriko Kawaguchi, Minister for Foreign Affairs of Japan, instructed me to hold this workshop and to issue this collation with the intention of facilitating the lead-up process to such negotiations.

Before concluding, I would like to express my sincere appreciation to H.E. Mr. Mike Smith, Ambassador of Australia, and Dr. Patricia Lewis, Director of UNIDIR, for their kind cooperation extended to me and my delegation. I also thank the Secretariat of the Conference on Disarmament for their great assistance.

Thank you.

Kuniko Inoguchi
Ambassador of Japan to the
Conference on Disarmament

Promoting Verification in Multilateral Arms Control Treaties
- Future verification regime, FMCT in particular -
Jointly organized by Japan, Australia and UNIDIR

1. Objective

- To learn generic lessons from existing verification regimes in multilateral disarmament conventions

- To discuss whether and how those lessons can be made use of in the creation of new verification regimes, inter alia, that of the FMCT

2. Schedule

Date and Place: Friday, March 28 2003, Council Chamber, Palais des Nations

10:00 Opening remarks by Ambassador INOGUCHI (Japan)

10:15 **Session 1:** Generic lessons from existing regimes
Moderator: Dr. Patricia LEWIS Director of UNIDIR

General overview of the existing verification mechanisms
Dr. Trevor FINDLAY Executive Director of VERTIC, UK

Presentation by IAEA
Dr. Tariq RAUF Head, Verification and Security Policy Co-ordination Office of External Relations and Policy Co-ordination, IAEA

Presentation by OPCW
Dr. Horst REEPS Director of Verification Division, OPCW

Presentation on CTBT
Dr. Ola DAHLMAN Chairman of Working Group B CTBTO Prep Com

11:30 Coffee break

11:45 Discussion

13:00 Lunch Time

14:00 **Session 2:** Some perspectives on FMCT verification
Moderator: Mr. Hiroyoshi KURIHARA Senior Executive Director
Nuclear Material Control Center,
JAPAN

General overview of FMCT by moderator
Remarks by panelists

- Dr. Geoffrey SHAW — Deputy Head, Australian Mission in Geneva
- Dr. Anders RINGBOM — Senior Research Officer, Project Manager for projects in the area of Nuclear Verification Techniques, Swedish Defence Research Agency
- Mr. Andrew BARLOW — Head, Arms Control and Disarmament Unit, Foreign and Commonwealth Office, UK
- Dr. Krishnamurti BALU — Former Director of Nuclear Recycle Group, Bahba Atomic Research Center, Munbai, India

15:30 Discussion

16:15 Concluding remarks by Ambassador INOGUCHI (Japan) and Ambassador SMITH (Australia)

17:00 Cocktail at the Delegates' Restaurant (8th floor)

Guideline for speakers

It is recommended that panelists take the following guidelines into consideration as they prepare for their presentation. Approximately 10 minutes are allocated to each panelist to make their presentation.

For Session one

- Ensuring correct and complete initial declarations
- Assurance derived from routine inspections
- Detectability of undeclared activities/effectiveness of challenge inspections
- Protection of sensitive/confidential information obtained from inspections
- Cost-effectiveness and efficiency
- Flexible response to technology progress as well as evolving security and political ituations

For Session Two

Verification of a ban on the production of FM for NW

- Ensuring correct and complete initial declarations
  - What should be declared (materials, facilities, activities etc.)?
  - Are precise definitions necessary? Should these be defined by technical specifications or purpose?
  - How should inconsistencies or questions concerning initial declarations be solved? What procedures should be taken when these inconsistencies/questions cannot be solved?

- Assurance derived from routine inspections
  - Are routine inspections needed for FMCT? Or can requirements only be met through challenge inspections?
  - If routine inspections are necessary, how much assurance should be derived from them – complete or partial?
  - How should the starting point and termination of verification measures be defined?
  - Should routine inspections be undertaken “mechanically and systematically”?
  - What kind of inspections are appropriate for FMCT routine inspections – the INFCIR/153 type of inspection, based on the “timeliness” concept, or random non/short notice type of inspection?
  - Would/should there be any additional obligations of routine inspections for NNWS that have already acceded both to INFCIRC 153 and 540?
  - Should a limit be imposed on the number of routine inspections for each country? If so, how – numerically, by number of facilities, or by facility type?

- Detectability of undeclared activities/effectiveness of challenge inspections
  - Is it possible to detect undeclared activities and materials?
  - Where are potential loopholes (Naval reactor fuel? Imports/exports? Non-accessible military facilities?)
  - What techniques would be useful in order to improve detectability for non-declared facilities and activities? (especially technical aspects: technology for detection instruments, techniques for collecting information – intelligence, evaluation techniques for countries under question…)

- Who will be responsible for putting inspections into action – organizations or States Parties? What will be the procedure?
- What will be the procedure for non-cooperative states?
- Is the special inspection of IAEA Safeguards or Additional Protocol adequate, or is an original FMCT challenge inspection needed?
- What procedure is appropriate when a violation of the FMCT is discovered?

■ Protection of sensitive/confidential information obtained from inspections
- How can sensitive information of States Parties be protected from inspectors – is "managed access" useful/appropriate?
- Is it possible to achieve inspection goals without disclosing sensitive information of inspected states?
- What method/technical means can balance the credibility of FMCT with confidentiality requirements?

■ Cost effectiveness and efficiency
- How can costs be balanced with effectiveness/detectability?
- How can the IAEA be utilized?

■ Flexible response to technological progress as well as evolving security and political situations
- IAEA Safeguards responded to security and political situations after the Gulf War. How can verification of FMCT flexibly react to such changes?
- How can the verification system respond to future progress in the technology for producing nuclear weapons, including producing FM?
- Can the verification system appropriately adopt new verification technologies?

Opening Remarks by Ambassador Kuniko Inoguchi at the Workshop entitled "Promoting Verification in Multilateral Disarmament Treaties"

28 March 2003, Geneva

Excellencies,
Distinguished participants,

It is my honor to announce, on behalf of the co-organizers, Governments of Japan and Australia, and UNIDIR, the opening of the Workshop entitled "Promoting Verification in Multilateral Disarmament Treaties". I extend my warmest welcome to all of you present here today. I would also like to express sincere gratitude to those who have kindly accepted to participate as moderators and panelists, especially to those who have traveled here from their home. My special thanks also go to the CD Secretariat for making available the Council Chamber and for all their assistance.

Today's world is largely preoccupied with the growing concern over the spread of weapons of mass destruction (WMD). The existing multilateral arms control regimes that should offer an essential foundation to prevent proliferation are under constant pressure of being undermined. In order to maintain and strengthen these regimes, compliance is a key issue, and verification is the most effective means to ensure, or at least provide an adequate guarantee of, compliance, particularly, in a multilateral setting. Therefore, verification as a system does in fact have political significance that is the heart of the multilateral arms control, although individual verification issues are indeed technical and scientific. In other words, all aspects of verification have an important dimension and must be thoroughly studied and examined in the creation of any verification system.

The verification systems created in certain existing multilateral arms control instruments are heavily detailed arrangements. It is interesting to note that all specific elements, as a whole, aim at addressing two questions: how to adequately guarantee, on a routine basis, that there is no deviation from treaty obligations; and how to deal with any suspicion of non-compliance once it has arisen.

The IAEA safeguards system is an extremely effective verification system in which all wisdom, expertise, knowledge, experience, etc. is crystalized to maintain the credibility of the Nuclear Non-Proliferation Treaty. The Chemical Weapons Convention has a strong verification regime that is being implemented in a full-fledged manner, though its substantial tests have yet to come. The Comprehensive Nuclear-Test-Ban Treaty has not yet come into force, but it has a vast verification system, which will play an important role for the implementation of the Treaty once it has come into effect.

At the same time, it must be acknowledged that verification can be challenged at any time in terms of credibility. It is not easy to detect clandestine activities, and it is difficult to receive cooperation from those who try to conceal such activities. Verification also entails a substantial need for financial resources, which may impose some limitations on the scope and scale of verification activities. Furthermore, verification could provide those interested in acquiring WMD with opportunities to obtain sensitive information and technical expertise. Such proliferation risks must be taken into account in the consideration of the intrusiveness of verification. Certainly insufficient intrusiveness could, in turn, lead to a lack of effectiveness of the verification.

It is therefore challenging to establish an adequately effective and efficient verification system that is built upon an optimum balance among all these parameters. In fact, such a difficulty underlies the failed negotiations on the verification of the Biological Weapons Convention. I would describe those parameters as follows:

1) Ensuring of correct and complete initial declarations
2) Assurance derived from routine inspections
3) Detectability of undeclared activities/ effectiveness of challenge inspections
4) Protection of sensitive/ confidential information obtained from inspections
5) Cost-effectiveness and efficiency
6) Flexible response to technology progress as well as evolving security and political situations

In my view this set of parameters will help us to structure our discussion on the issue of verification.

Now, let me proceed to an outline of today's workshop, which will be composed of two sessions.

Four presentations will be made during the morning session on existing regimes, including a general overview by Dr. Trevor Findlay of VERTIC, a renowned organization which has made substantive contributions to verification issues. I hope that this morning session will give us an insight on possible generic lessons to be learned from these existing regimes.

The afternoon session will focus on the verification of the Fissile Material Cut-Off Treaty. Clearly the FMCT is the highest priority for many countries, including Japan. The FMCT also seems to be the most pertinent and realistic focus for the delegations in Geneva in terms of the issue of verification. The co-organizers have circulated a list of specific questions to be addressed with a categorization based on the generic parameters described earlier. The discussions in this Workshop are also expected to contribute to a better understanding of the substance of the FMCT to be dealt with in future negotiations.

Before concluding my brief opening remarks, I would like to introduce our moderators. For the morning session, I will ask Dr. Patricia Lewis, Director of UNIDIR, to be the moderator, with full confidence that her well-practiced and sophisticated manner of conducting business will create a lively atmosphere and help us to engage in substantive discussions. The moderator for the afternoon session is Mr. Hiroyoshi Kurihara, Senior Executive Director of the Nuclear Material Control Center of Japan. Mr. Kurihara was also the moderator of the FMCT workshop organized by Japan and Australia in 2001. He is a well-known expert in the fields of the IAEA safeguards system, physical protection, non-proliferation of nuclear weapons and international cooperation concerning nuclear energy.

I once again thank all of you for being present here today. I would now like to proceed to the first session, and give the floor to Dr. Lewis.

General Overview of the Existing Multilateral Verification Mechanisms

Presentation to Seminar on Promoting Verification in Multilateral Arms Control Treaties, Geneva, 28 March 2003

Trevor Findlay
Executive Director
Verification Research, Training and Information Centre (VERTIC), London

Introduction

It seems strange to be talking about the future of multilateral verification at a time when the newest, most intrusive and most intensive multilateral verification effort ever seen_that of the UN Monitoring, Verification and Inspection Commission (UNMOVIC)_has been hastily dismantled and superseded by war. Those of us who support multilateral verification can only despair at the fact that UNMOVIC (along with the International Atomic Energy Agency (IAEA)) was not given the opportunity to fully prove itself in Iraq. Nonetheless, even though UNMOVIC was not permitted to fulfil its considerable promise, functioning inside Iraq for only for four months, and only in full operational mode for a few weeks, it is worth drawing on in considering the future of multilateral verification mechanisms. UNMOVIC thus joins the familiar 'family' of verification organisations, past and present, which provide the relatively small dataset from which to draw lessons and models for future verification mechanisms. In this presentation I will draw on the experience of all of these: the IAEA, the Organisation for the Prohibition of Chemical Weapons (OPCW), the Preparatory Commission for the Comprehensive Nuclear Test Ban Treaty Organisation (CTBTO), the UN Special Commission (UNSCOM) for Iraq and other less centralised models such as the verification system for the Conventional Forces in Europe (CFE) Treaty, the Open Skies Treaty and the Landmine Ban Treaty.

