Part A—Verification and Nuclear Nonproliferation

1

VERIFICATION CONCEPTS AND METHODOLOGIES

BEFORE DECIDING UPON WHICH TECHNOLOGIES TO EMPLOY IN A VERIFIcation regime, it is first necessary to determine the purpose of the verification task. Instinctively, one could arrive at two general definitions of "verification" as it relates to nonproliferation treaties and agreements. The first one is "to assure that nothing is being done in contravention of a state's international obligations." The second definition is even more basic: "to catch states that cheat before they can achieve a nuclear weapons capability." The first definition assumes inherent honesty; the second one assumes the exact opposite.

A closer examination of the technical aspects of verification leads to the distinction between "positive" and "negative" assurances. "Positive" verification relates to the gathering of *prima facie* evidence and trying to prove that a party to an agreement is fulfilling all its commitments. With respect to the Non-Proliferation Treaty (NPT), positive verification refers to verifying the declaration of states regarding their activities and nuclear material balances. Verification is then carried out by utilizing several methods, including: the balancing of inventories; verifying the use of certain pieces of equipment; and utilizing physical data to ascertain, for example, that the total neutron flux in a given reactor is as declared.

In contrast, "negative" verification means the attempt to assure an absence of activities. Negative verification efforts seek to determine that nothing untoward has occurred—that no explicitly forbidden materials, activities, or facilities are present in a given state, area, or site.

Of the two, negative verification is much more difficult to accomplish than positive verification. As a 1995 UN publication states:[1]

> In many circumstances it is virtually impossible, for technical reasons, to guarantee the absence of undeclared activities or objects. Care must therefore be taken to distinguish between the high level of assurance which can generally be provided in respect of the verification of declared activities and the necessarily lower level of assurance which verification can provide in relation to undeclared activities.

It is also worth taking note of a few additional verification concepts. The Comprehensive Nuclear Test-Ban Treaty (CTBT) negotiators at the Conference on Disarmament (CD) in Geneva enshrined the term "effectively verifiable treaty."[2] This concept is intended to provide an additional degree of assurance that states are not acting contrary to their obligations. The term also implies a degree of distrust, in that some states should be watched more carefully than others.

The CD also introduced the concept of a “nondiscriminatory” treaty in considering its mandate for the Fissile Material Cutoff Treaty (FMCT).[3] This term could be taken to mean that there should not be a separation of states parties into different categories. For example, the NPT is discriminatory in that it divides all states parties into two categories: five nuclear weapon states and many non-nuclear weapon states. However, “nondiscriminatory” could also be understood to mean that verification should be applied in the same manner in all states subject to a treaty, regardless of whether they are all equally suspected of cheating.

The Technical Side of Verification

Given these definitions, several general categories of technical verification methodologies and activities have evolved. These include: the prevention of illicit activities; qualitative and descriptive verification; accounting; investigative verification; and the detection of proscribed activities (negative verification). The nuclear nonproliferation verification regimes discussed in this book employ many of these methodologies; some employ more than one.

Prevention of Illicit Activities. Preventing a state from carrying out proscribed activities is a key goal of verification. To do so, prevention methodologies rely on deterrence and physical barriers.

The effect of deterrence is achieved mainly through the totality of the various verification activities that are being employed. The goal is simple: with verification in place, the inspected state can never be absolutely sure that the inspectors will not uncover illicit activities, provided such activities are taking place.

The other aspect of prevention is the emplacement of barriers to prevent the movement or the utilization of materials and installations without the fact becoming known to the inspectors. This aim is difficult to achieve in practice, since it not practical to set up a physical barrier that would prevent all activities. The aim of preventive barriers is to create a situation wherein all declared activities would come under supervision, and impermissible activities would be detected.

Physical barriers can include sophisticated seals that are hard to bypass, falsify, or duplicate. Seals would be checked and verified by inspectors whenever a state wished to conduct some activity using materials or items held under seal. Afterwards, the seals would be replaced.

Physical barriers also may include detectors and surveillance instruments to detect material movements. Barriers may also involve the use of mechanical and electro-mechanical systems that can be locked to prevent the movement of material without permission.

Qualitative and Descriptive Verification. States are generally loath to provide a comprehensive description of their activities to an inspectorate. As a rule, they do not want to divulge more than is absolutely necessary for the purpose of the treaty. States are afraid of revealing either proprietary, technical information of a commercial nature, or classified national security information.

