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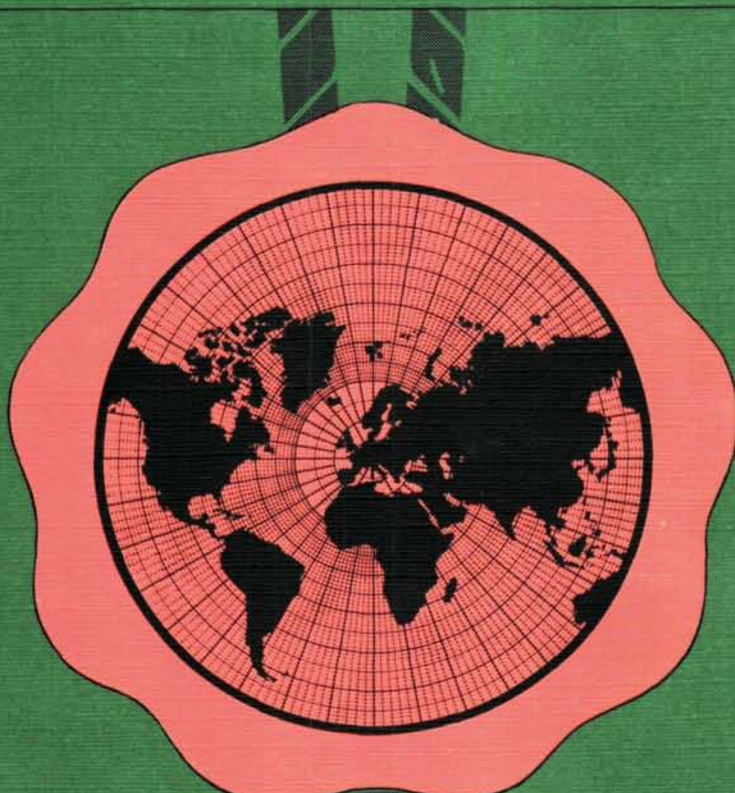
# IAEA SAFEGUARDS

# AIMS, LIMITATIONS, ACHIEVEMENTS



INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1983

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# AIMS, LIMITATIONS, ACHIEVEMENTS

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URUGUAY
VENEZUELA
VIET NAM
YUGOSLAVIA
ZAIRE
ZAMBIA

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".



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INTERNATIONAL ATOMIC ENERGY AGENCY
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## FOREWORD

This is the fourth booklet in the IAEA Safeguards Information Series. The need for a non-technical publication which would explain the history, purpose and aims of the IAEA Safeguards System has become increasingly acute as more and more attention focusses on international safeguards.

This booklet should be of interest to a wide range of readers, in both the public and private sphere, who are interested in the development and scope of IAEA safeguards.

Neither nuclear technology nor its accompanying safeguards are static. As safeguards continue to develop, the content of this booklet will therefore be periodically updated.

## PRINCIPAL IAEA DOCUMENTS REFERRED TO IN THIS BOOKLET

Statute of the International Atomic Energy Agency.

INFCIRC/66/Rev.2. The Agency's Safeguards System (1965, as provisionally extended in 1966 and 1968).

INFCIRC/153 (corrected). The Structure and Content of Agreements between the Agency and States required in connection with the Treaty on the Non-Proliferation of Nuclear Weapons.

INFCIRC/254. Communications received from certain Member States regarding Guidelines for the Export of Nuclear Material, Equipment or Technology.

GC(V)/INF/39. The Inspectors Document.

# CONTENTS

# I. INTRODUCTION

## 1. THE PURPOSE OF THIS BOOKLET

The main purpose of this booklet is to explain:

- How international safeguards emerged;
- Their role in helping to retard the spread of nuclear weapons and facilitate international trade in nuclear energy;
- Their purpose;
- Their technical objectives and goals;
- Their legal, financial and technical limitations; and
- What they have achieved.

## 2. A SHORT HISTORY OF SAFEGUARDS

International safeguards, like the peaceful uses of nuclear energy, are a post-Second World War phenomenon. The term "safeguards" was first used in 1945 to describe activities designed to prevent the use of peaceful nuclear plant or material for military purposes. On 15 November 1945, the President of the United States of America and the Prime Ministers of the United Kingdom and Canada issued an "Agreed Declaration on Atomic Energy" in which they warned against *"the spreading of the specialized information regarding the practical application of atomic energy, before it is possible to devise . . . safeguards acceptable to all nations . . ."* (see Ref. [1]). The Acheson-Lilienthal Plan[1], drawn up in 1945 and 1946, contained far-reaching concepts of the term "safeguards" including international control and operation of "sensitive" facilities. An essential element was, however, that the system should provide *"early, unambiguous and reliable signals that a nation was taking steps towards atomic warfare"* (see Ref. [2]). Today the central technical component of safeguards is a system *for verification* that nuclear plant and materials are being used for peaceful purposes only, coupled with a political/legal apparatus for negotiating and approving safeguards agreements, determining compliance, reporting non-compliance and imposing certain penalties in the case of non-compliance.

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[1] Also known as the Baruch Plan from the name of the US statesman who presented it at the United Nations.

Until now, international safeguards have been limited to nuclear and related materials[2] and nuclear equipment and facilities, destined for *peaceful use.* Some discussion is going on, but so far without tangible results, of applying similar verification measures to *military activities,* for instance, to verify a "cut-off" in the production of fissile material for military use or a "freeze" in the production of nuclear weapons, or a "transfer" of nuclear material from military to peaceful purposes.

There are several reasons why nuclear plant and materials have so far been singled out for international safeguards. The prime reason is their potential use in the most destructive weapon that man has made. Certain nuclear materials and the nuclear plants which produce or process these materials can be used for military as well as for peaceful purposes. It is also much easier to account reasonably accurately for nuclear materials than for most other potentially dangerous substances. Unlike conventional explosives, poison gases or bacteria, the physical characteristics of most nuclear materials permit their easy detection and accurate measurement. In the early years, nuclear materials were also scarce and expensive and confined to a few countries. Elsewhere there were no existing stocks and relatively few sources. The production, use and spread of nuclear materials and the construction of new plants could therefore be tracked relatively easily.

Trade in nuclear plant, equipment and materials led to an important innovation in relations between States. For the first time, international agreements would include arrangements to see whether they were being complied with. Previously, such agreements rested chiefly on the good faith of the parties. In the early 1950s, when States began to export nuclear materials and equipment, it became the practice for the relevant government-to-government agreements to specify a set of safeguards to verify systematically that the receiving State was carrying out its obligations and was using the material or equipment only for peaceful purposes.

At first, these agreements involved only the two States in the transaction (most were between the USA and other countries, but the USSR, the UK, France, Canada and other suppliers soon entered the field). The US supply agreements foresaw, however, that responsibility for applying safeguards could be transferred at a later date to the IAEA, which was then in the process of being created and which came into being in 1957. In the early 1960s this transfer of responsibilities began and the IAEA's safeguards came slowly into operation.

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[2] For the statutory definition of "nuclear material", see Article XX of the IAEA Statute. Besides the elements, compounds, etc., listed in that article, the IAEA is now applying safeguards to heavy water, zirconium tubes and reactor-grade graphite as well as to nuclear plant and equipment. Definitions of most of the terms used in this booklet are given in the *IAEA Safeguards Glossary* [3].

The widening acceptance of systematic on-site inspection, carried out at first by the officials of the exporting State and later by the inspectors of an international organization, represented a breakthrough which may have extensive implications for arms control and disarmament, even though safeguards are still confined to the peaceful nuclear fuel cycle.

The transfer of safeguards responsibilities to the IAEA made it necessary to develop safeguards approaches and the related legal arrangements. In 1961 the IAEA Board of Governors approved a safeguards system covering only small reactors (up to 100 MW(th)). The IAEA made its first inspection under this system in 1962 at a research reactor in Norway. In 1965 the system was replaced by one covering reactors of all sizes. In 1966 and 1968 the IAEA Board of Governors extended the system to cover fuel fabrication and reprocessing plants (IAEA Document INFCIRC/66/Rev. 2). This system is used in connection with safeguards agreements covering particular exports or covering individual nuclear activities which a State has unilaterally submitted to safeguards.

Endeavours to limit the spread and the use of nuclear weapons led to comprehensive safeguards agreements covering all the present and future activities of a State (sometimes referred to as "full-scope safeguards"). The first treaty to require such safeguards was the Treaty for the Prohibition of Nuclear Arms in Latin America (often referred to as the Tlatelolco Treaty). The Tlatelolco Treaty obliges each Party to conclude an agreement with the IAEA for the application of safeguards to *all its nuclear plants and material.*

On 1 July 1968, after endorsement by the United Nations General Assembly, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was opened for signature, and in March 1970 it came into force. The Treaty was largely the fruit of agreement between the USA and the USSR, subsequently amplified by other States at the Geneva Disarmament Committee. Under the NPT, every "non-nuclear-weapon (NNW) State" – that is, all except the five nuclear-weapon (NW) States at the time: China, France, UK, USA and USSR – which joins the Treaty is obliged to conclude an agreement with the IAEA for the application of safeguards to *all its peaceful nuclear activities.*

The "exclusive purpose" of these safeguards is to verify that the State concerned is not diverting *"nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices"*[3]. Under the NPT, the State concerned is not debarred from using nuclear energy for non-explosive military uses (e.g. nuclear submarines or other nuclear-propelled naval vessels). No NNW State has, in fact, done so.

All States which join the NPT also undertake not to export nuclear material or other items *"especially designed . . . for the processing, use or production"* of fissile material to any NNW State unless they are covered by IAEA safeguards.

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[3] NPT Article III.1.

The NPT has been described as the most important international treaty that has so far been concluded in the domain of nuclear arms control and disarmament. It gave great impetus to IAEA safeguards and, indirectly, to the other activities of the IAEA, for instance in the field of technical co-operation. It provided a framework for free nuclear trade and for the transfer of peaceful nuclear technology between its Parties.

After the Treaty came into force, the first task of the IAEA was to prepare a standard agreement which could be used in negotiations for applying safeguards to all the peaceful activities of NNW States. The IAEA's Board of Governors completed and approved the contents of a "model agreement"[4] before the end of 1970. In drawing up the model agreement the Board profited from experience with the earlier safeguards system of the IAEA, drawn up in the mid-1960s. As noted above, this earlier system still serves as the basis for agreements with countries that are not parties to the NPT[5].

Two milestones in the history of the NPT were its ratification by the NNW States of Euratom (Belgium, Federal Republic of Germany, Italy, Luxembourg, Netherlands, Denmark and Ireland) in 1975 and by Japan in 1976 (followed by Greece in 1981). These ratifications, coupled with those of the Scandinavian, Central and Eastern European countries, and of Australia and Canada, meant that almost all countries of the industrial world had accepted the Treaty[6].

A more detailed history of the development of safeguards is given in the IAEA booklet *IAEA Safeguards: An Introduction* [4]. Figure 1 shows the main steps taken so far to stop the spread of nuclear weapons.

By the end of 1982, 121 States including three NW States (UK, USA and USSR) had joined the NPT. Of the 118 NNW States Parties to the NPT, 39 had significant nuclear activities. Outside the NPT and Tlatelolco Treaty, only eleven NNW States were operating or constructing nuclear facilities. In seven[7] of them, all substantial

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[4] INFCIRC/153 (corrected), described as *"the basis for negotiating safeguards agreements"*. This document is hereinafter referred to simply as INFCIRC/153.