I will highlight what I believe are the most important generic lessons to be learned from these past and existing regimes_from their negotiation to full operation. Not all aspects of all past regimes will of course be relevant to the rather peculiar requirements of a Fissile Materials Treaty (FMT), which is the subject of this seminar, but nonetheless are worth examining to see if they are.

Political context

One of the most important variables in the life-cycle of a verification mechanism is the degree of political support it commands. Verification does not operate in a vacuum, no matter how clever we are in attempting to establish legal and organisational barriers to the intrusion of politics. Clearly, for example, it was the political context of the end of the Cold War that enabled the Chemical Weapons Convention to acquire such an ambitious and intrusive verification system. Similarly Resolution 1441 which launched UNMOVIC into Iraq was a product of its political time. This means we can use the politics of the moment to set up quite far-reaching verification if the time is ripe. It also means, however, that verification systems can atrophy if not well tended. They will become out of date and targeted at the wrong problem if care is not taken. For example, the threat of terrorism was not well taken into account by states when the goals of the verification systems for the original treaties dealing with weapons of mass destruction were negotiated.

Political support can wax and wane after a verification system has been put in place. Often there will be great enthusiasm for a new regime's establishment, but over time the interests of governments turn elsewhere.

While this might seem to be an unavoidable fact of international political life, there are things that verification bodies can do to cushion themselves: I'll turn to this later when I talk about the cultivation of stakeholders beyond states themselves. The flip side of states parties politically neglecting their verification regimes is the danger of unwarranted political interference. Many accused the United States of doing this in the case of the removal of the head of the OPCW, while in the case of UNSCOM a number of the permanent members seem to have attempted undue influence. The lesson here is to have proper guidelines in place, to encourage greater transparency in the operation of verification systems and to try to avoid over-dependence on one state or one group of states for material and financial support.

Negotiation of verification

Like all other aspects of an arms control or disarmament regime, the monitoring and verification aspects should be well negotiated in order that they function as well as possible when the treaty comes to be implemented. However there is almost always a tension between actually achieving consensus on a treaty to allow it to go forward and the characterisation of the verification system that is contained in the treaty. Often a powerful conception of verification is traded off for some other unrelated aspect of the envisaged treaty, such as the entry into force provisions. This again would seem to be a fact of international political life. States tend not to like intrusive verification which involves them in great effort and expense, but there is a price to be paid later in terms of verifiability and possible international controversy, as was learned in the case of the IAEA safeguards regime after the first Gulf War.

One other difficult trade-off that occurs in negotiating verification arrangements is the level of detail that is included prior to a treaty being concluded. The temptation is often to leave detail to the bodies that will be charged with implementing the treaty or to avoid issues of detail in favour of getting an early agreement. There is indeed some sense to avoiding too much detail since implementation always throws up unexpected difficulties which may be hard to resolve if options are precluded by treaty language set in concrete. On the other hand one wants to avoid a situation that faced the CTBTO, where it was charged with establishing seismic monitoring stations whose coordinates were in the sea or in urban areas_because the negotiation of the detail had been rushed to ensure the CTBT was adopted in time. All this speaks to the immense value of pre-negotiation research and preparation, of which this seminar today is a good example.

One aspiration that negotiators should have is to build flexibility into their verification system so that it can adapt itself to future needs and challenges. This needs to be done creatively. States will oppose too much flexibility because they want to be sure about what they are signing up to: they need reassurance that future modifications will be done on an agreed basis.

The organisation of verification

Much has been learned by now about the organisation of verification, especially when a large multilateral organisation is envisaged. There is now a standard model of a conference of states parties, an executive body and a technical secretariat, including where necessary a standing inspectorate. International verification organisations still however rarely adopt best management practices as used in the world of business. They still tend to use allegedly tried and true UN practices, often simply because they are readily available. They still tend to think that running a verification organisation is somehow a unique organisational challenge and that lessons cannot be learned from business and national governments. The OPCW has been grappling with this legacy in the past year. I see no reason why we should not expect the highest managerial, including financial, standards of our verification systems. International security is too important to be waylaid by distracting organisational problems that have ready solutions.
Which brings me to the fraught subject of funding. While it is clear that no-one expects verification systems to be given a blank cheque, one also must expect that it cannot be done on the cheap. All

the multilateral verification organisations are experiencing funding challenges at present. Luckily rescue money is being provided for the OPCW, but the IAEA has still not been released from the constraints of zero growth. Particularly when compared to spending on defence, spending on verification is a security bargain. It should be considered in the same light as allegedly more hard-headed cooperative threat reduction and counter-proliferation programmes. Verification on the cheap does not work and indeed discredits the whole verification enterprise. Verification systems need to be looking at other funding possibilities, including foundations and commercial spin-offs. For example, some of the data collected by the CTBTO's International Monitoring System has commercial value, such as for the airline industry.

The use of techniques and technologies

The extent to which the latest and most appropriate techniques and technologies can be used in multilateral verification systems is a fraught question. For a start there is always a trade-off between effectiveness and cost. States parties will naturally want to keep the costs of verification as low as possible, while still giving the verification system the requisite degree of credibility. But other issues are involved: some states are fearful of technology that is too capable and will want to restrict it. This was a difficulty in the Open Skies regime, to the point where the sensor technology being allowed for use by the treaty parties is now quaintly old-hat. In other cases technology needs to be limited to prevent proliferation-relevant information being disseminated: hence the use of blinded instrumentation. Another difficulty is that verification technology can be so specialised that it must be researched and developed by verification bodies themselves: no commercial company will invest in research for such a limited market and potentially low profit. This can be a heavy burden on verification organisations, although one can imagine creative partnerships with universities and less commercially-driven organisations.

The good news on technology is that off-the-shelf technology can be readily used for a variety of verification roles and its price often drops rapidly once it begins to permeate the commercial market. Both the hardware and software of computers have dramatically demonstrated this trend. In the past, however, the adoption of emerging technology by verification regimes has been prevented not so much by technology factors themselves, or even by cost factors, but by political resistance and bureaucratic inertia. Both of these must be avoided in the case of the FMT, as it is so vital to international security.

As a verification technique, on-site inspections have come a long way in recent decades. The confidence-building measures pioneered by the Organisation for Security and Cooperation in Europe (OSCE), the CFE on-site inspections and those for the US/Soviet bilateral treaties were the forerunners of today's modern inspections, demonstrated no better than in Iraq in the past few months. There are now bodies of professional on-site inspectors, detailed protocols, procedures and technologies for on-site inspections and a useful corpus of experience about how to make them effective. This includes 'managed access' techniques, the use of remote monitoring to supplement on-site inspections, environmental sampling and procedures for handling commercially and militarily sensitive information. The FMT will want to draw on all of these. The difficulties that the CTBTO is facing in reaching agreement on its on-site inspection manual indicate, however, the sensitivities surrounding on-site inspections and the need for an educative process about them.

Use of information

One of the most pleasing verification developments in recent years has been the realisation that multilateral verification organisations can and should use the vast array of open source material to their advantage. Clearly this needs careful and discriminate handling lest such organisations be overwhelmed by a tidal wave of information, as indeed some national intelligence agencies would their advantage. Clearly this needs careful and discriminate handling lest such organisations be overwhelmed by a tidal wave of information, as indeed some national intelligence agencies would appear to be. The IAEA is leading the way in this respect and is to be highly commended. The use of commercial satellite imagery and exploitation of the internet are the most obvious of the new information tools available. Clearly this has great relevance to future verification of an FMT.

Similarly, the use of information provided by states from their national technical means is a significant development. The experience of UNMOVIC is however a salutary lesson. The intelligence information provided to UNMOVIC and the IAEA was late in coming, much of it was of dubious character and when it proved to be unverifiable there was no acknowledgement by the providing state that it might have been mistaken and the international body correct. This can bring international bodies into disrepute through no fault of their own. While one has some sympathy with the difficulties in obtaining credible information from closed, autocratic regimes, and the need to protect sources, especially human ones, the UNMOVIC experience should not be the model for the standing verification bodies and indeed would do them great harm.

Determination of compliance

One of the least developed aspects of verification regimes is often the compliance aspects. While great attention is paid to what information to be collected and how it is to be collected, collated and analysed, there is often a reluctance to be clear about how a determination of non-compliance is to be made. Even IAEA safeguards have not been immune from this: the confusion surrounding special inspections has long been a factor in at least popular scepticism about the effectiveness of verification in respect of the Nuclear Non-Proliferation Treaty. The Landmine Ban Treaty or Ottawa Convention is probably the most extreme example of a treaty where the parties do not want to face up to the challenge of non-compliance, even though some states have already been named as being in violation of their commitments.

Stakeholders_building the international verification community

Finally, it seems to me that one of the critical lessons that can be drawn from the experience of multilateral verification over recent years has been the necessity for sustaining political support and relevancy. In this respect the multilateral organisations need to do better at promoting their contribution to international peace and security. This includes among governments themselves. Some governments, for example, when pressed to sign Additional Protocols to their nuclear safeguards agreements actually ask for technical and/or economic benefits in return, when clearly the real benefit derives from the enhancement of their national security. But the multilateral organisations also need to cultivate stakeholders elsewhere_including in civil society, among NGOs, the general public, the media, the philanthropic foundation world and, even in business. Unless they do this they will forever be dependent on the kindness of governments and the limited attention span they often display, and verification will always be seen as arcane and marginal.

International Atomic Energy Agency

Seminar

Promoting Verification in Multilateral Arms Control Treaties

Presentation on

IAEA SAFEGUARDS

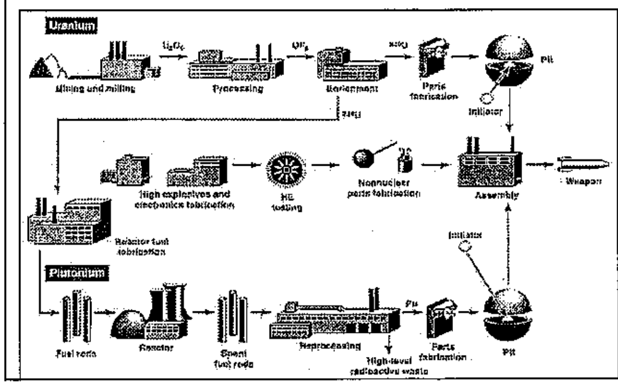
Tariq Rauf
Head, Verification and Security Policy Coordination
Office of External Relations and Policy Coordination

Note

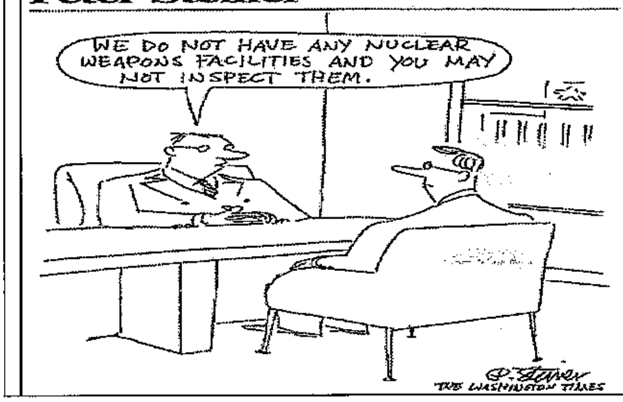
The views expressed in this presentation, and during this meeting are made on a *personal* basis.

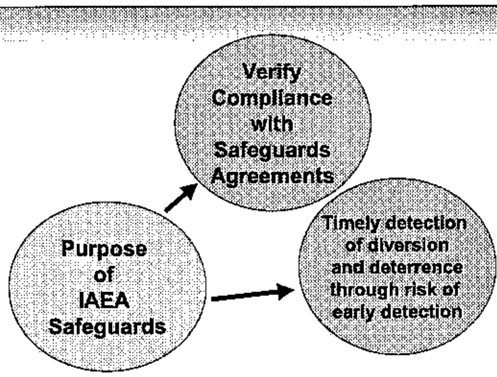
International Atomic Energy Agency

Nuclear Weapon Production Cycle



Peter Steiner





International Atomic Energy Agency

General Working Hypothesis 1

There is no imaginable form of direct verification that States' nuclear material declarations are complete that is do-able and affordable.