Nevertheless, in most verification regimes the state must furnish a declaration that details the facilities, equipment, activities, and other information relevant to the treaty. Initially verifying and periodically reviewing this declaration is one of the easier verification tasks. Moreover, the inspected state's attitude during this verification exercise will factor into the inspectorate's overall impression of the state's adherence to its obligations.

Activities known generally as "containment and surveillance" are another, more serious, aspect of qualitative verification. Such activities mainly utilize seals and surveillance cameras, such that the flow of persons or materials is observed. The seals, which may be very sophisticated, block passages of materials and persons, so that any transgressions will be detected and made known to the inspectors when they next examine the seal. In special cases, motion-sensitive devices could sound an alarm in real-time. Cameras have much the same purpose; their main advantage is that they can identify the culprit and record the time when the violation occurred. Cameras cannot physically prevent the access to the area "blocked" by the seal, but the fact will be recorded and become known to the inspectors.

Accounting. Verifying material balances and nuclear materials accounting were, and still are, cornerstones of the IAEA safeguards system. It is usually composed of two separate activities: weighing (including volume and concentration evaluation, when applicable), and content verification. In assessing the material balance, items (such as the number of reactor fuel elements) may be literally counted, and each one multiplied by its weight, to give the total amount of material. Alternatively, when bulk materials are being accounted for, a content analysis of the material must be made in each stage, and the quantities carefully summed.

Essentially, the system requires that a state declare an initial nuclear material inventory at the start of inspection activities, and that the subsequent balance be continuously checked and verified. When the volume of activity is large, such as occurring in large-scale reprocessing plants, the inspection can involve continuous oversight of the activity. In cases where the activity is minimal, the inspectors visit infrequently and rely more on declarations.

Two generic factors hamper any material balancing activity: the practical inability to carry out accounting of all activities, especially in a large-scale operation, and the inherent errors of measurement and accounting. For example, when measuring the length and area of a table, a diversity of results will be reported after numerous measurements.

In addition, and perhaps more important, there is the problem of process material loss, or "Material Unaccounted For" (MUF). Under the IAEA's safeguard system, if the annual deviation (absence) of the measured/calculated material inventory from the declared one is not too great (not more than one nuclear weapon's worth), then the verification is taken as having been satisfactorily accomplished.

The transformation of nuclear materials, either by natural processes such as radioactive decay, or through artificial processes, such as irradiation in a nuclear reactor, also has to be taken into account. The practical verification of these latter processes is much more difficult, and depends on the correct knowledge of the reactor and core parameters. For example, the declared irradiation history of nuclear material sometimes can only be proven absolutely correct only if and when the fuel elements are reprocessed.

Investigative Verification. Investigative verification is a much more recent verification methodology. Under the NPT and in the context of IAEA safeguards, investigative verification evolved from the need to verify that states' declarations were both correct and complete. This methodology usually employs methods that will give primarily a "yes" or "no" answer to the question of whether any activity is out of the ordinary at a particular location. On the technical level, this category involves making sensitive measurements of radioactivity, taking samples both inside and outside installations, and analyzing and evaluating the sample results for consistency with the declarations.

Investigative verification raises controversial issues, particularly in terms of deciding whether a declaration is complete. An anomaly between the declaration and the analyzed result can, without question, prove a violation. However, when undertaking the analysis, a positive finding (i.e., "detecting something") differs from a negative one ("not detecting something") in that it will be easier to confirm or negate, if necessary. A negative finding would represent the truth in most cases, meaning that that nothing is out of the ordinary. But "false-negative" findings (i.e., "*not* detecting something that is there") could also occur. Dealing with false-negative results is crucial because they could be concealing a violation.

Detection of Proscribed Activities ("Negative Verification"). Negative verification is not easy to achieve. Its methodology, and the problems associated with it, are similar to those of investigative verification. Negative verification involves going to a suspect state, and therein to a suspect site (if known); making the necessary measurements; taking the required samples; making a complete site survey; asking for and receiving necessary explanations; and walking away satisfied. If the inspectors do not know the exact site where the supposed illicit activities are being carried out, the task becomes much more difficult.