[5] INFCIRC/153 is, in effect, a complete model agreement. INFCIRC/66/Rev. 2 leaves room for variation in actual agreements, and deals only with the principles for applying safeguards, circumstances requiring them and safeguards procedures. It does not deal with other matters which must also be covered in safeguards agreements such as the consequences of non-compliance with the agreement, finance, liability, or settlement of disputes.

[6] The safeguards agreement with Euratom countries, while based on INFCIRC/153, also took account of the fact that Euratom already had its own safeguards system which provided an infrastructure for IAEA safeguards. In many respects, the agreement with Japan follows the Euratom text.

[7] Argentina, Brazil, Chile, Cuba, Democratic People's Republic of Korea, Spain and Viet Nam. It should be noted that Viet Nam is a Party to the NPT, and it is expected that negotiation of a safeguards agreement in connection with NPT will start soon. A "full-scope" safeguards agreement pursuant to the Tlatelolco Treaty is in force with Colombia. The Agency also applies safeguards to the nuclear facilities in the territory of Taiwan.

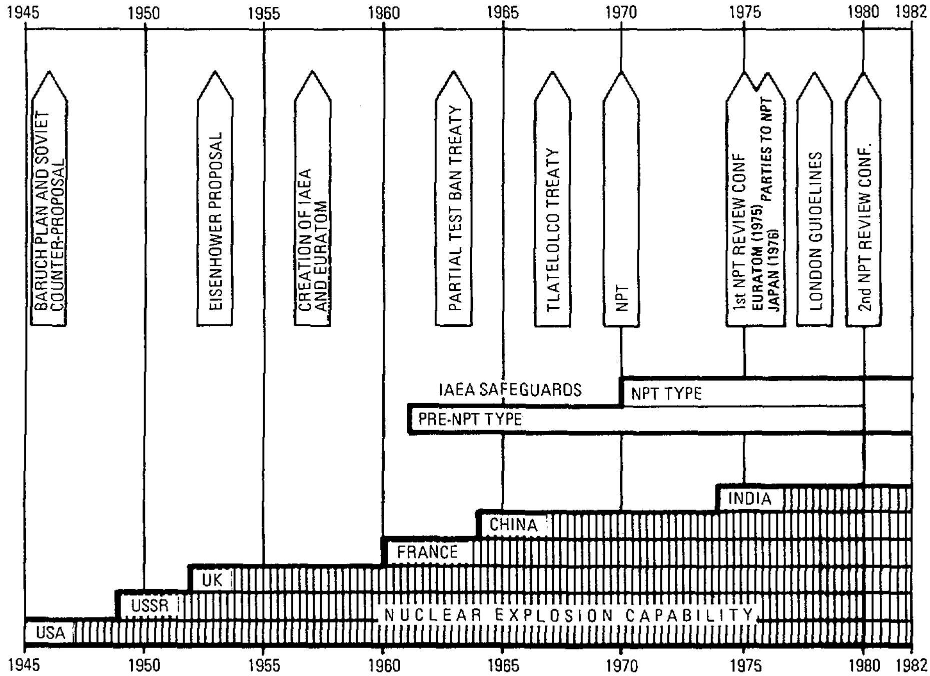


*FIG.1. Main international steps or proposals for stopping the spread of nuclear weapons.*

**Notes:** *(1) The first IAEA safeguards system (pre-NPT type) was adopted in 1961 to cover nuclear reactors with less than 100 MW thermal output. In 1964 this system was extended to cover all nuclear reactors. A second IAEA safeguards system (also pre-NPT type), adopted in 1965, replaced the first and is still applied. It covers nuclear reactors and, by extensions in 1966 and 1968, also reprocessing, conversion and fuel fabrication plants.*

*(2) In addition to the second IAEA safeguards system there exist provisions (NPT type) for the application of safeguards to all peaceful nuclear activities in the non-nuclear-weapon States parties to the NPT.*

nuclear activities known to the IAEA were covered by provisions of existing safeguards agreements. The remaining four[8] were operating safeguarded as well as unsafeguarded nuclear facilities.

In recent years, international safeguards have also played an important part in promoting the peaceful use of nuclear energy, since without them there would be little or no exchange of nuclear technology and equipment.

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[8] India, Israel, Pakistan and South Africa.

A number of events in the mid-1970s led to some concern that nuclear weapons, or the capacity to make them, were about to spread to several additional countries and that the NPT and IAEA safeguards would not be able to contain the spread. Amongst these events was India's explosion of a nuclear device in 1974[9], the sharp rise in the price of oil which led many to conclude that nuclear power would be adopted as an alternative to oil by many more countries (it was not), agreements for the supply of reprocessing or enrichment technology to a number of additional countries, and the anti-nuclear movement which contended that nuclear power would inevitably lead to nuclear weapons.

These concerns subsequently resulted in an informal agreement between supplying countries to attach certain additional conditions to nuclear exports[10]. They were also reflected more explicitly in the US Non-Proliferation Act of 1978 which sought to restrict the export and use of reprocessing and other technologies considered to be sensitive, and which required the renegotiation of many existing supply and co-operation agreements.

A division of interest between the supplying and receiving countries thus emerged in the mid-1970s. On the initiative of the USA it was agreed in 1977 to launch a general evaluation, without preconditions, of the technical assumptions concerning the future development of the nuclear fuel cycle on which the nuclear energy programmes of many countries had been based since the 1950s[11]. This International Nuclear Fuel Cycle Evaluation (INFCE) came to an end in March 1980 after a thorough examination of all aspects of the fuel cycle. From the work of INFCE it was clear that there is no easy technical means of preventing the acquisition of nuclear explosive material, nor is it possible to rank various fuel cycles according to the risk of proliferation they entail; proliferation should be regarded chiefly as a political and security problem to be dealt with by taking new institutional and other internationally acceptable measures and, above all, by improving and strengthening the international safeguards system.

During 1981, however, confidence in IAEA safeguards suffered a number of setbacks, chiefly as a result of the Israeli attack in June 1981 on a nuclear research centre of a State – Iraq – that had long been a party to the NPT and was abiding by its safeguards obligations. The inspection regime that the IAEA was to

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[9] No IAEA safeguarded material was used to make the device. This incident demonstrated a point emphasized throughout this booklet, that international safeguards cannot be expected to assume the full burden of preventing the spread of nuclear weapons or other nuclear explosive devices.

[10] The "London Guidelines", published upon the request of the States concerned in IAEA Document INFCIRC/254.

[11] Namely that, in due course, fast breeder and advanced converter reactors would supplant the earlier generations of thermal reactors, and that this evolution would require the large-scale reprocessing of spent fuel to produce the plutonium needed as fuel for the breeders.

introduce when the main reactor in the centre went critical would have been more than adequate to detect any attempted diversion.

The reason for some of the criticism of IAEA safeguards was that they had become an issue in the politics of the Middle East. It also became clear, however, that there was a good deal of misunderstanding of the way in which safeguards work, their aims, their potential and their limitations. Exaggerated expectations may also have contributed to the criticism.

There seems to be insufficient awareness of the fact that IAEA safeguards are only one of a number of political, technical and economic measures intended to retard the spread of nuclear weapons. The IAEA's safeguards operations and the reports it makes are also only one of several sources available to governments about the nuclear activities of other States. This booklet is therefore primarily intended to clarify these matters and also to be of assistance, for instance, in the training of IAEA inspectors. It is hoped that the booklet will serve to standardize the terminology and concepts employed in discussing complex safeguards questions so that we may arrive at a clear and common understanding of their meaning.

# II. NON-PROLIFERATION: OBJECTIVES AND MEANS

Proliferation has come to have two meanings: "vertical proliferation", or the growth in the nuclear armaments of the five recognized nuclear-weapon countries, and "horizontal proliferation", or the spread of nuclear weapons to other countries.

## 1. VERTICAL PROLIFERATION

The problems of vertical proliferation are chiefly in the hands of NW States themselves[12], of the UN and of world public opinion. The IAEA has no mandate in the field of arms control and disarmament.

[12] In 1970, when the NPT entered into force, the USA and the USSR possessed a total of 5800 strategic nuclear warheads of various kinds. By 1981, the figure had risen to about 16 000 warheads (figures from 1981 Stockholm International Peace Research Institute (SIPRI) Yearbook). The total number of nuclear warheads, tactical as well as strategic, is now estimated at more than 50 000.

The NW States have, however, accepted certain international obligations in this regard. Under the SALT-I Treaty and other bilateral agreements, the USA and the USSR have agreed to certain limitations on the numbers and types of missiles they may build as well as to limitations on the deployment of missile defences, and on the maximum size of the underground nuclear tests they may conduct. Under the Partial Test-Ban Treaty of 1963 (the "Moscow Test Ban Treaty"), they (and all other States that have joined the Treaty[13]) have bound themselves not to carry out any nuclear weapon tests in the atmosphere, in outer space and under the water, and have expressed the determination *"to seek to achieve the discontinuance of all test explosions of nuclear weapons for all times and to continue negotiations to this end"*[14].

Of direct importance to the IAEA is the fact that the Preamble to the NPT itself recalls this commitment to a comprehensive and permanent ban on all nuclear tests and that Article VI of the NPT provides that each of the Parties will undertake *"to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control"*.

It is obvious that progress in reaching the NPT's preambular objective and in carrying out the obligations of Article VI would strengthen the NPT and might also make it more acceptable to some of those countries that have not yet joined it. The NNW States have frequently made the point that the NPT is a bargain under which *their* agreement not to engage in "horizontal" proliferation is matched by the undertaking of the NW States to make progress in controlling and reversing "vertical" proliferation. Lack of progress in this regard could thus affect the long-term viability of the Treaty.

Thus, while these questions are outside the IAEA's mandate, their outcome may be of great importance to the success of its safeguards operation.

A step of value would be the conclusion of a treaty discontinuing testing of nuclear explosives of every kind in all environments (a "Comprehensive Test Ban Treaty"). This would not prevent those States that have unsafeguarded facilities from producing nuclear explosive material and perhaps even from manufacturing untested weapons. Nevertheless, a comprehensive and widely accepted test ban treaty might help to retard "horizontal" proliferation and would put some brake on "vertical" proliferation. It would also show that the NW States were making tangible progress towards arms control measures.

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[13] There are now 111 States party to the Partial Test Ban Treaty.

[14] In the meantime, however, the NW States have continued their tests of nuclear weapons, carrying out 667 tests between 1963 and the end of 1980.

## 2. HORIZONTAL PROLIFERATION

### 2.1. Motivations

Governments acquire nuclear weapons or strive to acquire them for the same reasons as they seek other sophisticated armaments: insecurity, political tension, power and prestige. The US war-time "Manhattan Project", which produced the atom bombs for Hiroshima and Nagasaki, was initially spurred by fear that Nazi Germany was on the road to nuclear weapons. Great Power and Cold War tensions as well as the impetus of wartime efforts were amongst the factors that led the USSR, the UK and France to make nuclear weapons in the late 1940s and the 1950s.

In short, the decision to acquire nuclear weapons or unsafeguarded nuclear material is political, and the means to restrain the spread of nuclear weapons must in the first place also be political.

### 2.2. The risks

The nuclear arms race between the NW States has brought, in Churchill's words, "a balance of terror"; a balance which neither side risks upsetting. Fear of each others' nuclear armaments has imposed restraint on the five nuclear powers; they have refrained from any form of direct military attack on each other and have moved forward from "peaceful coexistence" to a form of détente.