International Atomic Energy Agency

General Working Hypotheses

- Non compliance cannot be excluded
- Low but non-zero probability that a diversion can take place

International Atomic Energy Agency

Special Fissionable Material

Enriched Uranium (Z=92) $^{233, 235}U$	Plutonium (Z=94) ^{239}Pu

International Atomic Energy Agency

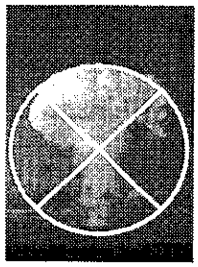
Source Material

Depleted Uranium

Natural Uranium

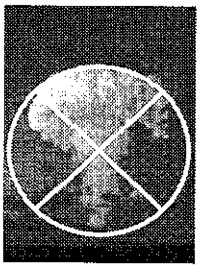
Thorium

Significant Quantity



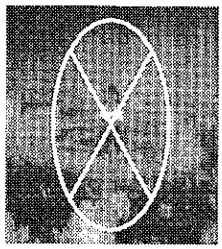
Approximate quantity of nuclear material in respect of which the possibility of manufacturing a nuclear explosive device cannot be excluded

Significant Quantity



Pu, ^{233}U	8 kg
U with $^{235}U \geq 20\%$ (HEU)	25 kg ^{235}U
U with $^{235}U < 20\%$ (LEU)	75 kg ^{235}U
NU ($^{235}U \approx 0.72\%$)	10 t
Th, DU	20 t

Detection/Conversion Time



Un-irradiated Direct-use Material	1 month
Irradiated Direct-use Material	3 months
Indirect-use Material	12 months

This generally indicates the time required for detection and conversion of nuclear material to an explosive device – it also determines the frequency of inspections

Nuclear Material Verification

The basic verification method used by the IAEA is
nuclear material accountancy
with
containment and surveillance
as important complementary measures

Nuclear Material Verification

IAEA inspectors have to make **independent measurements** to verify **declared** material quantities

Materials Measured

- Uranium and Plutonium in:
  - feed materials
  - fresh fuel
  - spent fuel

NDA = Non Destructive Assay

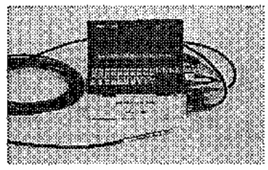
Measuring quantity or specific attribute(s) of nuclear material *without physically affecting the measured item*

Properties Measured

Gamma and X-rays

Neutrons

Mini MCA* with CdZnTe Detector (MMCC)



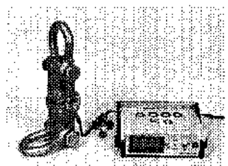
Materials: **U, Pu, MOX, fresh & spent fuel**

Detectors: **NaI, CdZnTe (shown), HPGe, ^{3}He (n)**

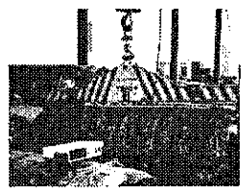
* multi-channel analyzer

Inspectors verifying fresh fuel at a Power Reactor

Load-Cell Based Weighing System (LCBS)



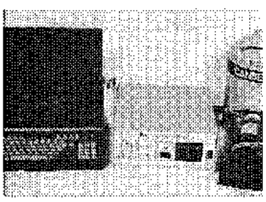
Purpose: **UF_6 mass in cylinders**



Material: **Uranium**

Technique: **Weight**

Medium Count Rate System (MCRS)



Measures plutonium isotopic composition; requires high-resolution Ge detector

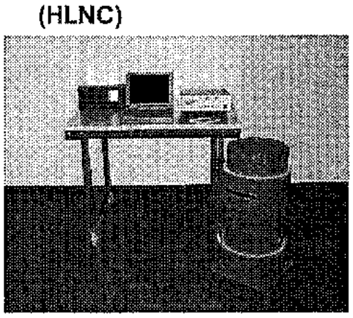
FieldSPEC

The FieldSPEC is a new, hand-held, digital gamma spectrometer with software developed for the Agency. It is geared to detect un-declared nuclear material and activities in nuclear facilities

High Level Neutron Coincidence Counter (HLNC)

Material: **Plutonium, measures $^{240}Pu_{eff}$ mass**

Detector: **^{3}He tubes in polyethylene, coincidence electronics**

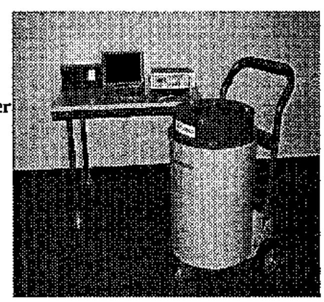


Active Well Coincidence Counter (AWCC)

Material: **^{235}U in UO_2 powder and HEU metal**

Technique: **Active neutron coincidence counting**

Detector: **^{3}He tubes in polyethylene, coincidence electronics**



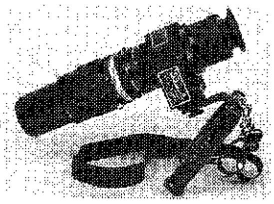
Cerenkov Viewing Device (ICVD)

Material: Spent Fuel

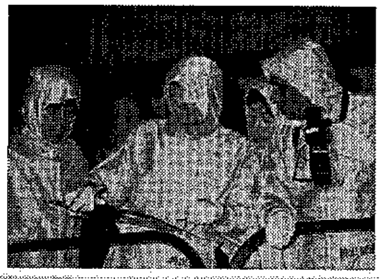
Technique: Observe Cerenkov glow

Detector: Enhanced night vision device. UV filter allows operation with lights on

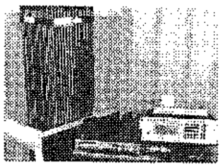
Purpose: Attribute verification of spent LWR assemblies



Inspectors Verifying Spent Fuel at a Power Reactor

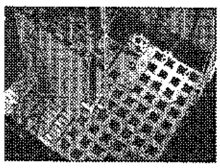


GRAND and Fork Detector



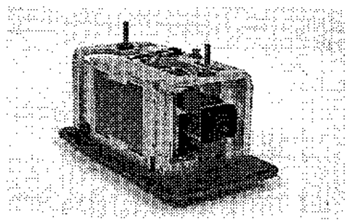
Material: Spent Fuel

Technique: Simultaneous neutron and γ-ray measurements



Purpose: Attribute verification of spent LWR assemblies. Combined with reactor codes it can verify burnup declaration.

All In One Surveillance System (ALIS)

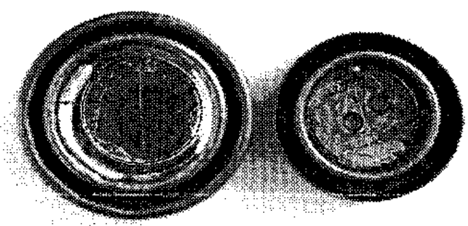


C/S Devices : Sealing Systems

Metallic Seals (CAPS)
- Type-E
- Type-X

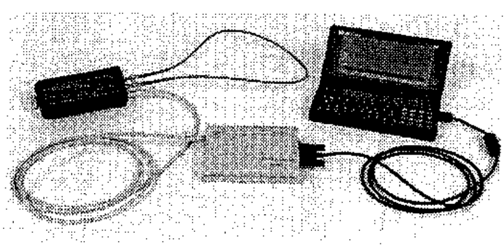
Advanced Seals
- Fibre-optic (COBRA) (FBOS)
- Fibre-optic (VACOSS) (VCOS)
- Ultrasonic (ARC) (ULCS)

Type-E Seal



Seals Verification

VACOSS-S Sealing System



Limitations of Traditional Safeguards

- Focus was on *declared* materials
- Routine inspections limited to agreed points and not continuous
- Assumed a State declared everything
- Did not take into account that the State might under-declare its initial inventory
- Did not provide assurances that the State was not building secret facilities

Fundamental Premise of Additional Protocol

- An audit function intended to indirectly assure that a State's nuclear material declarations are complete

Additional Protocol Activities

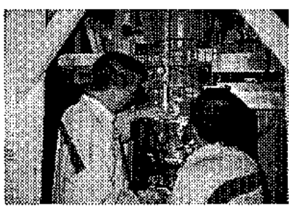
- Information from Mines to Waste
- Analysis of
  - States' declarations
  - Open sources (incl. satellite images)
- Complementary Access
  - Visual observations
  - Environmental samples
  - Radiation detection equipment
  - Examination of records

Environmental Sampling What can we identify?

- Enrichment Activities
  - Verify the product produced and operations
  - Identify multiple feed material
  - Change in operations
  - Start up of new cascades
- Hot Cell Activities
  - Post-irradiation examinations, irradiation history
  - ^{99}Mo production and associated uranium targets
  - Pu separation
  - Undeclared materials, irradiation
  - Pu, spent fuel age calculations possible

Traditional, Strengthened and Integrated Safeguards Techniques and Technology

Environmental Sampling



<u>Swipe Sampling:</u>

In 2001,

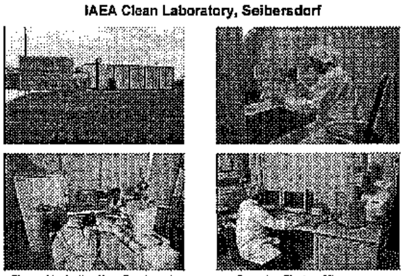
- 191 swipe samples taken at 12 enrichment plant, in 6 States
- 62 swipe samples taken at other nuclear facilities, usually with hot cells
- 72 swipe samples taken during complementary access, in 11 States
- Analytical Laboratories in 4 Member States and within EURATOM