Real-World Applications

Selecting among verification technologies can be a complicated task. First, one must define the parameters that will best serve the verification techniques. In NPT-related verification activities, the topics range from the "simple" issue of measuring quantities and mass of discrete items, to more complicated issues, such as the calculation of fissile material contained in irradiated fuel elements. The CTBT denotes many verification technologies, and in some cases details them down to the type of instrument to be used. Fundamentally, however, the choice of techniques has to satisfy two major requirements: they have to accomplish the job, and their utilization should not reveal sensitive information that is not relevant to the purpose of the verification activity.

The remainder of Part A discusses the verification regimes that underlie the NPT, the CTBT, and the UN Security Council-mandated verification effort in Iraq. A separate chapter also discusses the utility of wide-area environmental sampling in detecting illicit activities. The final chapter in the section also outlines regional verification arrangements, in particular the bilateral arrangement between Argentina and Brazil.

---

[1] "Verification in all its Aspects, Including the Role of the United Nations in the Field of Verification," Report of the Secretary General, A/50/377, September 22, 1995.

[2] See, for example, "Report of the Conference on Disarmament to the General Assembly of the United Nations" CD/1364 September 26, 1995, paragraph 23: "The Conference directs the Ad Hoc Committee to negotiate intensively a universal and multilaterally and effectively verifiable comprehensive nuclear test-ban treaty…"

[3] Ibid., paragraph 27: "The Conference on Disarmament decides to establish,…an ad hoc committee which shall negotiate…a nondiscriminatory, multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices."

2

NPT VERIFICATION ACCORDING TO INFCIRC/153

There is nothing more likely to start a disagreement among people or countries than an agreement.
-E.B. White, American Essayist and Author

UNDER THE NUCLEAR NON-PROLIFERATION TREATY (NPT), EACH NON-nuclear weapon state undertakes "not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices."[1] To verify this commitment, the International Atomic Energy Agency (IAEA) is to implement "full-scope" safeguards on all nuclear material declared by the state to the Agency.

A safeguards agreement, modeled on INFCIRC/153, is to be concluded between the non-weapon state and the IAEA within 18 months of the state's accession to the NPT.[2] In this manner, the IAEA acts as a contractor to the NPT verification mission. The IAEA is an independent organization with many duties and requirements; NPT safeguards being only one of them.

The basic objective of safeguards is to assure that all declared source and special fissionable materials are not diverted from peaceful to nuclear-explosive purposes. The goal is 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, and deterrence of such diversion by the risk of early detection."[3]

The implementation of "classical," full-scope safeguards by the IAEA involves many personnel, various types of specialized equipment, and substantial financial resources. The safeguards teams must function efficiently in all countries with nuclear sites and activities. Inspectors use many and varied pieces of equipment, including radiation measurement instruments, optical surveillance systems, spent fuel measurement systems, and many types of seals.

The responsibilities on the part of the inspected state are extensive. States possessing declared nuclear facilities are to create state systems of nuclear material accountancy and control. Without such systems in place, the Agency is unable to fulfill its requirements to assure that no nuclear materials have been diverted from peaceful purposes.

As of the end of 2000, the IAEA performed safeguards activities in more than 1,000 installations worldwide. The IAEA implements safeguards at some 236 nuclear power reactors, 168 research reactors and critical assemblies, and hundreds of other installations, including fuel fabrication, enrichment, and reprocessing plants.[4]

Implementing Classical Safeguards

Implementing INFCIRC/153-type safeguards relies heavily on nuclear material accountancy and checking material balances. The task is analogous to that of a financial audit, where an independent auditor periodically checks financial statements to assure that funds have not been stolen. In the case of nuclear safeguards, the objective is to verify declared material balances at declared nuclear sites and facilities to ensure that all of the material remains in peaceful nuclear process streams.

In order to enable the inspectors to carry out their duties and verify the nuclear material balance, INFCIRC/153 requires the state to provide a detailed declaration to the IAEA. This declaration includes a detailed inventory of all nuclear material, and detailed design information of all nuclear facilities (and locations outside facilities (LOFs)) relevant to safeguarding such material. The state is also to provide to the IAEA, as soon as possible, information about the design of a new or modified nuclear facility before nuclear material is introduced into the facility.