It has been asked whether the same restraints would not apply to other States that might obtain nuclear weapons. Peace between the two main power blocs rests, however, on the present balance of power; any major upset – for instance, if one of the main industrial NNW States were to denounce the NPT and launch a nuclear weapons programme – could entail incalculable risks.

In areas of regional tension, the overt acquisition and testing of nuclear weapons by one State might well precipitate a wasteful and dangerous nuclear arms race within the region. Even the fear that an adversary might be planning to acquire nuclear weapons could lead to "pre-emptive" military attack. The volatile political state of these regions and the several wars that have been fought in them since 1945 give little assurance that nuclear weapons, once acquired, would not be used, particularly if the possessor were risking ultimate defeat in a "conventional" war.

Each addition to the number of NW States may also make the task of stopping and reversing vertical proliferation even more difficult than it now is.

## 3. THE MEANS FOR RESTRAINING HORIZONTAL PROLIFERATION

Various means have been used by the international community or individual governments to contain the further spread of nuclear weapons. Broadly speaking, they can be classified under the headings of:

- Measures to prevent other countries from acquiring the technical capacity to make nuclear weapons;
- Formal agreements/commitments not to develop nuclear weapons;
- Application of IAEA safeguards; and
- Counter-motivation measures to reduce political and security related incentives.

These means are discussed in detail in the following sections.

## 4. PREVENTIVE MEASURES

The measures used to control the transfer of nuclear technology so as to retard the spread of nuclear weapons have varied over the years but they have consisted essentially of:

- Policies of embargo or "denial"; and
- Export controls.

### 4.1. Policies of denial

During the Second World War and until 1955, the USA, the USSR and the UK imposed strict controls which made the communication or transfer of nuclear technology, materials and information a criminal offence. By the early 1950s it had become clear that such controls could not, over time, prevent other States from making nuclear weapons. Three States (USA, USSR and UK) had already made nuclear weapons and a fourth (France) seemed likely to do so in the near future.

The policy was discarded by the 1954 US Atomic Energy Act (the "Atoms for Peace" programme) which authorized, in its place, the export of nuclear materials, plant and equipment *under safeguards.*

At the 1955 UN Conference on the Peaceful Uses of Atomic Energy, the USA, the USSR, the UK and France proceeded to a general declassification of information on nuclear technology, with one exception: techniques for enriching uranium were still regarded as militarily sensitive and remained strictly classified.

In spite of this, enrichment technology has been acquired by ten or more countries including one or two developing countries[15]. Probably about twenty to

[15] In most cases by using techniques such as gaseous ultra-centrifuge rather than the gaseous diffusion technique which is the process initially used by most NW States.

twenty-five countries today are also technically capable of taking the other path to the production of nuclear weapons-usable material, namely the reprocessing of spent fuel and separation of plutonium. There is little doubt that nuclear technologies will continue to spread and that the number of States technically capable of making nuclear weapons, or at least nuclear explosive material, will increase. Embargoes or other attempts to inhibit the transfer of technology have no doubt slowed down the diffusion of sensitive technologies. They are, however, likely to become steadily less effective and might even spur some States to develop their own independent, unsafeguarded fuel cycles.

## 4.2. Export controls

As has been indicated, the US Atomic Energy Act of 1954 permitted export of US nuclear technology under safeguards. At first these took the form of bilateral US controls but, in time, responsibility for applying safeguards was transferred to the IAEA or, in the case of the Common Market countries, to Euratom. The US example was followed by most other exporting countries (although there were some exports in the 1950s and early 1960s to which only nominal safeguards or none were attached).

Until the NPT came into force, the policy of exporting countries was usually to require the application of safeguards *only to the exported item* and to any fissile materials produced by using the exported item. As a growing number of countries accepted safeguards on their entire nuclear fuel cycles under the NPT (or, in a few cases, under the Tlatelolco Treaty), and as events of the mid-1970s raised fears of further proliferation, a number of exporting countries came to conclude that their safeguards requirements were inadequate and that exports should only be made to those countries which had placed their entire fuel cycles under the safeguards of the IAEA[16].

This policy was incorporated in the US Non-Proliferation Act of 1978 and is followed today by Australia, Canada and a number of Western European countries. Other exporters, however, continue to require IAEA safeguards only on the exporting item and its products and *not* on the entire fuel cycle of the importing country. With the slump in the nuclear manufacturing industry, which is operating today at half or less of its capacity, there is a risk that in the competition for scarce new orders, safeguards requirements may be scaled down. There is therefore a pressing need for international consensus on effective safeguards and the related question of assurance of supplies.

[16] The First NPT Review Conference, in 1975, also made recommendations to this effect.

## 5. NON-PROLIFERATION COMMITMENTS

### 5.1. The need for an international treaty – the NPT

Since "policies of denial" will not work in the long term, the chief hope for restraining the further spread of nuclear weapons resides in political and legal constraints and public attitudes. The most important factor is self-restraint – nations must continue to perceive, or come to perceive, that their national interests are not served by acquiring nuclear weapons (or unsafeguarded weapons-usable material); that, on the contrary, possessing nuclear weapons may diminish their national security. Whether a government reaches this perception and takes the decisive and sometimes difficult step of binding itself by treaty not to acquire nuclear weapons will depend chiefly upon its evaluation of the critical issues that affect its political and military security. Détente and other efforts to reduce international tensions and to defuse regional conflicts can help to tilt the balance towards a decision in favour of a binding non-proliferation commitment.

Public and political attitudes towards the acquisition of nuclear weapons have changed. Proliferation tended to be regarded as inevitable in the late 1940s and early 1950s, and the acquisition of nuclear arms carried no stigma. Today, however, it is increasingly regarded as an action that might endanger international peace and is therefore deplorable. Even the most frequently questioned unsafeguarded programmes in some of the NNW States are now stated to have no more than, at most, a "peaceful" nuclear explosive in mind.

If 20 to 30 countries are now technically capable of making nuclear explosives, and if within the next decades the number may double, what practical difference does it make whether a country uses this capacity to make nuclear weapons or keeps it directed to peaceful purposes? A change in its political situation could always prompt it to cross the line and it could do so without too much loss of time.

It must be recognized that this situation is what the future may hold. It is therefore all the more important that nuclear energy should be regulated by international commitments to ensure that it is in fact used only for peaceful purposes and that uncertainties be avoided by carrying out nuclear activities in the limelight of international safeguards. The most effective means of achieving this is adherence to the NPT, which enables States to ratify their renunciation of nuclear weapons in a formal and internationally binding manner and, by accepting IAEA comprehensive safeguards, to show that they are abiding by their commitment. As noted above, the majority of the world's nations have done so.

### 5.2. Regional initiatives – the Tlatelolco Treaty

The only existing regional measure to deter proliferation is the Tlatelolco Treaty, which preceded the NPT by two years and came into force in 1968. By mid-1982 it had been ratified by 24 Latin American States (out of a total of 29 eligible States). Brazil and Chile have ratified it and are thus under an obligation to refrain from any action contrary to the objectives and purposes of the Tlatelolco Treaty, but they have not taken certain additional legal steps without which the Treaty does not have full force in these countries[17]. Argentina has signed but not ratified the Treaty. Cuba and a few other smaller Latin American countries have not yet signed the Treaty.

Like the NPT, which in certain respects was modelled on it, the Tlatelolco Treaty requires the States that bring it fully into force to conclude safeguards agreements with the IAEA covering their entire nuclear fuel cycles. However, there are differing interpretations as to whether the Parties to the Treaty are permitted by it to acquire and detonate a nuclear explosive for *peaceful* purposes – a "peaceful nuclear explosive" (PNE). To avoid any such ambiguity, such an action is explicitly prohibited by Articles II and III of the NPT since the essential technology of nuclear explosives used for weapons or for PNEs is the same. The manufacture of any kind of nuclear explosive is also prohibited by all IAEA safeguards agreements including those with Parties to the Tlatelolco Treaty (all except one of these States have also ratified the NPT).

Despite this ambiguity in the Tlatelolco Treaty and the fact that it is not yet in force in Several Latin American countries, the Treaty offers an opportunity to transform Latin America into the first inhabited region of the world in which all forms of military and explosive use of nuclear energy would be prohibited by international law.

Both the NPT and the Tlatelolco Treaty require the application of IAEA safeguards to verify that the Parties are using nuclear energy only for permitted purposes. It is likely that any major treaty of this kind would do the same. The Tlatelolco Treaty also authorizes the Council which it established to arrange for special inspections if any Party suspects that another Party is carrying out a prohibited activity or will shortly do so – or if the suspected Party itself so requests. The Tlatelolco countries have not set up any machinery to carry out such inspections and none has taken place. However, it has been suggested that the concept of "adversary" or "challenge" inspections should form part of other regional agreements as a means of supplementing IAEA safeguards and ensuring that all nuclear plants are covered by them.

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[17] These conditions include the ratification of the Treaty by all the Latin American countries and the ratification of the Protocol of the Treaty containing certain undertakings by all the NW States and by all the countries still having international responsibility for territories in the region. States may waive these conditions, and all 22 Parties have done so.

### 5.3. Other regional initiatives

The example of the Tlatelolco Treaty has lent support to several proposals for similar measures, for instance in the Middle East, Africa, South Asia, in the Balkan countries and in Central Europe. So far, no new "nuclear-weapon-free zone" has advanced beyond the stage of a proposal except in cases where no major strategic or military interests were yet at issue[18].

The NNW States Parties to the NPT are debarred from acquiring their own nuclear weapons (or other nuclear explosive devices). However, neither their NPT obligations nor their safeguards agreements prohibit the *deployment* of nuclear weapons on their territories so long as such weapons are not under the control or jurisdiction of the NNW States in which they are located. In fact, such weapons, controlled by one or other of the main weapons States, are deployed in several NNW States[19] which are Parties to the NPT. Under the proposals for nuclear-free zones, however, the *deployment* of any nuclear weapon would be prohibited, i.e. the zone would be nuclear weapon free in every respect.

### 5.4. The right of withdrawal

The major political value of all the treaties mentioned is the formal undertaking by the State concerned not to acquire nuclear weapons or nuclear explosives (in the case of NPT) or not to permit nuclear weapons in its territory (e.g. the Tlatelolco Treaty).

However, no country can be prevented from withdrawing from a treaty or international agreement if it takes the political decision to do so. In the NPT, the right to withdraw from the Treaty is foreseen if a Party decides that *"extraordinary events related to the subject matter of the Treaty have jeopardized the supreme interests of its country"*[20]. Three months notice of withdrawal and certain other formal procedures are also prescribed. The expressions *"related to the subject matter"* and *"supreme interests of its country"* clearly imply that the events leading to withdrawal must have jeopardized the national security and

[18] The 1961 Antarctic Treaty – covering a region where little was at stake and agreement easily reached – prohibits all military activities including the testing of any weapon. The Outer Space Treaty of October 1967 prohibits the orbiting of nuclear weapons or their installation in celestial bodies or in outer space as well as the testing of any weapons on celestial bodies. The Seabed Treaty of May 1972 prohibits the deployment and testing of nuclear weapons on the seabed, the ocean floor or the earth beneath it.

[19] The Tlatelolco Treaty, on the other hand, explicitly prohibits the receipt, storage, installation and deployment of any nuclear weapon in the territories of any of the Parties.

[20] This clause was originally proposed by the USA for inclusion in the Moscow Test Ban Treaty to provide for the contingency that it might at some time consider that there were compelling national security reasons to resume atmospheric and underwater testing.

survival of the State concerned – for instance the threat of a nuclear attack by another State.