Traditional, Strengthened and Integrated Safeguards Techniques and Technology

Swipe Sampling Kit

Traditional, Strengthened and Integrated Safeguards Techniques and Technology

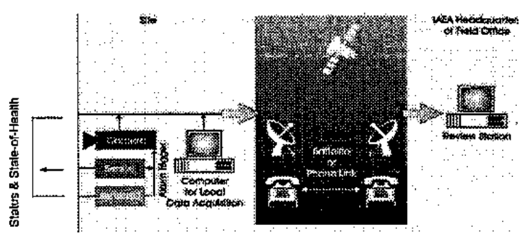
IAEA Clean Laboratory, Seibersdorf

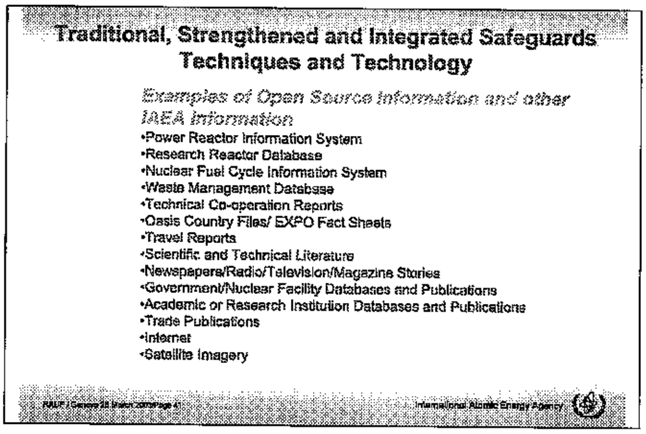


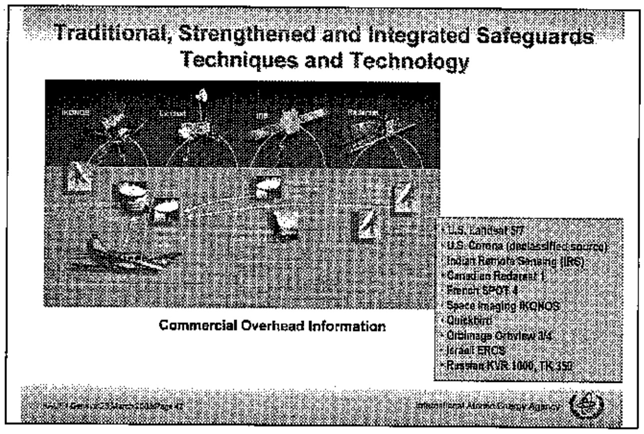
Thermal Ionization Mass Spectrometry

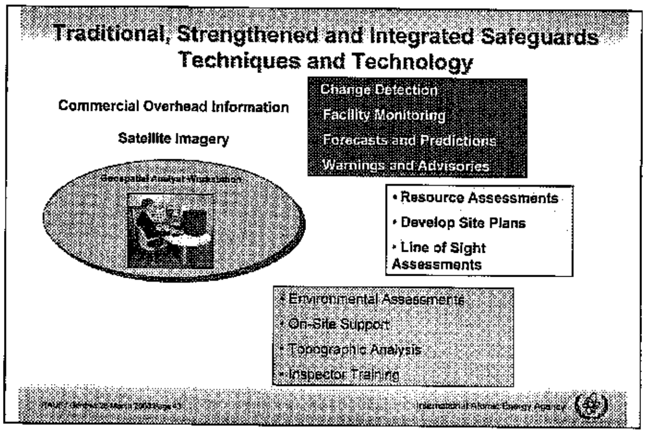
Scanning Electron Microscopy

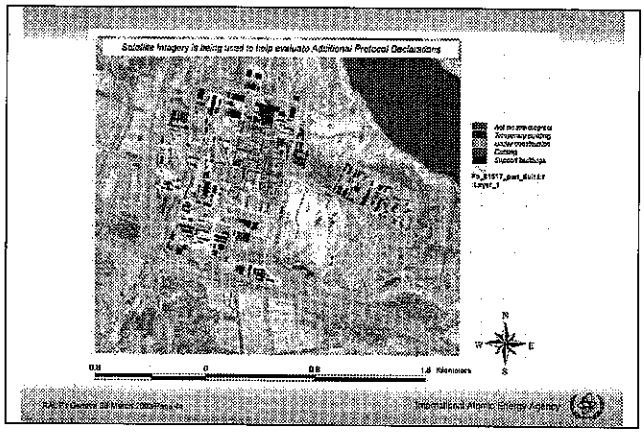
Remote Monitoring

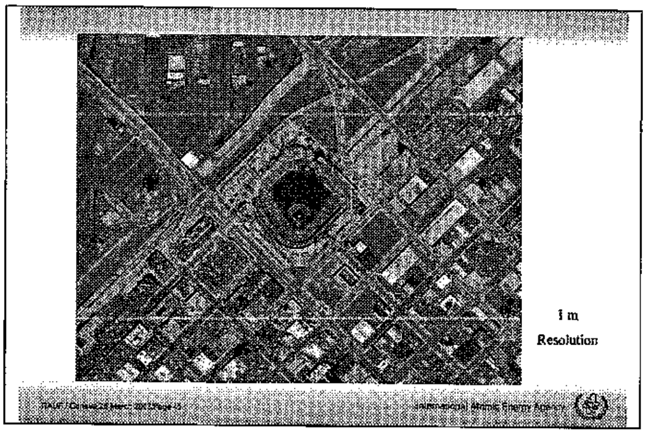


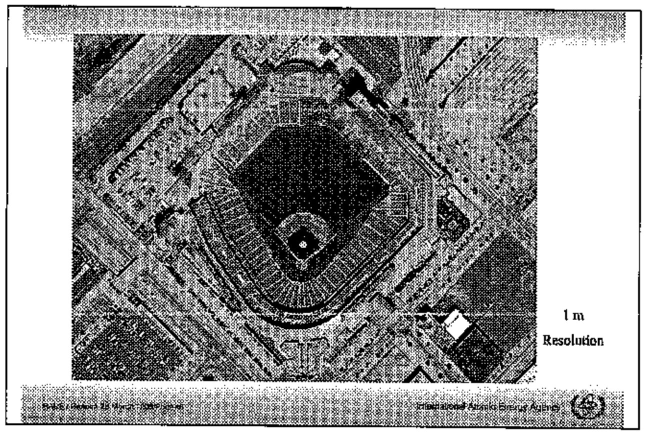

Traditional, Strengthened and Integrated Safeguards Techniques and Technology
Examples of Open Source Information and other IAEA Information
•Power Reactor Information System
•Research Reactor Database
•Nuclear Fuel Cycle Information System
•Waste Management Database
•Technical Co-operation Reports
•Oasis Country Files/ EXPO Fact Sheets
•Travel Reports
•Scientific and Technical Literature
•Newspapers/Radio/Television/Magazine Stories
•Government/Nuclear Facility Databases and Publications
•Academic or Research Institution Databases and Publications
•Trade Publications
•Internet
•Satellite Imagery
International Atomic Energy Agency

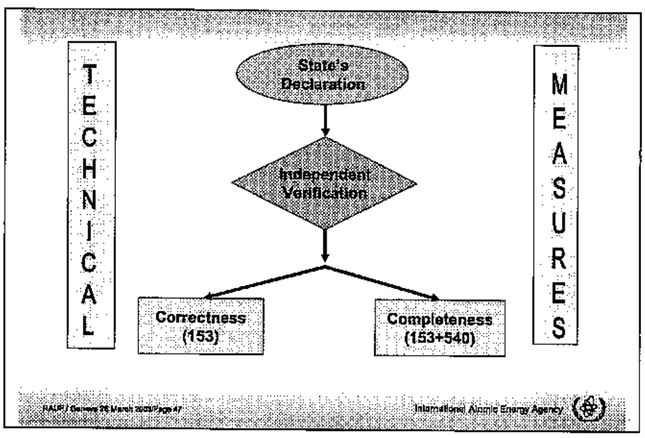

Traditional, Strengthened and Integrated Safeguards Techniques and Technology
Commercial Overhead Information
• U.S. Landsat 5/7
• U.S. Corona (declassified source)
• Indian Remote Sensing (IRS)
• Canadian Radarsat 1
• French SPOT 4
• Space Imaging IKONOS
• Quickbird
• Orbimage Orbview 3/4
• Israeli EROS
• Russian KVR 1000, TK 350
International Atomic Energy Agency

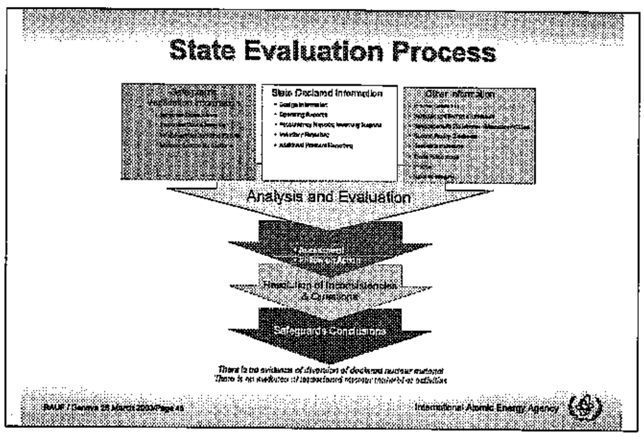

Traditional, Strengthened and Integrated Safeguards Techniques and Technology
Commercial Overhead Information
Satellite Imagery
Change Detection
Facility Monitoring
Forecasts and Predictions
Warnings and Advisories
Geospatial Analyst Workstation
• Resource Assessments
• Develop Site Plans
• Line of Sight Assessments
• Environmental Assessments
• On-Site Support
• Topographic Analysis
• Inspector Training
International Atomic Energy Agency


Satellite imagery is being used to help evaluate Additional Protocol Declarations
International Atomic Energy Agency


1 m
Resolution
International Atomic Energy Agency


1 m
Resolution
International Atomic Energy Agency


TECHNICAL
MEASURES
State's Declaration
Independent Verification
Correctness (153)
Completeness (153+540)
International Atomic Energy Agency


State Evaluation Process
State Declared Information
Other Information
Analysis and Evaluation
Resolution of Inconsistencies & Questions
Safeguards Conclusions
Geneva 28 March 2003/Page 48
International Atomic Energy Agency

IAEA Safeguards Elements

INFCIRC/153

- Precise declarations on nuclear material and facilities
- Inspections of nuclear material and verification of design information
- Quantitative verification

Conclusion on the non-diversion of nuclear material from declared activities

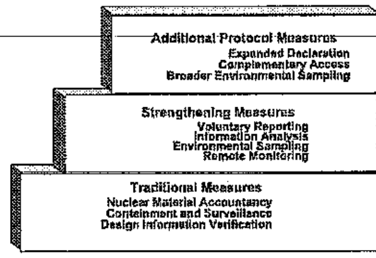
INFCIRC/540

- Descriptive declarations on other relevant materials and activities
- Complementary access to relevant locations
- Qualitative evaluation

Conclusion on the absence of undeclared nuclear material and activities in a State

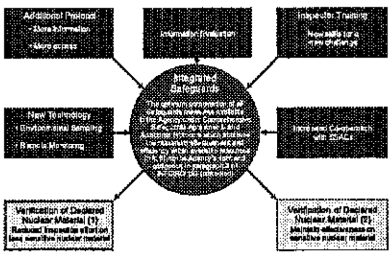
International Atomic Energy Agency

Measures from the Additional Protocol



International Atomic Energy Agency

Integrated Safeguards



To reduce inspection effort on less sensitive nuclear material, the Agency should first draw positive conclusions on the non-diversion of declared nuclear material and on the absence of undeclared nuclear material and activities in the State as a whole.

International Atomic Energy Agency

Protection of Confidential Information

Safeguards Confidential Information

4 Main categories

27 Sub-categories

- Safeguards Confidential
- Highly Confidential
- Confidential
- Restricted

International Atomic Energy Agency

Protection of Confidential Information

Information Security Measures

- Electronic security
- Physical security
- Managerial & Training

International Atomic Energy Agency

Note

The views expressed in this presentation, and during this meeting are made on a *personal* basis.

International Atomic Energy Agency

CHEMICAL WEAPONS CONVENTION

H. Reeps
Director of Verification

ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

CHEMICAL WEAPONS CONVENTION

- Disarmament
- Non-proliferation
- Assistance and Protection against CW
- Economic and Technological Development

2

CWC - VERIFICATION REGIME
DISARMAMENT AND NON-PROLIFERATION

- Declarations
- Inspections
  - Routine Inspections
    - CW Inspections (CWDF, CWSF, CWPF, O/ACW)
    - Industry Inspections (S1, S2, S3, OCPF)
  - Challenge Inspections

CWC - VERIFICATION

- Implementation of the CWC - General
  - Pragmatic approach
  - Preserve credibility and transparency of the verification regime
  - Equal treatment of all Member States
  - Close co-operation with Member States
  - Sound budget
  - Excellent personnel - "capital" = human resources
  - Review of approaches to verification on a regular basis to increase efficiency and cost-effectiveness

4

CWC - VERIFICATION

- Implementation of the CWC - Some specifics
  - Correct and complete declarations (assistance projects, national legislation)
  - Routine inspections (mechanism of uncertainties, regular training of inspectors)
  - No challenge inspections as of today
  - Protection of confidential information (CWC Confidentiality Annex - stringent regime, Confidential Business Information)

5

CWC - VERIFICATION
STATUS SUMMARY

- Successful implementation of CWC mandate
- Successful verification regime

Current challenges

- Changes/ adjustments are required
  - Lessons learnt (First Review Conference)
  - Increasing workload in upcoming years
  - Budgetary constraints
  - Tenure

6

Promoting Verification in Multilateral Arms Control Treaties

Generic lessons from the CTBT

Ola Dahlman

The views I present here today are my own. I do not speak for the Working Group on Verification of the Preparatory Commission of the Test Ban Treaty nor do I speak for any Swedish authority.