Facilities play a role in safeguards, inasmuch as they contain nuclear materials that need to be inventoried. So-called "Subsidiary Arrangements" to the safeguards agreement contain the locations of "strategic points" where the inspectors may visit and check material balances.[5]

Three basic types of inspections are described by INFCIRC/153.[6] The first type is an ad hoc inspection, where the Agency inspects declared nuclear facilities to verify the design information provided by the state. The second type of inspection, a "regular inspection," occurs with a known frequency, depending upon the quantity and type of material located at a facility. For weapons-usable nuclear material, such inspections may be very frequent. For less attractive material, inspections may take place over longer intervals.

To minimize regular interference, inspections are scheduled based upon the "timeliness" of detection. At present, the concept is loosely interpreted by the IAEA, though not without some justification. There are no hard-and-fast timelines set for detection. Rather, separate time intervals are determined depending on the type and quantity of nuclear material located at various installations. These intervals may range from the very short (for reprocessing plants), to the very long (for states with very low-key, non-reactor nuclear programs). For nuclear power reactors, the time intervals vary according to the reactor type and the type of fuel loading-unloading process.

In between regular inspections, containment and surveillance equipment, including cameras and seals, are typically employed at nuclear facilities. In this manner, the Agency seeks to avoid the need for a continuous presence of inspectors at nuclear facilities worldwide.

The third type of inspection is a "special inspection." A special inspection may be requested by the IAEA when it is unable to resolve discrepancies between the state's declaration and its own inspection findings.[7]

Throughout its history, the IAEA has been extremely reluctant to request a special inspection. The IAEA asked for a special inspection of undeclared North Korean facilities in 1993 when inspectors found overwhelming evidence that North Korea has separated more plutonium than it had declared.

INFCIRC/153 seeks to minimize the potential for invading an inspected state's privacy. Safeguards are to avoid hampering the inspected state's "economic and technological development … or international co-operation in the field of peaceful nuclear activities, including international exchange *nuclear material*," and are to be "implemented in a manner designed … to avoid undue interference in the State's peaceful nuclear activities … the operation of *facilities*, and [are] to be consistent with prudent management practices required for the economic and safe conduct of nuclear activities."[8] These restrictions place severe limitations on IAEA inspectors. For example, inspectors are not permitted to visit areas other than those listed in the Subsidiary Arrangements, nor are they obligated to inquire about activities are sites and facilities that are not included in the state's declaration.

Protecting commercial secrets is given great weight by INFCIRC/153. Safeguards agreements are to "take every precaution to protect commercial and industrial secrets and other confidential information" that may be revealed.[9] Great lengths are taken by the Agency to protect "safeguards-confidential" information from being revealed to the public or to other governments.

Problems in Implementing INFCIRC/153

A key problem with classical safeguards is the inability to achieve an indisputable conclusion. The methodology of classical safeguards—material accountancy—is highly dependant on statistics, particularly the statistical sampling of bulk materials. There are many calculated parameters that serve as a basis for drawing conclusions about physical realities, such as the amount of plutonium contained in spent fuel. These calculations are often based on assumptions, whose inaccuracies influence the final material balance estimates and their deviation from the truth. Such deviations could be used by a state to cover its diversion of nuclear material.

Errors in statistical sampling are almost unavoidable. There cannot be a 100 percent accurate verification effort, especially when most physical measurements are non-destructive. The quantity of material lost in the margin of error, and thus subject to diversion, could be very large, especially in a state with a large nuclear program.

There are political problems with the implementation of classical safeguards, as well. Many state parties to the NPT have not signed safeguards agreements with the IAEA, despite their obligation to do so. As of the end of 2000, 36 of the 178 non-weapon states party to the NPT had failed to sign an INFCIRC/153-type safeguards agreement, and an additional 17 states had signed an agreement but had yet to bring it into force.[10] One often hears that many of these states are poor, have a small population, lack a nuclear program, or have no obvious motivation for the development of nuclear weapons. However, these excuses (even if plausible) are not pertinent, especially given the "bon mot" of "nondiscriminatory" treaties. The lack of agreements politically undermines the safeguards regime, and erodes the normative value of the NPT.