In the twelve years since the NPT came into force no country has withdrawn from it. Nor has any country withdrawn from the 1963 Moscow Test Ban Treaty or the 1967 Tlatelolco Treaty, both of which contain similar withdrawal clauses. Nor has any breach of any of these treaties been established or seriously alleged.

## 6. THE ROLE OF SAFEGUARDS

In these circumstances, the chief value of safeguards is to provide evidence, as a confidence-building measure, that the country which has accepted these safeguards is faithfully abiding by its obligations. In this way, the assurance given by safeguards contributes to international security, lessens international tensions, facilitates international trade and helps to form mutually profitable links between States. A subsidiary purpose of safeguards is to deter any breach of treaty by the risk of early detection and by the ignominy and sanctions that might follow a detected breach. The extent to which safeguards are perceived as an assurance or as a deterrent varies somewhat from country to country – both according to the country in which they are being applied and in the perceptions of other countries. The deterrent element may also be more important to a supplying State if the importing State is not a Party to the NPT and has therefore *not* pledged itself to forgo nuclear weapons and other nuclear explosive devices. These matters are examined in Section 7.

### 6.1. Early steps to safeguards

As indicated, international safeguards are an institution which is historically unique. There were no precedents on which to build the system; it had to be set up largely from scratch and improved by trial and error.

Some of the main concepts go back to 1945 when, as we have seen, the USA proposed to the UN the ambitious Baruch Plan (see footnote 1) for establishing an International Atomic Development Authority to which should be entrusted *"all phases of the development and use of atomic energy"* from raw materials to the management and ownership of all potentially dangerous atomic energy activities, and power to control, inspect and license all other atomic activities. In a later variant of this plan, international ownership and management would have been confined essentially to enrichment and reprocessing facilities[21], while other nuclear activities would have been conducted under international safeguards.

[21] This concept was revived in the mid-1970s in proposals, which have so far not borne fruit, for establishing regional or multilateral fuel cycle centres. A study on this matter was carried out by the IAEA in 1977.

After the failure of the Baruch Plan, the main elements of safeguards were incorporated in US bilateral agreements for supplying material to other countries. These agreements gave the USA the right to examine design information, call for reports and carry out inspections.

These rights were subsequently incorporated in the IAEA's Statute and in its safeguards system.

### 6.2. The NPT safeguards system

The 1965/1968 system contained in INFCIRC/66 and its revisions was designed chiefly to apply to *individual* plants or to supplies of plant and material from particular countries.

When the NPT entered into force it was necessary to devise a system which would cover the flow of nuclear material through the *entire fuel cycle* of the country accepting NPT safeguards as well as international transfers of nuclear material between facilities in different countries. The system – in effect, the model agreement drawn up for this purpose, INFCIRC/153 – is divided into two parts. The first contains the political and general obligations of the State and the IAEA; in some respects this corresponds to the earlier 1965/1968 system. The second part contains an elaborate technical articulation of the safeguards to be applied. It reflects and embodies the very rapid evolution of safeguards approaches and techniques that had taken place in the 1960s. Using the language of the NPT itself, INFCIRC/153 explicitly prohibits any form of explosive use of safeguarded material. It does not, however, exclude withdrawal of material for other military uses of this material, but such withdrawal is subject to a number of strict conditions.

Under the NPT, the principal object of safeguards is nuclear material and not nuclear facilities as such[22]. The status of a plant which is said to contain *no* nuclear materials and the IAEA's right to inspect it are therefore somewhat unclear, although INFCIRC/153 does confer certain safeguards rights on the IAEA and imposes certain obligations on the State even in these cases.

[22] In practice, of course, the IAEA devises a safeguards approach for every facility and this takes into account "design information" which the State submits to the IAEA for each facility. The safeguards approach is incorporated in the Facility Attachment agreed to for each facility.

### 6.3. Full-scope and selective safeguards

The NNW States Parties to the NPT and the Parties to the Tlatelolco Treaty engage themselves to accept what is known as (de jure) full-scope safeguards[23]. In a small number of other States which have not made such a far-reaching commitment, a mosaic of individual safeguards agreements covers at present all nuclear activities of which the IAEA is aware from publicly available information (de facto full-scope safeguards). Finally, there are four NNW States in which both safeguarded and unsafeguarded nuclear facilities are in operation[24].

In all three cases, the State requests the IAEA fo apply its safeguards (although such a request may be a condition for obtaining nuclear supplies). However, the degree of assurance that the safeguards offer obviously differs between the three categories. In the first case, the intention is to provide a continuing assurance of non-proliferation. In the second case, the assurance given is that, at a particular time, all nuclear material or equipment of which the IAEA is aware is being used for non-explosive peaceful purposes. In the third case, this assurance would only relate to safeguarded facilities and no assurance could be given about those in which safeguards were not being applied.

### 6.4. Safeguards in evolution

After the IAEA Board of Governors had reached agreement on and approved each of the two safeguards documents (INFCIRC/66/Rev.2 and INFCIRC/153/ corrected), the IAEA faced the task of translating them into an effective operation for safeguarding and verifying the nuclear industries or those parts of them to which safeguards were to apply. It was necessary to organize and build up a specialized staff and to provide training in a new profession, that of an international inspector. It was also necessary to develop new techniques, procedures and strategies and to devise and deploy specialized instruments. The States in which safeguards were being applied had to learn to accept a novel experience, that of having international officials (always of another nationality) inspect one of their industries and research activities, moreover a particularly advanced and sensitive

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[23] The term "full-scope safeguards" covers two situations. It has been interpreted as a legal commitment to accept safeguards on all of a State's nuclear activities, for instance, while the State is party to a treaty which obliges it to do so. It has also been interpreted as a situation in which all the known nuclear activities of a State happen to be safeguarded at a particular time, by virtue of the operation of a mosaic of individual safeguards agreements applying to particular facilities or supply arrangements. In this case, the State concerned is under no continuing obligation to have safeguards applied on all of its facilities. On the contrary, it is legally free to build and operate unsafeguarded facilities. The first type of full-scope safeguards is sometimes referred to as "*de jure* full-scope" and the second as "*de facto* full-scope" safeguards.

[24] India, Israel, Pakistan and South Africa.

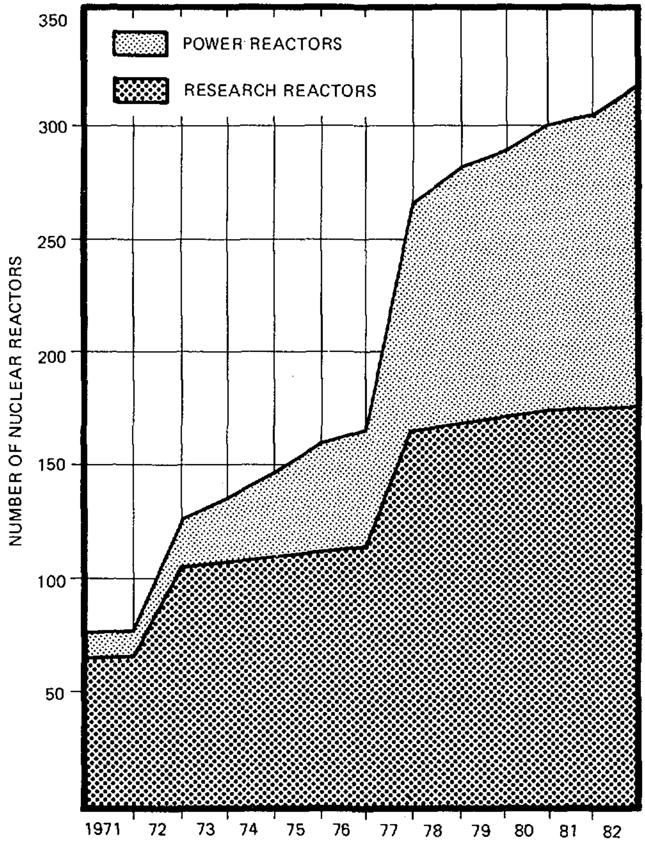


*FIG.2. Number of nuclear reactors under safeguards in non-nuclear-weapon States.*

one. The industry itself had to submit to the discipline[25] of international safeguards, of supplying design information to an international authority, of keeping the records required by that authority and opening them to its inspectors, of sending reports within a prescribed time limit to the authority, and of accepting its inspectors in their plants. In addition, under NPT safeguards, in due course the industry and governments had to co-operate in establishing what are known as State Systems of Accounting and Control (SSAC) as an infrastructure to ensure the effective operation of IAEA safeguards. Most of this evolution took place in the years after the NPT came into force, and particularly in the late 1970s after the ratification of the Treaty by leading industrial States when their large fuel

[25] The Member States of the European Atomic Energy Community voluntarily accepted a similar discipline in the late 1950s. However, Euratom's inspectors are nationals of Euratom States, and sometimes of the State in which safeguards are being applied.

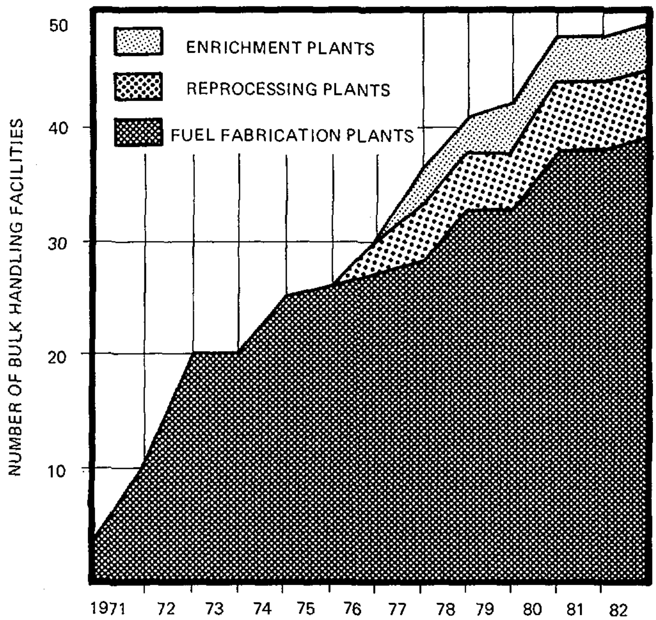


*FIG.3. Number of bulk handling facilities under safeguards in non-nuclear-weapon States.*

cycles began to come under the IAEA's safeguards and when the nuclear industry in many NPT countries was rapidly expanding. This is shown in Figs 2 and 3.

What is surprising is not that the system has encountered difficulties but that it has worked so well and so successfully despite its teething troubles.

As may be expected of a complex of novel administrative, scientific, technical and political measures, the system is in constant evolution. Progress is being made in overcoming most of the problems it has been faced with. The IAEA's safeguards are now anchored in the NPT, the Tlatelolco Treaty and in 153 safeguards agreements in force with 90 countries. The IAEA has now fully taken over the role once played by bilateral safeguards, and it has established itself as one of the major elements in the international non-proliferation regime. IAEA safeguards have become a prerequisite for nearly all international agreements for the supply of nuclear plant and materials and for the transfer of significant nuclear technology.

## 7. POSITIVE INTERNATIONAL MEASURES – COUNTER-MOTIVATION

If embargoes and other restraints are the stick of non-proliferation policies, positive measures to diminish international or regional tensions are the even more important carrot. It is necessary to create and maintain the political conditions conducive to the decision to relinquish nuclear weapons.