I think our hosts today have put a most relevant question when they ask what lessons we can learn from verification regimes of existing arms control and disarmament treaties and how those lessons can be instructive for future agreements. This is a question that so far has not been asked very often. A reason for that might be that the turn over of people in this building is considerably faster than the turn out of new treaties. I think we do have a lot to learn from past experience. A lot to learn when it comes to the generic structure of the verification arrangements for new treaties. A lot to learn also when it comes to the processes of developing, negotiating and implementing verification measures. I therefore hope that this event today will be not only an interesting single event in its own right but a starting point of a new process that might vitalize our consideration of new treaties.

I will address the lessons learned from technical work here in the CD that lead up to the verification system of the Nuclear Test Ban Treaty and the lessons we have learned during the implementation of the verification system over the last 6 years within the frame of the Preparatory Commission of the Treaty. As some of you may not be familiar with the verification regime of the Test Ban Treaty I will give a brief summary. A recent article summarizing the verification system and the progress in its implementation is available in the room.

The regime consists of two parts a global monitoring system and an on-site inspection regime. The international monitoring system is in a generic sense an information collection, storage and redistribution system with very high information capability and with a global reach. The purpose of the system is to provide each State Party with information that no single country can collect on its own. The information is easily accessable and preanalyzed to facilitate its use by States Signatories. The interpretation of the information rests with the States Signatories.

The global monitoring system is unprecedented in reach and consists of a globally linked network of 321 monitoring stations located in more than 90 countries. The stations are of different kinds. 50 primary and 120 auxillary seismological stations are designed to record acoustic signals propagating through the earth's interior. 11 stations are designed to record acoustic signals that propagate through the oceans. Such hydroacoustic stations have their sensors either deep in the oceans or at small islands. 60 so-called infrasound stations record acoustic low frequency signals propagating through the atmosphere. The Global monitoring system also contains 80 radionuclide stations that will measure radioactive particles as well as radioactive noble gases.

All stations are connected on-line, using a satellite communication system to an international data center located in Vienna. The center is receiving and storing all information in a huge data base of 125 terabytes (125 plus12 zeros) from which it is made available to States Signatories. It also conducts routine analysis of the data to facilitate the final interpretation by the States Signatories.

The On-site inspection regime provides for inspections to clarify events that States may find suspicious. Inspections have to be requested by a State Signatory and be approved by the Executive

Council. An on-site inspection can cover an area of up to 1000 square kilometers and use clearly defined technical inspection tools.

The negotiations on the CTBT would have been more arduous and the work in the Preparatory Commission in Vienna would not have advanced anywhere near as far as it has without the technical work that took place in advance, right here in the Conference on Disarmament. The CD established a Group of Scientific Experts, usually referred to as the GSE, that worked from 1978 until 1996. I had the pleasure of chairing the group for 13 years. GSE is an example of technical work on verification that went on for many years without political negotiations or even agreement to contemplate such negotiations. The progress of the GSE was related to the general political atmosphere of the cold war and was at times slow – but work went on steadily. The GSE served to encourage and coordinate national research and development efforts. Experts from many States participated and GSE was to a great extent an educational undertaking that produced new knowledge shared among experts from around the world.

Most important, the GSE also produced the principal design of the CTBT verification system. For political reasons the work of the Group was limited to seismological monitoring. A large number of seismological stations were installed around the world during the years of the GSE, many of which today are part of the International Monitoring System for the Treaty.

GSE also established a prototype International Data Centre. This centre provided for the development and testing of the data handling and analysis tools, being used today, and made it possible to test and evaluate the seismological system. The three large scale tests conducted by the GSE gave States a good understanding of how such a system would operate and what capabilities could be expected. This knowledge and the fact that it was shared among experts from basically all states that became deeply engaged in the CTBT negotiations greatly facilitated the negotiations. It became a solid basis on which the global verification system could be designed in a short time and in a way that was possible to implement.

The implementation of the CTBT verification system has now been going on for more than six years within the frame of the CTBTO Preparatory Commission. The work on the Global Verification System is progressing well, given the political situation that EIF is still in an unpredictable future. The Provisional Technical Secretariat, that is responsible for the build up and testing of the verification regime, is now a mature organization with a staff of about 280 people from around the world and a yearly budget of $88 million. It is estimated that overall 60 % of the total investments in the global station network, expected to be $275 million now have been made.

The build up of the system has progressed with different speed for the different technologies. We can expect that the primary seismic system, with the exception of a few stations, will be operational late next year and so will the hydro acoustic system. The infrasound system and the system to collect radionuclide particle will require a few more years before enough stations are in place to form an operational network. The stations to monitor radioactive noble gases will need a longer time to be fully implemented as these stations still are in an experimental mode only.

This difference in the development and installation of the various systems clearly reflects the degree of preparation prior to signature of the treaty and the amount of knowledge available in the scientific community. As I mentioned earlier the seismic system was to a large extent implemented and tested during the work of the GSE and many stations were established already in those early days. More importantly the knowledge of how to build such stations and to analyse the data is wellknown and a large number of qualified experts are available from all around the world. This is in strong contrast to the infrasound system were efforts are still underway to basically create that science and to understand what is actualy being observed.

The International Data Centre of the PTS was established swiftly, building on the experience and the software from the GSE prototype centre in Washington. The Data Center is now up and running and is receiving, storing and distributing large volumes of data. For a number of years it has already analyzed, in an almost routine way, data from the seismological stations and regularly published the results. The analysis tools for the non-seismic data are still not operational. This is yet another illustration of how the implementation is depending on the preparatory work carried out many years ago.

The internationally shared knowledge on on-site inspections in relation to test ban verification was essentially nonexistent prior to the negotiations. In the implementation we now see the difficulties of interpreting the treaty text and developing it into an operational manual. This process is going very slowly, it is politically sensitive and I have a feeling that States Signatories are re-inventing many proceedures that already exist in other treaties. One State has also choosen not to take part in any discussion of on-site inspection issues. On the more practical side, the PTS is developing training programs for inspectors and is also developing and testing methods and instruments to be used in an on-site inspection. Last autumn a successful large-scale field test was conducted in Kazakstan at the former nuclear test site in Semipalatinsk.

So what are the generic lessons to be learned from the CTBT verification regime, from the work to develop and negotiate it and from its implementation?

The CTBT has shown that it is possible to establish and operate a high-tech monitoring system with global reach operating on-line. It might be interesting and valuable to analyse in more detail the generic structures of this system and information systems of other existing treaties and consider how such a structure could be adapted to facilitate the verification of other international treaties such as the FMCT.

The present work within the CTBT Prepcom on the implementation of the on-site inspection regime has been cumbersome. It would be most valuable to make an in-depth analysis of existing OSI regimes. The purpose would be to find a better general understanding of the use of OSI for different purposes and to identify a number of rules and proceedures that could be used for possible new regimes.

To me the most important lesson learned relates to the process of working with CTBT verification issues over many tens of years. It proved possible and most useful to conduct sustained technical work within at the CD on the global verification system prior to the actual negotiations. This work greatly facilitated the negotiations and may be to an even greater extent the implementation of the verification system. Such preparatory technical efforts are not a substitute for political negotiations or in any way competing with such negotiations. They might be confidence building, but their prime purpose is to provide internationally shared knowledge and to develop and test methods and technical facilities that will facilitate the negotiations and the subsequent implementation of a verification regime. Such technical work takes a long time and as it can be conducted without political commitments I think it would be a useful step to initiate such work on issues such as the FMCT.

Verification of the FMCT

Geoffrey Shaw
Deputy Permanent Representative of Australia
to the Conference on Disarmament

FMCT

- Cap fissile material for nuclear weapons
  - proscribe the production of fissile material for nuclear weapons and other nuclear explosive devices
- Provide credible assurances of treaty compliance
- Must have an effective and affordable verification system

Issues

- NPT Non Nuclear Weapon States (NNWS) already have commitments not to produce fissile material for nuclear weapons purposes
- NNWS with comprehensive safeguards and an Additional Protocol in force likely to meet FMCT verification requirements
- Impact primarily on NPT Nuclear Weapon States (NWS) and the Nuclear Capable States (NCS)
- National security sensitivities

Comprehensive Approach

- Comprehensive :
  - verification of a State's entire nuclear fuel cycle
  - expanded coverage of NWS and NCS facilities
  - even handed
- But :
  - comprehensive safeguards cannot apply in states retaining nuclear material outside safeguards
  - divert inspection resources from tracking most proliferation sensitive material and facilities
  - expensive
  - cost effectiveness

Focused Approach

- Concentrate on the most proliferation sensitive materials and facilities
- Unirradiated direct use nuclear material produced after EIF :
  - . Plutonium
  - . Highly Enriched Uranium
  - . U-233
- Facilities } regardless of operational status
  - production . enrichment
    . reprocessing
  - conversion, fabrication and storage

How might verification work

- Declarations by Parties of subject facilities and fissile material production after EIF
- Supported by effective measures to
  - verify declared production
  - counter undeclared production
    . information analysis
    . access and inspections

Conclusion

- The FMCT will require use of the most effective and cost-efficient combination of available verification means
- Must :
  - detect possible undeclared production of fissile material after EIF; and
  - give assurance of the absence of undeclared fissile material production.

Technologies for detection of clandestine nuclear activities - Noble gases as an example

Anders Ringbom
Swedish Defence Research Agency (FOI)
SE-172 90 Stockholm, Sweden
E-mail: Anders.Ringbom@foi.se

1. Introduction

An important part of a future verification regime for a Fissile Material Cut-Off Treaty (FMCT) will deal with the problem of disclosing clandestine production of high-enriched uranium (HEU) or weapons-grade plutonium (WgPu). In principle this comprises the detection of all elements in the nuclear fuel cycle. For uranium this includes mining, milling, conversion to UF6, enrichment, conversion to metal, and for plutonium also fuel fabrication, moderator production, reactor operation and fuel reprocessing. The discussion is, however, usually focussed on uranium enrichment plants and reprocessing plants used for plutonium production [1].

It is a common opinion that an FMCT verification regime should heavily depend on the existing IAEA extended safeguard system, but that more technologies and methods still need to be incorporated in the existing regime. Analysis of information from specific states as well as from open sources would be a crucial part of such a system. It will be very difficult to design a system able to monitor the entire world for covert nuclear activities. Instead, the system has to be information driven, triggering technological activities at specific areas. Examples of technologies discussed in this context are satellite imagery (visible spectrum, infrared, and microwave) as well as environmental sampling in water, soil, vegetation and air. Many of these technologies are already being developed within the extended safeguard program [2], and will not be discussed in detail here.

Several of the suggested technologies deal with the problem of wide area environmental sampling (WAES), a technique based on detecting a signal (anomaly) superimposed on a natural background at some distance (maximum range a few kilometres up to several thousand kilometres from the point of release). The concept of WAES is of course already incorporated in several international efforts, such as the international monitoring system (IMS) for CTBT surveillance, the extended IAEA safeguard system, and also for detection of covert weapons material production in Iraq [2].

Compared to for instance the CTBT verification system, the anomaly searched for in an FMCT verification system is much more diverse, and hence a more multiform verification system will be needed. Also, the background contribution, originating from existing declared facilities as well as the natural environment, imposes special problems. But, as described in this paper, some techniques developed for CTBT verification purposes could have implications also for a future FMCT.

2. Air sampling in general

Perhaps the most promising environmental signatures from undeclared enrichment or reprocessing concern airborne releases. The main reason is that gases and aerosols are more difficult to contain inside a facility compared to for instance substances contained in water.
Uranium enrichment will result in releases of uranium in the form of UF6 (gas centrifuge or gaseous diffusion plants) or UCl4 (electromagnetic isotope separation or EMIS). Both compounds can easily attach to aerosols. The amount released will be very dependent on the type of operation

and skill of the operators, but generally centrifuge plants are considered clean, while the largest releases are to be expected from EMIS plants. There are estimates that an EMIS plant could be detected from a distance of more than 100 kilometres, while the corresponding number for a gas centrifuge plant is about 10 kilometres [3].