A third problem in implementing classical safeguards is that disputes over issues of noncompliance are settled by political bodies. The first body to take notice of a possible case of noncompliance is the IAEA Board of Governors. Next, disputes are elevated to the UN Security Council, and ultimately the General Assembly. These political bodies are composed of IAEA Member States, but both the IAEA Board and the Security Council have a limited membership that is chosen based on the allocation of membership quotas to regional groups, which are usually based on intra-regional arrangements. As a result of this selection process, the Board and Security Council representatives do not always have the necessary expertise to address complex, technical issues, and they often do not seek expert advice. Decisions, therefore, are often made on purely political grounds.

The Achilles' Heel of classical safeguards is not statistical error or lack of political backing, however. Rather, the main shortcoming of INFCIRC/153-type safeguards is that the states themselves decide which facilities and materials to declare to the Agency for safeguards purposes. INFCIRC/153 neither requires states to tell "the truth, the whole truth, and nothing but the truth," nor does it give the IAEA the tools to challenge the "completeness" of a state's declaration.

INFCIRC/153 has operated in practice on the unstated assumption that nuclear weapons programs will always begin with the diversion of nuclear materials from peaceful purposes. The safeguards did not envision the likelihood of a separate, clandestine nuclear program that is operating outside of declared facilities and processing undeclared nuclear material. The IAEA did not test the possibility that undeclared facilities and materials may exist until 1992, when discrepancies with North Korea's declaration were uncovered, and only then after the embarrassment of Iraq's program came to light.

Three cases forced the IAEA to reconsider its approach to safeguards. The result was a significant modification of safeguards, so as to better enable the Agency to ensure both the correctness and the completeness of a state's declaration.

- **Iraq.** Under the rule of Saddam Hussein, Iraq initiated a nuclear arms R&D program in the mid-1970s. When Iraq's ambitions to acquire plutonium by the irradiation of natural uranium in a French nuclear reactor were thwarted by the reactor's destruction by Israel in 1981, Iraq turned to uranium enrichment technologies to produce fissile materials for nuclear weapons. To avoid being detected, Iraq operated outside of declared nuclear facilities. On many occasions up until the Persian Gulf War, IAEA safeguards inspectors could find nothing to indicate that Iraq was in violation of its safeguards agreement or the NPT.

- **North Korea.** The case of North Korea shows how difficult it is for the IAEA to implement all its rights under INFCIRC/153—specifically, the right to conduct special inspections. It also showed that the Agency needed broader rights of routine access to information and facilities to avoid political showdowns.

  In 1993, following the discovery of discrepancies between sampled results and North Korean declarations, the IAEA Board of Governors requested a special inspection of undeclared North Korean facilities.[11] This was the first and so far only time that the Agency has requested a special inspection of undeclared facilities. North Korea refused.

  As of 2001, the North Korean situation remains unresolved. North Korea has pledged to come into compliance with its safeguards agreement under the terms of the U.S.-North Korean Agreed Framework, but that day may be many years off. That the crisis required a special "Agreed Framework," rather than be resolved through the IAEA or UN Security Council, demonstrates the importance of political backing by the UN Security Council to make the regime work.
- **South Africa.** When South Africa declared in 1993 that it had dismantled a small nuclear arsenal prior to joining the NPT, the IAEA was left in a quandary. Never before had the Agency been faced with the problem of verifying that a nuclear weapons program had been dismantled with all nuclear material accounted for. To avoid the spread of sensitive information about the design of South Africa's nuclear weapons, a special inspection effort, including inspectors from nuclear weapon states, was formed to verify that South Africa's declaration was complete. The inspection methods employed by this team helped to inform subsequent efforts to strengthen IAEA safeguards.

Towards an Improved Safeguards Regime

The term "full-scope safeguards," as applied under INFCIRC/153, is clearly a misnomer. INFCIRC/153 certainly is not full-scope, even in the narrowest sense of verifying the design and operations of declared facilities, let alone the verification of undeclared activities and facilities in known sites. The IAEA acknowledged the failure of this regime, by pursuing "Program 93+2," which culminated in 1995 with the adoption of "Part I" safeguards improvements, and the 1997 publication and adoption of INFCIRC/540—the Model

Additional Protocol. These measures—and their problems—are discussed in the next two chapters.

---

[1] Nuclear Non-Proliferation Treaty, Article I.

[2] Ibid., Article III, paragraph 4. The full title of INFCIRC/153 is "The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons."

[3] INFCIRC/153, paragraph 28. Italics in this and subsequent quotations from INFCIRC/153 are in the original.