This is, first, a question of whether and how effectively the foreign policies of the great powers foster greater security, particularly in the more volatile regions of the world. Secondly, the relations between the NW States themselves are also crucial. It was not possible to develop an acceptable international safeguards system during the years of the Cold War. A third factor is action and agreement at the regional level, in particular for the creation of the nuclear-weapon-free zones. As noted above, another confidence-building measure would be a comprehensive test ban treaty.

Greater assurance of the supply of nuclear plants, material and technology under effective safeguards to countries building up their nuclear industries would also help to build confidence between States. As indicated, such assurances are implicit in Article IV of the NPT, which provides that *"all the Parties to the Treaty undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information of the peaceful uses of nuclear energy"*. This point was stressed at the Second NPT Review Conference, in 1980, to review the operation of the NPT[26].

INFCE also stressed the importance of the unresolved question of nuclear supply assurances, and at the end of 1980 the IAEA Board of Governors established a Committee on Assurances of Supply with a mandate *"to consider and advise the Board of Governors on ways and means in which supplies of nuclear material, equipment and technology and fuel cycle services can be assured on a more predictable and long-term basis in accordance with mutually acceptable considerations of non-proliferation and the Agency's role and responsibilities in relation thereto"*[27].

One of the main barriers to horizontal proliferation has been the growth of an *international* fuel cycle during recent decades and the consequent international interdependence in which countries rely upon each other increasingly for vital supplies or services. Conversely, the extension of national fuel cycles, including enrichment and reprocessing plants, would mean that an increasing number of countries would have direct access to weapons-usable material[28]. While in the long term it may not be possible to prevent this, a stable system of supply assurances could help to discourage the construction of uneconomic national plants.

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[26] These review conferences are held every five years; see NPT Article VIII.3.

[27] Terms of reference of the Committee on Assurance of Supplies.

[28] In the second half of the 1970s, most of the countries that are the chief suppliers of nuclear plant and materials required certain additional safeguards and other conditions on their supplies (the "London Guidelines"). Many importing countries objected to what they saw as unilateral actions that went beyond the requirements of the NPT.

# III. PURPOSES AND OBJECTIVES OF SAFEGUARDS

## 1. ASSURANCE

IAEA safeguards implementation is regulated by the IAEA Statute and by safeguards agreements. These documents define, inter alia, the purposes and technical objectives of safeguards[29]. Under Article III.A.5 of the Statute, the IAEA is authorized:

> *"To establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose; and to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy."*

The first part of Article III.A.5 refers to the original concept of the IAEA as a major supplier or broker for the supply of nuclear materials and plants, a concept which did not materialize. Present safeguards are based almost exclusively on the second part of the Article.

As noted above, the safeguards agreements are based either on INFCIRC/66/Rev.2 or INFCIRC/153. Paragraph 46 of INFCIRC/66/Rev.2 states that the purpose of safeguards inspections shall be, among other things, to verify compliance with safeguards agreements. Paragraph 2 of INFCIRC/153 stipulates more specifically that safeguards will be applied "*. . . for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices . . .*".

Both provisions place the emphasis on verification. The IAEA's independent verification enables a State to demonstrate to other States that it is abiding by its obligations under the NPT, the Tlatelolco Treaty or, in the case of INFCIRC/66/Rev. 2 agreements, the particular agreement in question. Since the acceptance of safeguards is the consequence of a deliberate and legally binding international commitment, the normal result of the IAEA's verification will be to demonstrate compliance with the commitment.

It is the Director General's obligation promptly to bring to the attention of the Board of Governors any event or situation which may lead the Secretariat to conclude that nuclear material has been diverted from peaceful uses. In the twenty years during which IAEA safeguards have been applied no such case has occurred.

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[29] A more detailed analysis can be found in *Main Features of Safeguards Agreements* (IAEA/78-9671/Sep. 1978).

## 2. INABILITY TO PROVIDE ASSURANCE

It is also the Director General's duty promptly to inform the Board of Governors if events or circumstances arise which make the IAEA "... *not able to verify that there has been no diversion of nuclear material required to be safeguarded* ... "[30]. Such events would not be limited to accounting anomalies which could not be adequately explained (for instance, if nuclear material were missing). They might also arise because of: the continuing refusal by a State to accept the necessary inspectors; restrictions or other problems preventing inspectors from having adequate access to safeguarded plants or materials; restrictions on the use by the IAEA of necessary safeguards equipment; or if the State had failed to report nuclear material or nuclear facilities required to be reported. If the Board of Governors were to find that the IAEA was not able to verify the absence of diversion, it would be entitled to invoke any or all of the sanctions provided for in the IAEA Statute.

There have so far been only two cases in which the Director General found it necessary to report to the Board that the Secretariat was for a certain period unable to provide the required assurances, and both cases were subsequently resolved[31].

## 3. DETERRENCE

The wording of the above quoted clause in NPT agreements ("... *not able to verify that there has been no diversion* ...") also implies that the normal result of the IAEA's verification activities will be the assurance of absence of any diversion rather than the detection of violations.

The possibility cannot, however, be excluded that a State might contemplate diverting nuclear material. Hence, paragraph 28 of INFCIRC/153 defines another purpose of IAEA safeguards: "... *the deterrence of such diversion by the risk of early detection*".

Safeguards must therefore be effective enough, and be perceived to be effective enough, to entail a substantial risk that the diversion of significant quantity of nuclear material would be detected at an early date.

The risk of detection should also be sufficient to make it preferable for any State which had decided to acquire nuclear weapons to choose for this purpose a path *other* than clandestine diversion. In the case of an NNW State Party to the NPT, such a path might be the denunciation of the NPT which, as we have seen,

[30] This is the language of a standard NPT agreement clause; see paragraph 19 of INFCIRC/153.

[31] The agreements in question were concluded under INFCIRC/66/Rev.2 and not under the NPT.

is possible upon three month's notice if the State decides, in the language of Article X of the Treaty, "*. . . that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interest of its country*". For States not Parties to the NPT, the alternative path might take the form of abrogating relevant safeguards agreements. In all such instances the State's action would attract much attention and the State concerned would expose itself to penalties which might be severe. A notice of withdrawal from the NPT or the abrogation of a safeguards agreement by a non-NPT State might be interpreted as a declaration of intent promptly to acquire nuclear weapons and might thus trigger economic, political and possibly military repercussions.

As another option, the State might consider the construction of an unsafeguarded fuel cycle. In the case of an NNW State Party to the NPT this would mean a breach of the treaty.

A State confronted by these choices would evaluate the consequences of a detected diversion. This raises the question of sanctions.

## 4. SANCTIONS

By itself, detection of non-compliance might not represent a meaningful risk to the State if it did not believe that such detection would attract effective sanctions. The question of penalties or sanctions is sensitive and important but it has received relatively little attention in recent years. Some general observations may be made.

First, certain formal sanctions are provided for in the IAEA Statute. If a State fails to comply with a safeguards agreement, the Board of Governors is required under the Statute to call upon it *"to remedy forthwith any non-compliance which it* [the Board] *finds to have occurred"* (Statute Article XII.C). The Board must also report the non-compliance to all Members of the IAEA as well as to the Security Council and the General Assembly of the UN. If the State fails to take *"fully corrective action within a reasonable time"* (Statute Article XII.C) the Board may curtail or suspend assistance to it and may call for the return of materials and equipment made available to it. The IAEA may also suspend the State from the exercise of the privileges and rights of membership. It is likely that, at a minimum, a State would be exposed to some public humiliation if the IAEA formally determined that it had violated its international obligations.

Formal sanctions imposed by the international community acting *collectively* – for example, by the League of Nations against Italy in 1936 and by the UN against Southern Rhodesia in 1968 – have not been very effective. The most important sanctions would, however, be the *individual* reactions of other States to the determination made by the IAEA and the alert that it had given.

The experience of the UN and other organizations has shown that States are very reluctant to specify in advance the sanctions that they would agree to impose for the breach of any treaty or agreement.

It is unlikely that the sanctions imposed by other States on the offending State would be the same in every case (if one should ever occur). On the contrary, it is probable that they would differ according to the geopolitical situation of the offending State, the extent to which programmes were dependent upon external supplies, and other economic and political factors.

# IV. TECHNICAL OBJECTIVES OF SAFEGUARDS

Document INFCIRC/66/Rev. 2 does not contain explicitly formulated technical objectives. Specific approaches have, however, been developed through practice in devising verification procedures[32]. The experience gained in applying safeguards in accordance with these approaches was drawn on in formulating the technical objective of IAEA safeguards to be applied under the NPT.

The technical objective of these safeguards is made explicit in paragraph 28 of INFCIRC/153:

> "*. . . the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown . . .*".

These objectives together with the purposes of IAEA safeguards are summarized in Table I.

Four terms require quantification for planning implementation and for evaluating performance: significant quantities, timely detection, risk of early detection and the probability of raising a false alarm, i.e. of wrongly concluding that there has been non-compliance with an agreement. The associated numerical parameters:

- significant quantity
- detection time
- detection probability
- false alarm probability

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[32] For details see *IAEA Safeguards: Glossary* [3] and *IAEA Safeguards: Guidelines for States' Systems of Accounting for and Control of Nuclear Materials* [5].

TABLE I. SUMMARY OF PURPOSES AND TECHNICAL OBJECTIVE OF IAEA SAFEGUARDS

| | | |
|---|---|---|
| PURPOSES: | *To give assurance* | if no diversion or misuse occurred |
| | *To deter* diversion or misuse | if contemplated |
| | *To detect* diversion or misuse | if undertaken |
| Obligation of the IAEA: | | |
| | *To alarm* | if diversion or misuse is suspected |
| | *To report* | if verification is inadequate or impossible |
| TECHNICAL OBJECTIVE: | Timely detection of diversion of significant quantities of nuclear material or misuse of other items | |
| Verification measures: | Nuclear material accountancy, containment and surveillance | |

constitute *detection goals.* These parameters cannot be deduced from physical or technical axioms; policy as well as technical factors must be considered in selecting them. The present detection goals were presented to the Board in the Safeguards Implementation Report (SIR) for 1977 (GOV/1911).

The values for detection goals were set on a provisional basis. They will be used until new goals are developed which would help to improve the effectiveness and efficiency of safeguards.

The detection goals are not rigid requirements but serve as guidelines from which the IAEA may derive the targets of actual verification activities, the *inspection goals.*

## 1. SIGNIFICANT QUANTITY

For a national system designed chiefly to protect nuclear material against theft or acts of terrorism (a "physical protection" system), a relatively small quantity of nuclear material may be regarded as "significant", for instance, because of its high toxicity (e.g. plutonium). International safeguards are, however, intended chiefly to verify that governments are not acquiring nuclear weapons or other nuclear explosive devices. A relatively large quantity of nuclear material is needed to make even a single nuclear explosive device. This *"threshold amount"* has been estimated as[33]:

- 8 kg of plutonium (containing more than 95% of the isotope Pu-239);
- 25 kg of uranium (containing more than 90–95% of the isotope U-235);
- 8 kg of U-233.

These threshold amounts include the material that will unavoidably be lost in manufacturing a nuclear explosive device. They should not be confused with the minimum critical mass needed for an explosive chain reaction, which is smaller[34].