The detection of uranium enrichment is performed by investigating isotopic ratios of various uranium isotopes, in particular looking for deviations of the normal 235:238 ratio of 0.72%. This can be achieved by conducting air sampling on filters, and perform either bulk analysis on the filter, or isolating individual particles for further analysis using various mass-spectrometric techniques. The detection of uranium is complicated by the fact that uranium is a naturally occurring element. For instance, the filters used in air sampling all contain uranium, making the bulk analysis difficult. The most promising way is probably analysis of individual particles, like is done today on swipe samples taken at the site [2].

Since reprocessing involves the handling of irradiated fuel elements, it is likely that various fission products will be released. The expected emissions include 137Cs, 129I as well as noble gases like xenon and krypton. In particular 85Kr seems to be a promising signature for plutonium production, and will here be considered in more detail.

3. The specific problem of noble gases

Noble gases (here only xenon and krypton are discussed) are produced in large amounts during fission of uranium and plutonium. Noble gases are therefore produced in nuclear reactors as well as in nuclear explosions. What make noble gases particularly interesting in verification contexts are their volatile properties that make them difficult to contain. This is one important reason for using noble gases in the International Monitoring System (IMS) for CTBT. Another reason is that radioactive noble gases are not produced by any other mechanism than fission, yielding relatively clean background conditions.

In the absence of nuclear tests, the presence of radioactive xenon is a very good indicator of reactor operation. This is seen in data collected in reactor-rich regions like Europe, Japan and North America. A typical average atmospheric concentration in these regions is about 1 mBq/m3 for 133Xe.

When detection of reprocessing is considered, krypton is more relevant. This is due to the fact that the irradiated fuel elements usually are cooled down for more than six months before opened, and by then all xenon isotopes have decayed (the most long-lived xenon isotope, 131mXe, has a half-life of 11.9 days), and only 85Kr, with a half-life of 10.7 years, still remains inside the fuel cladding. When the fuel is opened, large amounts of krypton is released, and since it is relatively difficult to contain, a pulse is expected in the atmosphere surrounding the plant. Designing a facility able to contain all krypton emissions is a complicated endeavour, illustrated by the fact that not even the most modern reprocessing facilities today are equipped with such systems .

One major complication one encounters when using krypton as a tracer for reprocessing is the large background that has been accumulating in the atmosphere since the early days of reprocessing in the 1950's. In the northern hemisphere an atmospheric concentration of 1 Bq/m3 is observed, which is a thousand times higher compared to the normal xenon background from reactor operation.

One estimate [4] of the source term shows that more than 170 TBq of 85Kr is released in the production of one significant quantity (8 kg) of plutonium. Assuming a release time of five hours gives an emission rate of 35 TBq/h. This would result in an increase of the background of 0.8 Bq/m3 100 km away from the plant, and indeed the usefulness of krypton detection has been demonstrated by experiments conducted in Germany [4], showing that pulsed discharges of krypton can be detected at distances of more than hundred kilometres.

4. Methodology for noble gas sampling in FMCT

Recently, a new generation of noble gas samplers has been developed for CTBT verification purposes, and they are right now being tested under field conditions [5]. Systems have been developed in Sweden [6], USA [7], Russia [5], and France [5]. The new equipment is more sensitive, and produces data with higher time resolution compared to previous systems. Furthermore, the systems are all automatic, requiring only a minimum of operator attendance. The systems are so far dedicated xenon samplers, and none of the systems measure krypton in their present version.

Another, perhaps even more relevant development for FMCT, is the modification of some of the systems right now being performed with the intention to be used as equipment for On-Site Inspection (OSI) under CTBT [8]. This work will produce small, mobile, automatic noble-gas sampling units that with some modifications also could be used for krypton sampling.

Noble gas samplers are all based on collection in activated charcoal columns. The main difference between xenon and krypton sampling is that krypton is more difficult to contain in charcoal compared to xenon. While some xenon systems can be operated in ambient temperature, krypton collection will require cooling. Another difficulty is the decay mode of krypton (pure beta decay), which puts other more severe demands on the detection system used for activity determination.

Due to the large background caused by decades of reprocessing, a network of krypton sampling stations would require thousands of stations around the earth. The cost-benefit factor for such a system would perhaps not be very favourable, and instead a system consisting of mobile units is advisable. A possible system for krypton sampling and detection could consist of small mobile units of field samplers in combination with a field processing and detection system capable of measuring several samples per day. The units could be moved to locations suggested from information analysis. The use of such a system raises questions concerning for instance field laboratories and sample transport. Another topic for discussion is the need for a database containing global background data.

5. Conclusions

A large part of the verification techniques necessary for a future FMCT already exists within the IAEA extended safeguard system. There is however still room for development. One example is the experience gained from the development of CTBT verification techniques. In particular the recent development of automatic and sensitive noble gas sampling systems could be useful, if further developed into mobile versions with the capability to detect 85Kr.

[1] The Sellafield plant released 24 000 TBq of ^{85}Kr during 2001, according to *"Discharges and monitoring of the environment in the UK, 2001"*, published by BNFL.

References

[1] *"Workshop on FMCT Verification – Detection of Clandestine Activities"*, Krägga, Sweden, June 21-22, 1999. Ed: G. Arbman and M. Eiborn.

[2] David L. Donohue. *"Key tools for Nuclear Inspections- Advances in Environmental Sampling Strengthen Safeguards"*, IAEA Bulletin 44/2/2002 (December 2002).

[3] K. W. Nicholson, *"Detection of undeclared enrichment facilities by environmental sampling"*, in *"Workshop on FMCT Verification – Detection of Clandestine Activities"*, Krägga, Sweden, June 21-22, 1999. Ed: G. Arbman and M. Eiborn.

[4] M. B. Kalinowski, *"Measurements and modelling of atmospheric krytpon-85 as indicator for plutonium separation"*, INESAP Information Bulletin, 13, July 1997.

[5] M. Auer et al., *"The international programme to test and evaluate CTBT/IMS Noble Gas Equipment", "Third international meeting on low-level air radioactivity monitoring"*, 25-29 September 2000, Dabrowo near Nidzica, Poland.

[6] A. Ringbom et al. *"SAUNA - a system for automatic sampling, processing, and analysis of radioactive xenon"*, accepted for publication in Nuclear Instruments and Methods for Physics Research.

[7] P.L. Reeder, T.W. Bowyer, and R.W. Perkins. J. Radioanal. Chem. 235, 89, (1998).

[8] A. Ringbom, contribution in *"On-Site Inspection Workshop 8: Procedures, equipment and field data analysis"*, Austria Vienna, 24 – 28 June 2002.

Annex

Technologies for detection of clandestine nuclear activities

- Noble gases as an example

Anders.Ringbom@foi.se

- Some introductory remarks
- Short overview of techniques
- Noble gases as a verification tool
- Examples of equipment
- Conclusions

FOI

Worksop on FMCT verification - detection of clandestine activities, Krägga, Sweden, June 21-22, 1999

- Information analysis
- Satellite imagery
- Detection of clandestine enrichment
- Detection of clandestine reprocessing

FOI

General remarks

- Use existing (extended) safeguard system
- Avoid "proliferation of verification regimes"
- Information driven system
- Develop certain technology areas
- Use the experience gained within other regimes
  - **NPT**: Environmental sampling for safeguard
  - **CTBT**: Techniques developed for IMS and OSI

FOI

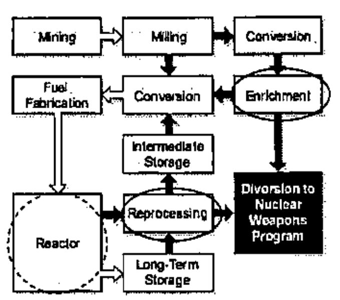
Noble gases as tracers for nuclear activity

- Produced in fission of U and Pu only (unique signature)
- Volatile, difficult to contain, difficult (but possible!) to sample
- Produced in reactors and in nuclear tests only
- Xenon isotopic ratio is source specific

FOI

Facilities

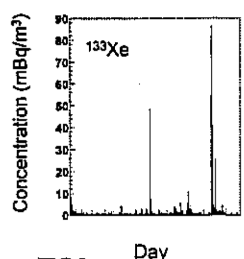
(*)



FOI

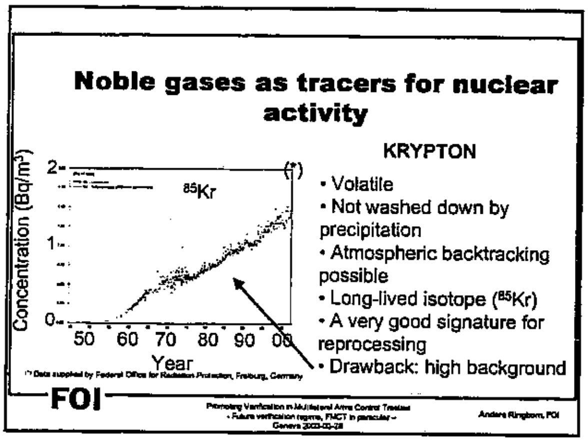
Noble gases as tracers for nuclear activity

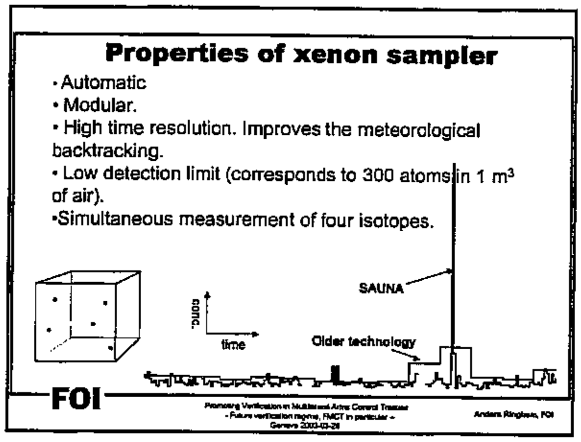
XENON

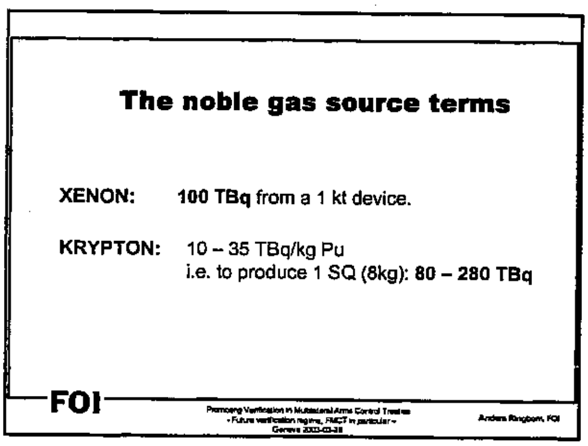


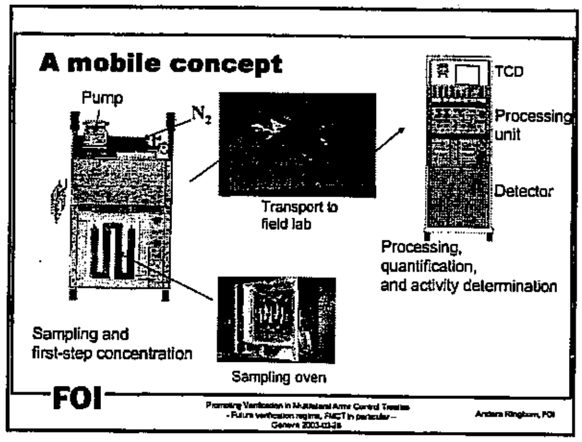
- Good indicator of reactor operation
- Isotopic ratios give source information
- Atmospheric backtracking possible
- Not washed down by precipitation