[4] IAEA Yearbook, 2000, Table A-18, page 142.

[5] INFCIRC/153, paragraph (76)(c).

[6] The basic purposes of ad hoc, routine, and special inspections are delineated in INFCIRC/153, paragraphs 71–73.

[7] Ibid., paragraph 73: Specifically, the IAEA may request a special inspection "if [it] considers that information made available by the State, including explanations from the State and information obtained from routine inspections, is not adequate for the Agency to fulfill its [safeguards] responsibilities."

[8] Ibid., paragraph 4.

[9] Ibid., paragraph 5.

[10] The 36 states that have failed to sign a safeguards agreement as of December 31, 2000 are: Albania, Angola, Bahrain, Benin, Botswana, Burkina Faso, Burundi, Cape Verde, Central African Republic, Chad, Colombia, Comoros, Congo, Djibouti, Eritrea, Guinea, Guinea-Bissau, Liberia, Mali, Marshall Islands, Mauritania, Micronesia (Federated States of), Mozambique, Niger, Palau (Republic of), Qatar, Rwanda, Sao Tome and Principe, Saudi Arabia, Seychelles, Somalia,Tajikistan, Turkmenistan, Uganda, United Arab Emirates, and Vanuatu. The 17 countries that *signed* but *failed to ratify or bring into force* a safeguards agreement as of December 31, 2000 are: Andorra, Cameroon, Equatorial Guinea, Gabon, Georgia, Haiti, Kuwait, Kyrgyzstan, Laos, Oman, Panama, Republic of Moldova, Sierra Leone, The Former Yugoslav Republic of Macedonia, Togo, United Republic of Tanzania, and Yemen. Of these 53 states, Albania has a *sui generis* safeguards agreement in force, and Colombia and Panama concluded a full-scope safeguards agreement pursuant to their obligations under the Treaty of Tlatelolco. In addition, Taiwan, Republic of China has a full-scope safeguards agreement with the IAEA in force. Source: IAEA Yearbook, 2000, table A13, pp. 128-133.

[11] A chronology of the conflict between the Agency and North Korea regarding the accuracy of North Korea's declaration and the request for special inspections may be found in appendix 4 of David Albright and Kevin O'Neill (eds.), *Solving the North Korean Nuclear Puzzle*, (Washington, DC: ISIS Press, 2000).

3

NPT Verification and "Program 93+2"

Following the discovery of Iraq's clandestine nuclear weapons program, the International Atomic Energy Agency (IAEA) decided to improve on the existing safeguards system. In 1993, the IAEA embarked on a two-year project ("Program 93+2") to do so. The intent of the reforms was to make state nuclear programs more transparent, thereby enhancing the level of assurance as to the peaceful nature of their programs.

In 1995, the IAEA Board determined that many of the proposals generated by Program 93+2 fell within the IAEA's present legal authority under existing safeguards agreements, and could be implemented within the existing framework of INFCIRC/153. These so-called "Part I" activities include: broader access by the IAEA to information about the state's declared facilities; no-notice inspections at declared facilities; and measures for optimizing the use of the present system, including safeguards technology advances and increased cooperation with states and their state systems of nuclear accounting and control. Part I activities also provide for taking environmental samples at locations selected from among the strategic points at facilities where the Agency already had rights of access.

INFCIRC/540

In its assessment of Program 93+2, the IAEA Board determined that many additional measures fell outside the scope of the Agency's existing legal authority.[1] The Agency would need a grant of new authority to carry these measures out. These measures were codified in the Additional Model Protocol, which was adopted by the IAEA Board in 1997 and published as INFCIRC/540.[2]

The Model Protocol establishes a framework that supplements and augments the existing safeguards agreements between the IAEA and non-nuclear weapon states. It is intended to serve as the basis for a new safeguards agreement that supplements the older INFCIRC/153-type agreements.

The Protocol is more expansive than the original intent of the Nuclear Non-Proliferation Treaty (NPT), and it goes a long way towards remedying the flaws that were discovered in the application of INFCIRC/153-type safeguards agreements. It gives the IAEA the potential to detect and deter illicit activities. The Protocol requires states to submit broader and more detailed declarations, provides the Agency with greater access rights to facilities, and permits the Agency to use advanced verification methodologies as part of the verification process.