In practice, safeguards are applied to nuclear materials which contain various proportions of uranium and plutonium isotopes and proportions of plutonium and uranium. It is therefore necessary to define a "significant quantity" (SQ) for each category of nuclear material so that we may specify the amount of material the diversion of which safeguards should be designed to detect. In a given situation the SQ is defined as *"the approximate quantity of nuclear material in respect of which, taking into account any conversion process involved, the manufacturing of a nuclear explosive device cannot be excluded"*[35]. The SQ differs according to whether the material could be directly used for a nuclear explosive device or whether it would first require further transmutation or enrichment (indirect-use material).

For direct-use material the SQs have been set at present to coincide in weight (though not exactly in composition) with the threshold amounts:

- 8 kg of plutonium element (containing, however, less than *80%* Pu-238);
- 25 kg of U-235 contained in uranium enriched to *20%* or more;
- 8 kg of U-233.

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[33] See UN Document A/6858 of 6 Oct. 1967, *Effects of the Possible Use of Nuclear Weapons* . . . .

[34] Using highly sophisticated techniques available to NW States, the critical mass and the corresponding threshold amount can also be significantly reduced, but these are special cases that need not be considered here.

[35] This is a technical definition used in designing and evaluating safeguards approaches. The quantity of nuclear material that might be significant in a political sense would, however, differ very widely according to the circumstances of the State and other political factors. The diversion of (or inability to account for) a single SQ by a NNW State might in certain circumstances have considerable political repercussions and local military significance. In another NNW State, the inability to account for a single SQ might have much less significance, and in a NW State a single SQ would hardly have any political or military meaning.

For indirect-use material the SQ for low enriched uranium (enriched to less than 20%) is 75 kg of contained U-235, which is, for instance, the amount of U-235 contained in about 10 tonnes of natural uranium[36].

However, the actual *inspection goal* for a particular facility need not, and in some cases cannot, rigidly aim at detecting the diversion of a single SQ (the detection goal). In practice, the IAEA must take account of: (a) the current status of the technology for measuring nuclear materials (how accurate is it?); (b) the type and throughput of the facility; (c) the amount and form of the nuclear material present in it (for instance, is the material in the form of discrete *items* such as fuel elements, or is it in *bulk* such as powder, solutions, gases and pellets?); and (d) what can reasonably be required of the plant operator.

In the case of reactors fuelled by solid assemblies, that number of assemblies which contains one SQ would be set as the inspection goal for those verification activities using *sampling techniques,* for instance, when non-destructive assay (NDA) of a representative number of assemblies is used to verify that there are no "dummy" assemblies in the reactor or in the spent fuel pond.

The inspection goal for *item counting* in a typical research reactor is, however, to detect the absence of a single fuel assembly, which normally contains not more than 400 grams of highly enriched uranium. In other words, the inspection goal for *item counting* in this case is far below a single SQ (25 kg) of highly enriched uranium. Similarly, the inspection goal for item counting at an LWR is to detect the absence of a single assembly. This would normally contain at the most up to one half of the SQ for plutonium.

The situation may be different in large bulk handling facilities (chiefly conversion, fuel fabrication, reprocessing and enrichment plants). As noted, verification at many reactors consists chiefly of counting, identifying and measuring individual and usually relatively large items. In bulk handling plants, verification requires measurement of large quantities of nuclear materials of different physical forms and chemical composition including materials of *low quality* such as scrap or waste. No instrument or measurement procedure ever ensures complete accuracy, and there are inevitably measurement uncertainties. Today these uncertainties are generally of the order of 1% of the total amount of nuclear material measured or sampled. It should be emphasized that this measurement uncertainty does not reflect an actual physical loss or gain of material.

One per cent of the inventory or throughput of a large bulk handling facility may be larger than 1 SQ – in some cases considerably larger. It would, however, be unreasonable to set a target that cannot be technically achieved today, and this uncertainty must be taken into account in setting the final inspection goals.

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[36] SQs have also been set for U-233 and thorium, and rules have been laid down for determining the SQs for mixtures of various elements.

Most of the large bulk handling facilities in this category which handle direct-use material are in NW States and none is yet under safeguards. A number of smaller fuel fabrication, reprocessing or enrichment plants which handle much smaller quantities of plutonium or highly enriched uranium are already under safeguards. At these plants, with one exception, an inspection goal of 1 SQ (i.e. the capability to detect the absence of 1 SQ or more) can still be achieved by accounting techniques, although sometimes with difficulty. New methods and approaches which may require a different set of goal quantities are being developed for the larger facilities which may come into operation and under safeguards during the 1990s.

Several bulk handling plants processing large quantities of indirect-use material, for example low enriched fuel (particularly fuel fabrication plants), are also under safeguards. Because of measurement uncertainty and other factors, it has been necessary in a few cases to set an inspection goal of up to five SQs. This means that the possibility cannot be excluded (with the degree of confidence desired, i.e. 90–95%) that an SQ of low enriched uranium could be diverted at such plants without the IAEA detecting the diversion by verification activities confined to the plant. This does not mean that safeguards are ineffective in such cases. To obtain weapons-usable material, diverted low enriched uranium would have to be put into a reactor to produce plutonium or would have to be enriched in an enrichment facility. There would thus be additional opportunities to detect diversion.

In a large fuel cycle it would be theoretically possible to divert considerable quantities of material by "partitioning", i.e. by aggregating diversions of less than 1 SQ at each of a large number of facilities; in other words, by diverting quantities which are less than the limits that might be set for detection goals at each of these facilities. The strategy in question would, however, involve different types and classes of material and would require a concerted effort by a large number of installations, operators and their staff. It is therefore unattractive and entails high risks. Conversely, if the IAEA attempted to counter such very hypothetical scenarios, a politically unacceptable inspection regime would be required, similar to a national physical protection system. The IAEA's goals must be politically realistic and must take into account the technical capabilities of the verification measures available.

Finally, it should be borne in mind that the adoption of a detection goal of several SQ does not mean that the diversion of a single SQ or even smaller quantities could not be detected at all. Detection is possible also in this case, but with a smaller probability.

The situation is obviously not entirely satisfactory and the limitations of nuclear materials accounting must be offset by the development of effective containment and surveillance measures and by improving the techniques for measuring and accounting for nuclear materials.

## 2. TIMELY DETECTION

Since timely detection is a requirement of IAEA safeguards, the term *"timely"* must be quantified to the extent possible so that the IAEA can design the safeguards approaches that will assure the necessary degree of timeliness. The practical interpretation given to timely detection – days, weeks, or months – varies according to the type of nuclear material being safeguarded (for example, natural uranium is at one end of the scale and metallic highly enriched uranium or plutonium at the other).

To establish a practical starting point for this quantification, it is necessary to look at *"conversion times"* – the time required under optimal conditions to convert various forms of nuclear material into the metallic components of a nuclear explosive device. On the advice of the IAEA's Standing Advisory Group on Safeguards Implementation (SAGSI), typical conversion times have been set at:

- Seven to ten days for Pu-239 or highly enriched uranium in metallic form,
- One to three months for plutonium in irradiated fuel, and
- About one year for natural or low enriched uranium.

These are obviously rough approximations[37].

Further, on the advice of SAGSI, the IAEA has provisionally set a *detection time* of the same order of magnitude as the corresponding conversion time[38]. This is a guideline: in setting the *actual inspection goal* for a particular facility, the timeliness of detection aimed at must be achievable with reasonable effort on the part of the IAEA and the operator of the facility.

There are practical difficulties in reconciling short detection times with the requirements of normal operations at bulk handling facilities. If, for instance, the IAEA were to set a detection time equal to the conversion time (i.e. seven to ten days for plutonium or highly enriched uranium) and were to achieve timeliness only by complete inventory-taking, then physical inventories should also be taken every seven to ten days. In practice, however, a proper physical inventory requires shutting down the process operation, cleaning out the process equipment and, in the ideal case, converting the materials in the process into a form in which they can be accurately measured. It often takes more than seven to ten days to complete such an inventory. In this case, a total loss of production would result.

In practice, therefore, not more than four inventories requiring the shutdown of the process can be carried out each year. In fact, most plant operators would be reluctant to consider more than one or, at most, two. In such cases, the "timeliness" of detection that can be achieved by complete inventory-taking is in the range of three months to one year. Whatever procedure is followed, the

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[37] It is assumed inter alia that the non-nuclear components of the device have been tested and a set has been prepared for the insertion of the nuclear components.

[38] "Order of magnitude" is understood in this context as a factor of one to three.

IAEA requires that there should be at least one complete physical inventory per year. This is sufficient to achieve the timeliness goals for low enriched and natural uranium.

Where the number of inventories that can be taken each year is not enough to reach the timeliness goals, other measures are undertaken to achieve the desired detection capability. If the safeguarded material is relatively static (e.g. spent fuel in a storage pond), it can be kept under surveillance by cameras, or seals can be applied. Automatic tamper-proof, twin-film camera systems take pictures of the storage ponds at short intervals. Evaluation of the film at intervals of two to three months enables the inspector to detect any unreported removal of spent fuel from the pond within the timeliness goal for spent fuel containing plutonium.

In the case of plutonium and highly enriched uranium, the inspection goals are set at two to three weeks, i.e. at the upper end of the range recommended by SAGSI. If the material is moving through the plant (e.g. in a reprocessing or fabrication plant) these goals are met as far as possible by frequent partial inventory-taking carried out in such a way as to minimize disturbance of plant operation. At some larger plants the IAEA also requires the continuous presence of inspectors to verify the internal *flow* of nuclear material, and thus to achieve the timeliness goal.

The IAEA is also studying "near-real-time" accountancy. This method involves taking many very frequent "in-process" partial inventories. Installed process control instrumentation is used for this purpose as well as advanced statistical techniques and computers.

Containment and surveillance measures may also assist in achieving timely detection at bulk handling facilities. For instance, sealing of material not in active use may make it unnecessary to repeat at frequent intervals the verification of measurements already made and of data already collected.

It should also be borne in mind that the contingency that short detection times are chiefly designed to deal with is that of a State planning to divert "abruptly" a relatively large quantity of nuclear material. Although this "diversion strategy" cannot be excluded, it is even less likely than the "protracted" diversion scenario in which the State would divert many small amounts of nuclear material over a lengthy period of time[39]. In this case, the diverter would need a

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[39] Assessing the likelihood (or improbability) of a particular diversion scenario involves complex political as well as technical factors. However, if, for instance, NPT NNW States were intent on using safeguarded nuclear material for a weapons' programme, it would be difficult to see what advantage the State would gain in abruptly diverting several SQs of material – since it would know that this diversion would be detected at the next inventory-taking, if not before. We must remember that the State could *legally* withdraw from the NPT in giving three months' notice and thus withdraw all nuclear material in the country from NPT safeguards. (Some material might in some cases revert to INFCIRC/66/Rev.2 or other "fall-back" safeguards.) On the other hand, it is conceivable, though unlikely, that a State might contemplate the possibility of diverting small amounts of nuclear material with a low risk of detection over several years and thus have a clandestine stockpile to draw upon in an emergency.

considerable time to collect one SQ or more and the need for a short detection time does not arise.

Nevertheless, the number of countries that would be *technically* able to stage an abrupt diversion is bound to grow as both reprocessing technology and the ability to produce highly enriched uranium become more widespread and as the amounts of these materials in accessible form increase. The IAEA must therefore strive to enhance the effectiveness of safeguards and expand its verification activities at reprocessing and enrichment facilities and at stores of plutonium and highly enriched uranium. Continuous human or instrumental inspection may be necessary as well as improved containment and other surveillance measures.