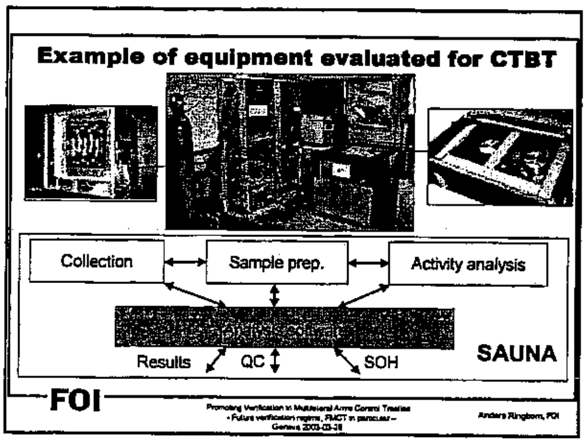
FOI

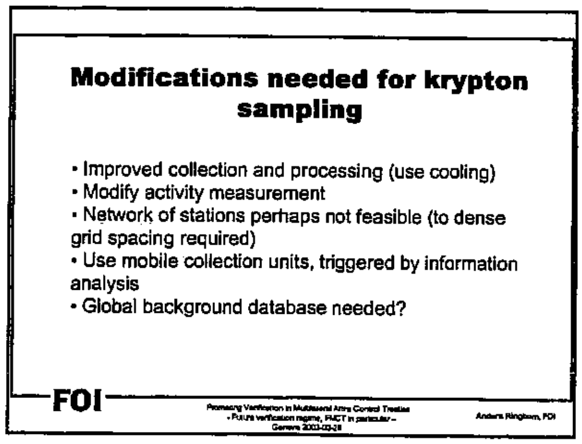

Noble gases as tracers for nuclear activity
KRYPTON
Concentration (Bq/m³)
85Kr
Year
50 60 70 80 90 00
• Volatile
• Not washed down by precipitation
• Atmospheric backtracking possible
• Long-lived isotope (85Kr)
• A very good signature for reprocessing
• Drawback: high background
FOI


Properties of xenon sampler
• Automatic
• Modular.
• High time resolution. Improves the meteorological backtracking.
• Low detection limit (corresponds to 300 atoms in 1 m³ of air).
•Simultaneous measurement of four isotopes.
SAUNA
conc.
time
Older technology
FOI


The noble gas source terms
XENON: 100 TBq from a 1 kt device.
KRYPTON: 10 – 35 TBq/kg Pu
i.e. to produce 1 SQ (8kg): 80 – 280 TBq
FOI


A mobile concept
Pump
N2
TCD
Processing unit
Detector
Transport to field lab
Processing, quantification, and activity determination
Sampling and first-step concentration
Sampling oven
FOI


Example of equipment evaluated for CTBT
Collection
Sample prep.
Activity analysis
Results
QC
SOH
SAUNA
FOI


Modifications needed for krypton sampling
• Improved collection and processing (use cooling)
• Modify activity measurement
• Network of stations perhaps not feasible (to dense grid spacing required)
• Use mobile collection units, triggered by information analysis
• Global background database needed?
FOI

SOME PERSPECTIVES ON FMCT VERIFICATION: REMARKS BY ANDREW BARLOW

TO JAPAN/AUSTRALIA/UNIDIR SEMINAR IN GENEVA
ON 28 MARCH 2003

Introduction

1. First of all I would like to thank Japan, Australia, and UNIDIR for organising this event and for the opportunity to be a panellist at this session. As Ambassador Inoguchi said at the start, the organisers have set the panellists for this session a whole page of excellent but difficult exam questions, falling into six main categories - and then asked us to cover all of these questions in no more than ten minutes! This is certainly a challenging task, but I will try my best to discharge it.

First Set of Questions

2. The first set of questions essentially concerns what the extent and nature of the initial declarations under an FMCT should be. I think the answer to this question must largely depend on what the scope of the FMCT will be and on the overall approach to verifying it. In our view the key thing this Treaty must do is ban the future production of fissile material for nuclear weapons or other nuclear explosive devices. This suggests to us that we need to focus the verification arrangements on (a) the materials that can be directly used to make a nuclear weapon (principally HEU, plutonium and U-233) and (b) the facilities that can be used to make such materials (namely, enrichment and reprocessing facilities).

3. Not surprisingly, therefore, we believe declarations under an FMCT will certainly have to cover:

- first, all enrichment and reprocessing facilities (regardless of their operational status); and

- second, all the HEU, plutonium and U-233 they produce after the cut-off date as it moves into downstream facilities such as product stores, fuel fabrication facilities, fresh fuel stores, and reactors using such materials in their fuels (until such time as the fuel is sufficiently irradiated that it would need to be reprocessed before it could be used to make a nuclear weapon).

4. There are also some other things we might think about asking states to declare in order to assist the detection of any undeclared enrichment or reprocessing facilities. I am thinking here, for example, of such things as hot cells and places where equipment relevant to enrichment and reprocessing is manufactured.

Second Set of Questions

5. The second set of exam questions essentially concerns what the nature and extent of the routine verification arrangements under an FMCT should be. Leaving aside the exceptional arrangements that will have to be devised for the naval fuel cycle, our general approach to this question is that the easiest way of applying routine verification arrangements to the facilities and materials I have mentioned (in paragraph 3) would be to apply the same sort of IAEA safeguards techniques to them that are applied under all existing IAEA safeguards agreements - namely, in addition to declarations, nuclear material accountancy, inspections, and containment and surveillance measures. We also tend to think that these standard techniques should be applied with a view to achieving the same detection goals that existing IAEA safeguards strive to achieve. In short, this off-the-shelf approach - of drawing on existing IAEA safeguards techniques and detection goals - is likely to offer the easiest and least discriminatory approach to the routine aspects of verifying an FMCT.

6. But it is important to note that under the focussed approach to verifying an FMCT there would be some significant differences between the extent to which IAEA safeguards are applied under an

FMCT and the extent to which they are applied under existing Comprehensive Safeguards Agreements. For example, the focussed approach to verifying an FMCT does not envisage IAEA safeguards applying to depleted, natural or low-enriched uranium, to spent fuel, or to reactors that are not using fuels containing HEU, plutonium and U-233. Nor, of course, do we envisage routine verification arrangments under an FMCT extending to the nuclear weapons infrastucture in nuclear weapon states party to the NPT or in any of the three non-parties to the NPT that have nuclear weapons.

Third Set of Questions

7. This brings me to the third set of exam questons about how to detect undeclared activities under an FMCT. The first point I want to stress here is that under an FMCT the five nuclear weapon states party to the NPT and three non-parties to the NPT will continue to have nuclear activities that are not declared and whose non-declaration will not consitute a violation of the FMCT. What would constitute a violation, in our view, would be undeclared enrichment and reprocessing facilities and any diversion of relevant material produced by declared enrichment or reprocessing facilities. These, in our view, are the particular undeclared activities which we will need to be able to detect and deter under an FMCT.

8. The first of these tasks poses the more difficult problem, and there seem to be two broad ways of approaching it. One approach would be to extend the routine verification arrangments to cover all or most of the potential feed materials for undecalred enrichment or reprocessing facilities (which would mean abandoning the focussed approach to routine verification arrangements in favour of a more extensive approach). The other approach would be to develop a set of arrangements that would enable us to detect directly any undeclared enrichment or reprocessing facilities. If we go down this latter route, this would put a premium on developing credible arrangments for non-routine inspections.

9. Such arrangements might draw on the two existing models for such inspections. One model would be that offered by the CWC and CTBT - namely, a system whereby a State Party has to request a challenge or on-site inspection, and that inspection can then only take place if it is not disallowed or is positively approved by some sort of Executive Council of the Parties. The other model is the older one offered by IAEA safeguards, where it is left to the Director-General of the IAEA to decide whether to request a special inspection (though of course he needs to be confident that his request will subsequently be suppported by the Board of Governors should that be necessary). And there might of course be other possibilities we should consider as well.

Fourth Set of Questions

10. The fourth set of exam questions concerned the arrangements for protecting commercially- or proliferation-sensitive information. I think the IAEA already has some experience of protecting such information resulting from routine verification arrangements at the sort of facilities I mentioned earlier - enrichment, reprocessing and downstream facilities. As for the even more sensitive facilities that might be the subject of any non-routine inspections under an FMCT, I think that in these cases the obvious approach to protecting sensitive information is the one that was initially developed for the CWC - namely, the "managed access" approach.

11. Having said that, applying this approach in the FMCT case could prove even more difficult than applying it in the CWC case. After all, if a nuclear weapon state is subject to a challenge inspection at a sensitive nuclear site under the CWC all it has to do is demonstrate that no chemical weapons related activity is taking place there. But under an FMCT it may have to demonstrate that it is not undertaking one particular kind of nuclear activity rather than another. This could make it much more difficult to find the right balance between revealing enough information to demonstrate compliance and not revealing so much as to give away sensitive

information - and of course in the post 11 September world there are heightened concerns about any leakage of sensitive information.

Fifth Set of Questions

12. The fifth set of questions posed by the organisers concerned cost-effectiveness and efficiency. One of the reasons the UK favours using existing IAEA safeguards techniques and detection goals for the routine aspects of verifying an FMCT is precisely because we believe it would be less costly and more efficient to do this than to start trying to devise a new set of techniques or goals. For the same reasons we favour making the best possible use of the IAEA as the FMCT's verification organisation, so that we can avoid all the costs and inefficiencies of creating a new one.

13. Cost-effectiveness is also one of the key factors in our thinking about whether the overall approach to verifying an FMCT should be a focussed or more extensive one. This is a point on which reasonable people can and do differ. Everyone agrees, I think, that there must be effective routine verification arrangements on all declared enrichment and reprocessing facilities and on any HEU, plutonium and U-233 they produce as it moves into downstream facilities (at least up to specified termination points). The really debateable point concerns what is the most cost-effective solution to the problem of detecting any undeclared enrichment or reprcoessing facilities. Is it to develop non-routine inspection arrangements capable of directly detecting such facilities? Or is it to extend the application of routine verification arrangements to all or most of the feed materials for such facilities - ie depleted, natural and low-enriched uranium in the case of enrichment facilities and spent fuel in the case of reprocessing facilities?

14. Given that we are principally concerned under an FMCT with the five ncuelar weapon states party to the NPT and the three states not party to the NPT (all of whom will continue to have unsafeguarded stocks of fissile material under an FMCT), our judgment, so far, has been that, in this FMCT case, it is developing credible non-routine inspection arrangements that probably represents the most cost-effective approach to detecting undeclared enrichment and reprocessing facilities.

Sixth Set of Questions

15. The sixth and final set of exam questions concerned the need for verification arrangements to have flexibiltiy in terms of technical, security and political developments. Certainly we do need to develop verification arrangements that can incorporate technological advances in monitoring methods and provide some mechanism for adapting them to new circumstances without too much difficulty.

16. But, that said, I think there are some things we cannot be too flexible about - for example, I cannot imagine that Parties will want the scope of the Treaty to be too easily amended or that they will want the overall parameters of the verification arrangements to be too readily changed. So we will probably need to think in terms of allowing for flexibility but only within a set of clearly defined constraints.

Conclusion

17. Chairman, I think I am approaching my allotted time, or even slightly over it, but I hope I have managed to give you at least a thumb-nail sketch of my answers to your six exam questions. Thank you very much.

Verification of ban on production of Fissile material for Nuclear Weapons

K.Balu, India.

I am very happy to have this opportunity to share my thoughts with you in this workshop relating to verification regime in future with particular reference to FMCT. In my view it would be necessary to have in perspective what would be the scope and character of FMCT before we get to the verification regime as the latter would largely depend on the former.

At the outset, the treaty should be conceived, negotiated and drafted with the following four cardinal principles as the foundation, namely :

1. Universality
2. Non-discriminitory nature
3. Internationally and effectively verifiable regime
4. Credibility.

If the scope of the treaty would be to ban production of fissile material for nuclear weapons and other explosive devices after Entry into Force, the credibility of the treaty would be established if it is seen that the treaty goes beyond the realm of non-profileration and serves as a step, however small, along the road to Universal Disarmament.Towards this all the states who would be party to the treaty should comply with this basic obligation of not producing fissile material for nuclear weapons and other explosive devices once the treaty comes into force.