However, as a partial counterbalance to these advancements, the Additional Model Protocol restrains the IAEA: the Agency "shall not mechanistically or systematically seek to verify" the additional information provided by the state.[3] It also cautions that the activities described in the Protocol are to be kept to a minimum, with the objective of strengthening not only the effectiveness but also the efficiency of safeguards. In effect, the Agency limits the discretion of the inspectors to aggressively follow up on any discrepancies discovered in the field.

Key Provisions. Under the Protocol, the state party is obligated to provide much more information to the Agency about its past and present nuclear programs, and about its future plans.[4] The new declaration is to include a general description of a broader range of nuclear facilities that may or may not contain nuclear material, particularly research and development facilities. The declaration is to include more detailed information about sites and facilities than previously required. Activities and materials covered by the declaration include: mining; uranium concentration; source material that is not yet suitable for fuel fabrication or for enrichment; material otherwise exempted from safeguards; and high-level waste that contains nuclear materials. In addition, the state party must also provide the Agency with 10-year plans for fuel cycle developments, a general description of nuclear fuel cycle research and development activities that do not involve nuclear material, and other information.

The Protocol gives the Agency additional access rights to assess and verify the expanded declaration.[5] In particular, the Agency shall have access to any location in order to assure the absence of undeclared nuclear material or activities; any location to resolve questions and inconsistencies related to information provided by the state; and any location to confirm the decommissioned status of a facility.

Broadened Agency access to undeclared sites and facilities is key to the Protocol's efforts to provide assurances that states are not conducting undeclared activities. The deterrent effect of verification is increased, because the inspected state can no longer be sure that it can hide its activities away from the inspectors.

The Protocol further provides that the Agency may take additional measurements when carrying out inspections. In particular, inspectors may make visual observations; take environmental samples; use radiation detection and measurement devices; apply seals and other tamper-indicating devices; and undertake other "objective measures."[6] The main purpose of these activities is to enable the inspectors to determine if undeclared activities are taking place.

Environmental Sampling and "Negative Verification." Environmental sampling is a new tool that the Protocol provides the Agency to help it to determine if the inspected state is carrying out clandestine activities. It is a two-stage activity aimed at *finding* nuclear material and then ascertaining that the material or the activity its presence indicates is *undeclared*. The first part is a more or less a straightforward activity. The second part is guesswork, inference and decision-making that will usually entail sophisticated, lengthy, and costly analysis. Such analyses will not always be clearly unambiguous.

Both location-specific and wide-area environmental sampling (WAES) are included in the Protocol. “Location-specific environmental sampling” is defined as “the collection of environmental samples…at, and in the immediate vicinity of, a location specified by the Agency to draw conclusions about the absence of undeclared *nuclear material* or nuclear activities at the specified location.”[7] “Wide-area environmental sampling” is similarly defined, except that samples may be taken at “a set of locations…for the purpose of assisting the Agency to draw conclusions about the absence of undeclared *nuclear material* or nuclear activities over a wide area.”[8]

The implementation of location-specific environmental sampling needs no further approval, and the IAEA can begin taking samples whenever it deems it necessary to do so. However, WAES is not permitted until such measures are specifically approved by the Board. The IAEA has conducted feasibility studies on its use.

Location-specific environmental sampling can be a useful tool for verifying that only declared activities are taking place at a site. The task of assessing the extent of these activities is, however, much more difficult, and not always attainable. For example, a positive finding may not allow the inspectors to distinguish on-going materials and activities from past (perhaps undeclared) activities.

Not finding any nuclear material in samples taken from undeclared sites would provide some assurances that there are no undeclared activities taking place, but these assurances are not absolute. The absence of nuclear material could mean either that there are no undeclared nuclear material or activities to be found, or that the environmental sampling has not managed to detect the undeclared nuclear material or activity that is, in fact, present. Such false-negatives are problematic.

Selecting undeclared sites for an inspection must be done carefully, particularly if the IAEA wishes to take environmental samples. The IAEA would need good information to justify the selection of such a site. Alternatively, the IAEA would randomly select a site out of a list of possible sites. To be most effective, the Agency should set a precedent of randomly selecting an undeclared site within an inspected state from the very beginning to carry out sampling.

Where Could it Succeed? Where Could it Fail?