## 3. "RISK OF TIMELY DETECTION" – DETECTION PROBABILITY

If a State should contemplate diversion, it would form its own concept of how great would be the risk of timely detection (as well as the penalties that would follow.) Its perception would depend on several factors.

No system is able to detect diversion with 100% certainty. From the IAEA's point of view, however, the objective must be to make the probability of detection sufficiently high both to deter a State from making a decision to divert and to provide the necessary degree of assurance to the international community. To the extent possible, the IAEA should also be able to assess the probability of detection objectively and, if possible, to quantify it.

The matter is complex. While the IAEA can, to some extent, adjust *detection probability* by varying the intensity of its safeguards, it cannot know what *perception of risk* the State concerned might be forming. Nor can the IAEA be certain of the penalties that the international community would inflict on any State detected in a diversion. What degree of assurance will be adequate for the international community is also a matter of judgement.

At present it is only possible to quantify the detection probability that can be achieved by materials accounting. In particular, sampling techniques are used to achieve the required detection capability with the minimum of effort. Their use avoids the need for verification of all the nuclear material present at a facility. Randomly selected samples of the material are verified. The number of samples to be taken depend on the total amount of material, the detection goal, the measurement accuracy, the desired probability of detection, and the acceptable probability of false alarm. The IAEA aims at a 90–95% detection probability level and less than 5% probability of false alarms[40].

[40] The value of 5% is only used for determining sample sizes. The actual false alarm probability is far lower because an anomaly detected by sampling would be followed by follow-up actions in order to exclude innocent cases.

Whereas the detection probability of material accountancy can be predetermined, there is no satisfactory method for quantifying the additional detection probability achieved by using surveillance and containment measures as a complement or by verifying the flow of materials. Thus, there is today no method for calculating the *overall* detection probability at any plant where, as is normally the case, both materials accounting and containment and surveillance measures are used. In fact, the extent to which a prescribed overall detection probability can be achieved is affected by many factors. These include the type of facility, the nature and extent of the State's nuclear fuel cycle, the co-operation of the State and, of course, the manpower and equipment resources available to the IAEA.

With greater experience and resources, improvements in accounting and inspection procedures, the development of more sophisticated and reliable containment and surveillance measures, and improvements in SSACs, the IAEA expects that the overall detection probability, and thereby the effectiveness of its safeguards, will further increase. The eventual target is to achieve full attainment of the inspection goals at all facilities under safeguards.

## V. CREDIBILITY OF THE IAEA'S CONCLUSIONS

Each year the Secretariat submits to the Board a report on the preceding year's safeguards operations (the Safeguards Implementation Report or SIR). This sets forth the main conclusions reached, draws attention to deficiencies revealed and recommends steps to remedy them.

For the past five years the Board of Governors has reported to the IAEA General Conference that, on the basis of the corresponding SIR, *"the Secretariat considers it was reasonable to conclude that all safeguarded material remained in peaceful nuclear activities or was otherwise adequately accounted for".*

The SIR contains ample detailed information and analysis for judging the validity of this conclusion. In 1982, the conclusion was based on almost 1700 inspections at about 500 facilities as well as on about 655 000 items of information processed by the IAEA computer. The conclusion was also subject to a number of observations most of which relate to matters in which improvements are required.

Each year, the IAEA's verification activities detect numerous anomalies and inconsistencies. Most of them are minor and, after investigation, each has been resolved, but the fact that so many are detected gives an indication of the detection capabilities of the system. Anomalies are usually due to printing errors, problems of interpretation, measurement errors and instrument failures.

The SIR's and the Secretariat's conclusions have not been challenged, and subsequent developments have tended to strengthen and confirm them. For instance, small facilities which could not be inspected during the year covered by the SIR were inspected in the following year; accounting operations in subsequent years have tended to confirm the accuracy of conclusions reached during preceding years and to cast further light on any earlier anomalies. There have never been any overt signs of diversion of safeguarded material and no allegation of such diversion has been made.

The IAEA provides information about the safeguards operation in many ways besides its statutory reports and public information documents. The Director General regularly reports to the Board on the safeguards operation and on any significant problems that arise[41]. In the absence of any report by the Director General, the Board is entitled to assume that no serious problems are being encountered.

The information generated by IAEA safeguards is, however, only one, although an important one, of several sources of information about the nuclear activities and intentions of States. One of the main merits of the system is to draw attention to situations of potential risk so as to permit the action of political forces external to the IAEA.

In other cases nuclear programmes, even in NPT NNW States, which appear to have little technical or economic justification are likely to attract attention, but it should be stressed that the IAEA has neither the authority nor the means of evaluating the future nuclear intentions of States, whether they are Parties to the NPT or not.

A State not Party to the NPT or Tlatelolco Treaty is under no obligation to report all its nuclear material or facilities to the IAEA. Therefore, even if all *publicly known* facilities are under safeguards there may still be uncertainty about the completeness of safeguards coverage. Moreover, since the State is free to build unsafeguarded plant and produce unsafeguarded weapons-usable material (to the extent that this does not conflict with bilateral or INFCIRC/66/Rev.2 agreements), there may be uncertainty about its future intentions in this regard.

Finally, a NNW State which is known to be operating or building unsafeguarded nuclear facilities capable of producing weapons-usable material will be perceived as being able to carry out a nuclear explosion at relatively short notice[42].

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41 Since the Board's meetings are private, such information is not normally directly communicated to the public information media. However, all papers presented to the Board and the records of all its proceedings are distributed to each of the 111 Member States of the IAEA.

42 There is, of course, a significant technological distance between having weapons-usable material and being able to construct and detonate a nuclear explosive device. There is also a considerable technical distance between such a device and, for instance, the nuclear warhead of a missile. And there is also a considerable distance in terms of military capabilities between one or a few warheads and a nuclear arsenal.

It has thus often been said that the true risk of nuclear proliferation starts where IAEA safeguards end, and that those who are concerned about proliferation should focus principally on such cases rather than on the limitations of IAEA safeguards where they are fully applied.

## VI. LIMITATIONS AND PRACTICAL PROBLEMS

It is important to understand the inherent limitations under which IAEA safeguards must operate.

### 1. VOLUNTARY ACCEPTANCE OF SAFEGUARDS

The IAEA has no power to compel any country to sign any treaty or agreement on safeguards. All safeguards agreements are entered into at the request of the country or countries concerned. They may result from treaty obligations or because safeguards are a condition set by the supplying country for the import of nuclear plant, material or technology. The 118 NNW States Parties to the NPT and those NNW States Parties to the Tlatelolco Treaty fall into the first category. The eleven NNW States which do not have safeguards agreements in force pursuant to either the NPT or the Tlatelolco Treaty, but which are operating nuclear plants, fall mainly into the second category[43].

### 2. COMPROMISES IN NEGOTIATIONS

All NPT safeguards agreements are essentially identical[44] and are based on the "model" drawn up by the Board of Governors in 1970 (INFCIRC/153). The guidelines contained in the earlier INFCIRC/66/Rev.2 permit greater variation, and during the eighteen years since INFCIRC/66 was approved it has been necessary to take account of significant changes in safeguards approaches. There has also

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[43] See footnote 7 regarding Colombia and Viet Nam.

[44] Many of the States that are now Parties to the NPT had previously concluded safeguards agreements in order to obtain particular nuclear supplies from abroad. Most of these agreements have been put into suspense. In some cases, however, even *after* a country became Party to the NPT it has been required to conclude a "fallback" agreement with a supplying country as a condition of supply. These fallback agreements would come into effect if, for instance, the importing country were to denounce the NPT.

been a considerable evolution in safeguards techniques. As a result, the safeguards agreements that are concluded today under INFCIRC/66 differ in many respects from those negotiated in the late 1960s[45]. This evolution has often involved lengthy negotiations with the States concerned, and some of the earlier agreements do not contain all the provisions required under today's standards. However, all recent INFCIRC/66 agreements stipulate the same basic principles and procedures.

## 3. THE IAEA HAS NO ENFORCEMENT POWERS

The difference between the power of a State to enforce compliance with its laws and regulations and that of the IAEA must be clearly understood. Most countries operating nuclear plants have extensive legislation and procedures at present to regulate the conduct of facility operators and to protect nuclear facilities and material against sabotage, theft or other criminal actions. The State can and will, if necessary, use the full force of law, including penal action and armed personnel, to enforce its laws and to repel attack or recover stolen property.

The IAEA has no such power. Its authority is limited to verifying that the State is carrying out its safeguards obligation. If the IAEA finds that the State is not complying with a safeguards agreement it may invoke the sanctions described above. The IAEA has, however, no means of physically preventing the State from breaching its safeguards agreements or of compelling it to comply with any directives issued by the Board of Governors.

## 4. LIMITED POWERS OF INSPECTION

The responsibility of reporting to the IAEA all plant or nuclear material that has to be safeguarded rests with the State or States concerned. If safeguards are to be applied to facilities or material already in existence in or indigenously produced by the State concerned, it is solely the government of the State that has this responsibility. In each NPT agreement, the NNW State concerned is, however, legally obliged to report *all nuclear material* in all peaceful nuclear activities (e.g. paragraph 62 of INFCIRC/153). Failure to report would be a breach of the

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[45] For instance, the meaning of the statutory requirement that safeguarded items should not be used *"in such a way as to further any military purpose"* has been articulated so as to make it explicitly clear that the making of any form of nuclear explosive is prohibited. Safeguards agreements also now include explicit provisions for use of surveillance and containment techniques. Most agreements now cover the transfer of significant technological information and the safeguarding of plant and equipment made by the use of such information. They provide explicitly for the conclusion of Subsidiary Arrangements and Facility Attachments. Their duration clauses have been amplified and standardized.

agreement. The State is also legally required to report, as early as possible before its introduction, any nuclear facility into which nuclear material will be introduced (paragraph 42 of INFCIRC/153). The IAEA's inspectors do not, however, have the right to search the State for unreported facilities, nor does the IAEA have any power to carry out an intelligence operation.

These are important limitations, but they are inherent in any international or regional verification system. No State would today allow foreign inspectors to move around freely in its territory in a search for unreported items. This is as true of those NW States that have voluntarily placed civilian nuclear material under safeguards as it is of NNW States.

The practical impact of this limitation should also not be exaggerated. In the case of NPT NNW States, both the exporting and importing States must report all transfers of nuclear material between them. The three NW States (USSR, USA, UK) Parties to the NPT also inform the IAEA of exports to and imports from NNW States. In the case of non-NPT NNW States, the exporting country often has the right and sometimes the obligation to make such reports. Checking "shipper/receiver differences" (i.e. any differences between the reports of the exporting and importing States) is therefore a useful means of detecting anomalies or, conversely, of confirming the correctness of the report from the importing State. Collusion between two States for the purpose of diversion is regarded as improbable.

IAEA inspectors also become familiar with facilities in which safeguards are being applied. If they were to detect any *unreported* nuclear material at such facilities, they would promptly inform IAEA Headquarters, which would then take appropriate measures.

Finally, the IAEA has no access to national intelligence services. However, it is probable that such services would detect the construction by another State of any significant facility which should have been but was not reported to the IAEA under the provisions of the relevant safeguards agreement. The State which discovered the facility would be free to draw the fact to the attention of the Board of Governors.