The success of bringing about the Universality and the non-discriminitory nature of the Treaty will depend on the judicious balance that needs to be maintained among a number of factors like the desirable objectives of the Treaty, the need to maintain the correctness of scientific facts and the realities of the situation.

Much has been said about the adequacy of including only the Reprocessing and Enrichment Facilities; this ofcourse would be the minimalist approach where the verification would be restricted to *un-irradiated direct-use material.*But then scientifically speaking such a minimalistic approach, though easier to implemnt would not entirely meet the objective of a cut-off in the production of fissile materials for nuclear weapons, as production takes place in a reactor, atleast in the case of two of the fissile materials. What then would be the alternative ? It may mean verification of production of *all direct-use materials* and this would be possible only if reactors are brought within the ambit of verification and spent fuel which is *irradiated direct-use material* would be included for verification. Though more effort and expenditure may be involved this approach would plug the gap and remove the scientific inconsistancy. Now the need to be realistic. It is not conceivable that any of the Nuclear Weapons States – including mine – would agree to include stocks that exist prior to EIF within the scope of the treaty. So realism would warrant the discussion being restricted to production of fissile material for nuclear weapons and other explosive devices after the treaty enters into force.

I would now turn my attention to some of the points brought out in the guidelines provided by the organizers for this session :

- *What should be declared?(Materials, Facilities, Activities, etc)*
- This is best answered by what we would be verifying. As verification would be relating to fissile materials which are being produced, stored, or processed in various facilities, I feel that facilities should be declared.

- *Are precise definitions necessary? Should these be defined by technical specifications or purpose?*
- The treaty may be negotiated among state parties at the diplomatic and political levels. But it is important to remember that in its implementation- particularly verification- the subject is highly technical and complex.

Precise definitions are therefore necessary. Definitions should be based on technical understanding and parlance. Any definition , if attempted , on the basis of 'purpose' should not result in what is factually incorrect.

How should inconsistencies or questions concerning initial declarations be solved? What procedures should be taken when these inconsistencies / questions can not be solved ?

Declarations, whether initially or later are an input from a state which is party to the treaty. This question, in my view, should be kept in mind while negotiating the clause on non-compliance or partial compliance of a state party to the treaty; at any rate it is too early to address this question when the scope and nature of the treaty are yet to be negotiated.

- Assurance derived from routine inspection

Is routine inspection needed for FMCT? Or can requirements only be met through challenge inspections ?

To start with , I would think , routine inspections will be necessary for FMCT. Depending on the size and nature of the programme in a given state, it would be necessary to make a determination regarding the samples that may have to be collected by the Inspectors for independent verification . At this stage it would be difficult to comment on 'challenge inspections '; much would depend upon the internationally verifiable nature of the basis on which 'challenge inspections' are undertaken; care is required to maintain the universality and non-discriminitory nature of verification .

How should the starting point and termination of verification measures be defined ?

For the verification regime to be universal, non-discriminatory , effective and credible, the regime should include not only separated but all direct-use material produced after EIF.This would mean that the starting point will have to be where 'direct-use material' is produced, as I had indicated in my introductory remarks; verification should follow the material downstream, through reprocessing and fabrication of 'fresh fuel' for use in a reactor again ; the termination should be defined by that stage when the fissile material content in the material becomes irrecoverable either by getting 'burnt' in the reactor or getting 'diluted' to an extent when recovery of the FM is not envisaged.

What kind of inspection is appropriate for FMCT routine inspection-the INFCIRC 153 type based on 'timeliness' concept or random non/short notice type inspection ?

In my view FMCT would require inspection of the kind adopted in INFCIRC 153 , as for the methodology goes; but in its application it must be ensured that it is universal and non-discriminitory.

Would there be any additional obligations of routine inspections for NNWSthat have already acceded both to INFCIRC 153 & 540 ?

I have a difficulty with this question. It would appear that verification under FMCT is only an extension of what is being done by IAEA under the safeguards programme which is based on NPT.I would like to believe that FMCT, would be a self-standing treaty with its own objectives and scope which are hopefully quite different from NPT, in terms of Universality, Non-discriminatory nature and credibility.

Should a limit be imposed on the number of routine inspections for each country? If so how— numerically, by number of facilities or by facility type ?

The number of routine inspections and the effort involved for inspection will naturally be a function of the size and type of nuclear programme the country has; it may not be possible or correct to stipulate a limit that can be applied across the board.

- Detectability of undeclared activities / Effectiveness of challenge inspections.
- With the advent of the techniques currently being employed and the degree of intrusiveness being sought I would think it would be inconceivable for a non-declared facility to operate for a meaningful period without being detected.
- Flexible response to technoligal progress as well as evolving security and polical situations.
- For the verification regime of FMCT to remain least impacted by technological progress it is essential that the scope and definitions are formulated in technical terms which are firmly anchored in scientific principles to remain independent of the technology used in future; efforts are required to minimize, if not prevent, invention of terms and phrases 'for the purposes of the treaty '.

STATEMENT BY H.E. DR. KUNIKO INOGUCHI AMBASSADOR, PERMANENT REPRESENTATIVE OF JAPAN TO THE CONFERENCE ON DISARMAMENT

Geneva, 15th May 2003

Mme. President,
Distinguished delegates,

Allow me, Mme. President, to assure you once again the full support of my delegation for your steadfast efforts to advance the work of the Conference towards the fulfillment of its task.

I have asked for the floor to inform the Conference of the discussions held at the workshop entitled "Promoting Verification in Multilateral Arms Control Treaties - Future verification regime, FMCT in particular" on 28 March co-organized by Japan, Australia and the United Nations Institute of Disarmament Research. Many delegations and knowledgeable persons from civil society attended the workshop and participated in the discussions. The co-organizers are especially grateful to those panellists, who came over to Geneva, for their valuable contributions.

Mme. President,

Now please allow me to present a rather detailed account of elements discussed at the Workshop.

The workshop focused on the issue of verification, the key to maintaining and strengthening the credibility of multilateral arms control regimes. In our view, verification deserves special attention, particularly at this juncture, where concern is growing over clandestine activities to develop proscribed weapons of mass destruction. The most critical requirement of verification is, therefore, how effectively it can detect an undeclared activity. However, there are always risks that verification may fail to meet this requirement due to the difficulty of finding clues in submitted declarations and information. In addition, ineffective verification also contributes to the cover-up of clandestine activities. Verification must be adequately effective so that credibility of arms control regimes can be maintained. Ultimately, effective verification will help diplomacy to succeed before choices become limited to acceptance of the inability to solve a problem or military options.

Effectiveness and adequacy of verification is, however, not unconditional. There are quite a few constraints. All verification systems in existence, dealing with weapons of mass destruction, involve a substantial need for financial resources. Cost-efficiency is a guiding principle in arms control as much as in other fields.

Another constraint is related to intrusiveness, not only in terms of a State's legitimate interest in protecting sensitive military information, but also in terms of proliferation risks that intrusive inspections entail. Those interested in acquiring WMD may get access to priceless information and expertise from such inspections.

All these aspects are interrelated in the overall issue of verification, and it is a profoundly important task to arrive at an optimum solution to balance these factors.

The Workshop was composed of two sessions. In the first session, we discussed possible generic lessons that could be learned from existing verification systems. My special thanks go to those panellists from the IAEA, the OPCW, the Preparatory Commission for the CTBTO and VERTIC, a non-governmental organization. Their contributions enabled us to discuss different verification regimes in a comparative manner. I believe that it was a unique opportunity, not only for its intellectual interest but also in its contribution towards the debate on new systems, such as FMCT verification. I would now like to share several important points outlined in the discussion.

Firstly, while perfect assurance of compliance may not be given by verification, verification must be effective enough to detect any diversion activity or, at least, suspicious hints of such an activity, in a timely fashion before the problem becomes too serious.

Secondly, cost-efficiency is clearly an important factor, as I have already mentioned. However, it is also true that financial constraints should not override the essential purpose of verification.

Thirdly, the IAEA has a robust infrastructure for verification in the field of nuclear weapons, including equipment and personnel, and therefore the future FMCT verification system should make maximum use of the existing IAEA infrastructure.

Fourthly, while non-routine inspection has never been used, such inspection is still vital for any verification system, particularly in view of its deterrent effect against clandestine activities.

Finally, the Group of Scientific Experts made significant contributions to the seismological verification of the CTBT. It is, indeed, a good example as a modality to advance technical discussions before full-fledged negotiations start. However, whether or not this example is applicable to the FMCT requires careful consideration to determine appropriate issues for such technical discussions.

The second session focused on verification of the FMCT. The co-organizers circulated a list of specific questions in order to structure the debate. I hope that this list of questions will also facilitate an understanding by all interested parties of the overall picture of the debate on FMCT verification. The list includes the following questions:

- What should be declared and monitored on a routine basis;
- What techniques would be useful in order to improve the detectability for non-declared facilities and activities for FMCT, the IAEA-INFCIRC/153 type inspection or random, short-notice type inspection;
- How sensitive information can be protected and if "managed access" is appropriate;
- How the IAEA can be utilized for FMCT verification, etc.

The most fundamental purpose of FMCT verification is to detect any undeclared enrichment or reprocessing activities, which consequently brings us to the question of what approach to adopt in order to meet this requirement. The scope of declaration and routine inspection is, among others, of utmost importance. In this respect, two well-known approaches were discussed: the focused approach and the extended approach. The first approach focuses on enrichment and reprocessing facilities, on highly enriched uranium and plutonium (and U-233) in downstream facilities and on some other types of places, including hot cells. The second approach covers, above and beyond the first approach, low enriched uranium, spent fuel, and so on, that are considered to be feed materials for the production of HEU and plutonium.

This question should be examined in terms of a balance between adequacy and cost-effectiveness. The first approach seems to be less costly than the second approach, but just how expensive the extended approach would be needs to be clarified. Also, there are questions concerning ability to detect undeclared activity, for example, how significantly more effective the extended approach will be if spent fuel is included in the scope of routine inspection. In order to advance the debate further, more precise analyses are required on these questions.

The modality of inspections, including intrusiveness of inspections, is also an important issue in the context of FMCT verification. This issue is related to the protection of sensitive information, the so-called notion of confidentiality. This technical but difficult issue was not extensively discussed at the workshop, however a view was expressed that the idea of managed access that is being adopted under the CWC can be applied under the FMCT. There will be technological as well as financial challenges to overcome the differences.

In this connection there was a useful presentation by one of the panellists on scientific expertise related to noble gases. I believe that environmental sampling is clearly one of the useful verification techniques, for the FMCT.

The issue of verification organization is also complex because it involves questions such as how to use the existing institution of the IAEA. One view expressed was that no stand-alone organization apart from the IAEA would be necessary, while another view maintained that there was a need for a different organization.

The flexibility of the Treaty to adapt itself to technological development in the future without too much difficulty is not a forefront issue, but should always be kept in mind.

Other specific questions, such as how to deal with special cases, including naval reactors, etc., were also raised.

Finally, discussions revealed an uneasy possibility that the most contentious issue, i.e., whether fissile material stocks should be included in the Treaty, could drive the whole negotiations to a stalemate. I believe that such a stalemate is not in the interest of any country, especially after all member States of the Conference have agreed on the commencement of negotiations.

Before concluding, I would like to show my appreciation to both Dr. Patricia Lewis, Director of UNIDIR, and Mr. Hiroyoshi Kurihara, Senior Executive Director of the Nuclear Material Control Center of Japan, for having done excellent jobs as moderators. I would also like to express my special thanks to the CD Secretariat for having assisted us in all the logistical aspects. Finally, I would like to thank my colleague, Ambassador Mike Smith of Australia, and his delegation, for having extended essential support to my delegation.

Thank you.