## 5. PROBLEMS IN DESIGNATING INSPECTORS

The IAEA is equally unable to compel any State to agree to accept and admit particular IAEA inspectors. In fact, some States have refused to accept entire categories of inspectors. For instance, certain States have objected to designation of inspectors of particular nationalities. Other States have in the past sought to limit the total number of inspectors designated to carry out inspections in their territory. These restrictions make it more difficult for the IAEA to deploy effectively the relatively small corps of inspectors at its disposal and to carry out the necessary verification activities. (It goes without saying that no IAEA inspector is permitted to make inspections in his own country. More important facilities are visited by at least two inspectors of different nationalities.)

Both the Inspectors Document (GC(V)/INF/39, Annex), which is applied to safeguards agreements concluded on the basis of INFCIRC/66/Rev.2 and the standard INFCIRC/153 agreement provide that the repeated refusal of a State to accept the designation of Agency inspectors which would impede the inspections conducted under the agreement can be referred to the Board by the Director General with a view to appropriate action.

In practice, this procedure – referral to the Board of a "repeated refusal" – has not yet been followed, although the Board has been apprised of the problem in general. Instead, the Secretariat has attempted to persuade the States concerned to withdraw their objections. Some problems have been solved in this manner but others continue to cause difficulties.

In short, in its powers of persuasion and enforcement and in the scope of activities of its inspectors, the IAEA has to work within the political framework of the world of independent sovereign States.

## 6. FINANCIAL LIMITATIONS

Member governments decide upon the level of the IAEA's budget for all its operations, including safeguards, on the basis of proposals made each year by the IAEA Secretariat. The growing budgets of international organizations place increasing demands on the resources of Member States, and a good case must now be made to persuade an international executive body to expand the allocation for any particular operation. The IAEA's safeguards have fared quite well, rising from US $1.2 million in 1970 to US $31 million in 1982[46] (including US $2 million from "Extra Budgetary Resources").

Even this relatively rapid expansion has left the IAEA short of the resources it needs for its safeguards operation. In the case of NPT NNW States, the IAEA and the State concerned agree on a "Facility Attachment" for each nuclear facility in that State. This Facility Attachment specifies the number of man-days of routine inspection effort that the IAEA is to carry out at the facility ("Actual Routine Inspection Effort" (ARIE)). By 1981 the IAEA was only carrying out about 54% of the total ARIE figures (and even less – 39% – in 1979).

This has not prevented the IAEA from achieving to a considerable extent the goals it has set in terms of quantity for detecting the diversion of material at most of the sensitive plants[47] under safeguards, although inspection of certain less sensitive plants has had to be curtailed.

[46] In terms of 1970 US $ this would have amounted to $6 252 000.

[47] Plants that contain large amounts of weapons-usable material or are able to produce such material.

The financial requirements of IAEA safeguards will continue to expand. It is essential to reach adequate levels of inspection at each facility, and the number and range of facilities under safeguards is growing. Adequate financing will also be required for the use of the expensive but more effective surveillance and containment equipment which has been under development for some years and is now becoming available.

## 7. RESTRICTIONS ON THE IAEA AND ITS INSPECTORS

When the IAEA Board drew up the two safeguards documents in the 1960s and 1970 it was venturing into new territory. Accordingly, the systems contain several prudent directives as to how the IAEA and its inspectors should behave in applying safeguards. The IAEA must, for instance, avoid hampering peaceful international co-operation or the economic and technological development of the State concerned. The IAEA must avoid undue interference in the State's peaceful nuclear activities and, in particular, in the operation of facilities. The safeguards applied must be consistent with prudent management practices required for carrying out nuclear activities safely and economically[48]. Inspectors must perform their tasks in such a way as to avoid hampering or delaying the construction, commissioning or operation of facilities or affecting their safety. Inspectors are not allowed to operate any facility themselves or to order the staff of a facility to carry out any operation[49].

The State concerned is, however, equally obliged to co-operate with the IAEA in applying safeguards[50]. In general, the many States in which safeguards are now being applied have accepted them without undue difficulty and have co-operated with the IAEA in applying them.

## 8. PROTECTION OF INFORMATION

A particular sensitive point is the information that inspectors and the safeguards staff of the IAEA acquire or collect in applying safeguards. The IAEA is required to take every precaution to protect commercial and industrial secrets and other confidential information coming to its knowledge as a result of the application of safeguards. Strict rules are laid down for the publication of such information[51]. These reflect not only the concern that information of technical

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[48] Paragraph 4, INFCIRC/153.
[49] Paragraph 87, INFCIRC/153.
[50] Paragraphs 3 and 9, INFCIRC/153.
[51] Paragraph 5 of INFCIRC/153 and paragraph 13 of INFCIRC/66/Rev.2.

or commercial value might be used in such a way as to damage the interests of the State concerned or its nuclear industry, but also the fact that certain States – the NW States – are not legally required to accept safeguards even if they are Parties to the NPT (four[52] have voluntarily done so on some or all of their civilian activities). These rules also reflect the fear that this would put the nuclear industry of the NPT NNW States, which must accept safeguards, at a disadvantage in relation to their competitors in NW States.

Accordingly, the IAEA has made elaborate arrangements for protecting the information it receives from States and from its safeguards operations. This information is increasingly in computerized form, and the Department of Safeguards has recently acquired its own computer which can be accessed only on a "need to know" basis by authorized safeguards personnel.

While States in which safeguards are applied are anxious to protect the confidentiality of safeguards information, the press, the public and government officials have become more interested in knowing how effective the system is in detecting an actual diversion and to what extent the criticisms levelled against IAEA safeguards are justified. There is therefore strong pressure to increase the transparency of the operation. A new balance will have to be found between this and the need to protect confidential data.

## 9. REQUIREMENTS THAT SAFEGUARDS SHOULD NOT DISCRIMINATE BETWEEN STATES

Under its Statute (e.g. Article III C and IV C) the IAEA must not discriminate between its Member States in carrying out safeguards. International secretariats cannot evaluate or speculate about the intentions and aspirations of States; safeguards must deal with physically observable and, as far as possible, measurable facts. However, the hypothetical assumption that every State in which safeguards are applied *might* divert safeguarded nuclear material from the peaceful fuel cycle, or might misuse safeguarded facilities, is basic to the safeguards operation. If this, assumption were excluded there would be no reason for safeguards[53]. Accordingly, effective safeguards require that the IAEA should work out technically plausible diversion strategies for every plant under safeguards and must devise approaches to counter these strategies.

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[52] The USA and UK on all civilian plants; France on selected civilian plants. The USSR has also announced that it will place certain civilian nuclear plants under IAEA safeguards, and negotiation of the relevant agreement has begun.

[53] This does not imply distrust of any particular State or plant operator. To borrow an example from civil aviation, the fact that all passengers are today subject to security controls at all international airports does not imply mistrust of any specific individual, nor is any exemption made simply because one person is better dressed than another.

Because of the limited resources available and the relative novelty of the safeguards operation, the normal approach[54] to ensure non-discrimination is, at present, to apply the same amount of inspection effort (i.e. the same number of inspection man-days per year) to all facilities of the same type in all States. The IAEA is, however, seeking to develop criteria so that the actual routine inspection carried out might be varied on an objective basis in order to take account of the character and extent of the States' fuel cycle and the extent to which it is subject to safeguards. This is, however, a complex and time-consuming task.

### 10. THE NEED TO IMPROVE STATES' ACCOUNTING AND CONTROL SYSTEMS

In many countries there is considerable room for improvement in the State's System of Accounting for and Control (SSAC) of nuclear materials. Effective safeguards depend on the extent to which governments ensure that operators keep accurate, precise and complete records, promptly send the IAEA (usually through government channels) the required reports, employ reliable and accurate equipment for measurement and analysis, take inventories of nuclear material at the prescribed intervals, and determine at each inventory the amount of material unaccounted for (MUF). The IAEA holds annual training courses to help Member States to improve their SSACs.

## VII. WHAT HAVE SAFEGUARDS ACHIEVED?

The growth of IAEA safeguards since their modest beginnings in the 1960s has been considerable. By the end of 1982, safeguards agreements had been concluded with 90 States (including Euratom NNW States[55]. As a result of the extensive safeguards coverage under NPT and non-NPT agreements, more than 98% of the world's nuclear facilities outside the NW States were under IAEA safeguards. At the end of 1982 the amount of nuclear material under safeguards had reached 89 tonnes of plutonium (6 tonnes in separated form, the remainder

[54] This may be varied even today, to take account of the effectiveness and functional independence of the States' own accountancy and control system. The agreements with Euratom and Japan provide for such variations.

[55] By the end of 1982, 118 NNW States had become Parties to the NPT but 38 of these States had not yet complied with their obligations under Article III.4 of the treaty regarding the conclusion of the relevant safeguards agreement. However, none of these 38 States has, as far as the Agency is aware, significant nuclear activity.

in irradiated fuel), 10 tonnes of uranium enriched to 20% or more, about 16 000 tonnes of uranium of lower enrichment, and 25 000 tonnes of natural or depleted uranium and thorium. The plants under safeguards included 143 power reactors, 177 research reactors and 55 bulk handling plants including six reprocessing and four enrichment plants.

The workload in 1982 included applying and checking 6000 seals, reports on about 700 installations and 655 000 data entries into the safeguards computer. The IAEA carried out almost 1700 inspections.

Finally, the ratification of the NPT by so many countries and the widespread acceptance of the IAEA's safeguards have probably encouraged many other NNW States to reach the perception that their national interests would also best be served by formally relinquishing nuclear weapons – for example, by ratifying the NPT. Through increasing confidence in the nuclear field between States, the non-proliferation process gains its own momentum.

The fact that a working IAEA safeguards system was already at hand in the late 1960s and that the IAEA provided an established means of international nuclear co-operation also made it easier to reach agreement on the content of the NPT and on the means of verifying it. IAEA safeguards also play a key role under the Tlatelolco Treaty and might equally do so in any other regional agreements for nuclear-weapon-free zones that might be concluded in the future.

The existence of a credible and effective safeguards operation has also made possible today's international trade in nuclear plant and materials and the transfer of nuclear technology to the developing countries as well as between the industrial countries. Very little, if any, such trade or transfer could take place today without IAEA safeguards.

## Other technical and international arrangements

Since the NPT was approved in 1968 there have been many proposals for additional institutional arrangements designed to strengthen the non-proliferation regime. They have included:

– *Multinational centres* at which sensitive operations such as reprocessing, enrichment and manufacture of mixed oxide fuel would be carried out, thus obviating the need for a larger number of smaller and less economic national centres and also, it is hoped, diminishing the risks of proliferation.

– An *international fuel bank* and other "back-up" arrangements to come into operation in the event of a future interruption of supplies. Such international arrangements would be intended to give greater assurance of supply and thus also diminish the perceived need to develop national fuel cycle facilities.

– International or regional centres for the *storage of spent fuel*, thus diminishing the need for national reprocessing;

– An *international plutonium storage* system as an extension of the existing safeguards system;

– Regional *nuclear-weapons-free zones* in Africa, Europe, the Middle East, South Asia, the Indian Ocean, etc.

So far, it has not been possible to bring any of these projects to fruition. This may be partly due to changes in the international political climate and in the structure of international nuclear relations since 1968. For the time being at least, it therefore seems likely that the main institutional barriers to proliferation will continue to be those that already exist, namely, the political decision of States not to acquire nuclear weapons, formalized in the NPT and the Tlatelolco Treaty and verified by the IAEA's safeguards. If additional institutional arrangements prove feasible, they could make a contribution to the NPT regime but, until the prospects for them improve, it would seem best to focus the main international effort on making the existing NPT regime, including the Tlatelolco Treaty, and IAEA safeguards more effective and nearly universal.

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