There is no doubt that INFCIRC/540 goes a long way towards remedying the shortcomings of INFCIRC/153. It gives the inspectorate the right to have more and better information, additional rights of access, including the access to some records and data, the right to make better and more probing measurements, and the ability to take samples at a wide range of places. In short, it is a promising launch of negative verification provisions within the NPT framework.

Although not perfect, INFCIRC/540 presents a much stronger deterrent than INFCIRC/153 to those who are cheating or intend to do so. By accepting the Model Protocol, states are committing themselves to a stricter safeguards regime than hitherto, with an advanced capability to detect cheating.

From the perspective of states that are not planning on cheating, the Protocol still can be a very large nuisance. This is especially true for states with large-scale nuclear programs. Such states may, nevertheless, see value in joining the Protocol. Reasons could include setting an example, proving their nonproliferation *bona fides*, enhancing the additional security that comes with a large number of adherents, and hoping for a “clean bill of health.”

Nuclear forensics make the implementation of INFCIRC/540, with all its provisions, valuable. Without the ability to utilize both full access rights and the right of sampling at suspect sites, the ability to detect and identify illicit materials and activities is strongly curtailed.

However, the Model Protocol cannot reach conclusions about the absence of undeclared nuclear material and activities. There can be no doubt that those that accede to the Protocol do so in anticipation that the Agency will be able to draw such conclusions, thereby receiving their “clean bill of health.” However, any attempt to reach firm conclusions based on proving a negative could be disastrous, and the damage—in a case where a state actually cheated—irreparable.

Will the Protocol Work in Practice?

Realistically, it is doubtful whether the IAEA will be accorded all of the rights specified in INFCIRC/540. Only in rare circumstances will a highly advanced non-nuclear weapon state offer complete transparency from the first moment of implementation. The IAEA will be faced with the issue of what to do, and to whom to go to in case complete transparency is not offered.

In addition, the broadened declaration still may be incomplete and not always readily verifiable. This would generally be not the result of ill will, but rather because of differences of opinion between the state and the IAEA on form and contents, which will have to be resolved before any reasonable verification work could proceed.

Receiving complete access to facilities is even more difficult, since it involves an invasion of privacy and the possibility of abuse by disclosing security-related or commercially sensitive information. Access requirements are not that extensive under the Protocol, but if the inspected state believes that environmental samples could contain or otherwise reveal sensitive commercial information, the samples would probably need to be protected.

Difficult situations are foreseeable in the event that there are condemnatory or ambiguous analytical findings of the collected data. There are few mandatory procedures that address a situation when verification uncovers disturbing information. First, the Agency is to seek clarifications from the inspected state. It may then use additional technical methods to try and clarify an unanswered issue. If the issue remains unresolved, then the dispute is elevated to the Board and eventually the UN Security Council. It is not surprising, therefore, that the IAEA abhors discovering any misdeeds in the inspected states, unless the general political mood is favorable to such discoveries.

Adherence is a Problem

As of December 2000, the Model Protocol had been signed by only 57 states, 18 of which had brought it into force.[9] Few of these are suspected of harboring nuclear weapons ambitions. For other states, the Protocol is unable to address proliferation concerns. For example, ambiguous conclusions about Algeria's nuclear intentions, based on open-source analysis, could be better resolved if the Protocol was implemented.[10] The IAEA Board created this problem when it decided not to make it mandatory for all states to join the Protocol—even for those states that have yet to sign a safeguards agreement with the Agency, contrary to their NPT obligations.

Some NPT non-nuclear weapon states are demanding concessions and expect rewards for adhering to INFCIRC/540. This attitude signifies that their main interest is not the assurance of nuclear nonproliferation, but in material gains. One such reward is the "clean bill of health" that would enable them to procure technologies, equipment, and materials without hindrance, as long as they obey the safeguards requirements.

---

[1] For a contemporary IAEA analysis of which components are covered by existing legal authority (i.e., Part I measures) and which are not, see "Annex 1: A Summary of the Legal Evaluation of Measures Proposed for Strengthened and More Effective Safeguards," in "Strengthening the Effectiveness and Improving the Efficiency of the Safeguards System: Report by the Director General to the Board of Governors," GOV/INF 2863, May 6, 1996. The latter document is attached as Annex 1 to "Strengthening the Effectiveness and Improving the Efficiency of the Safeguards System: Report of the Director General to the General Conference," GC(40)(17), August 23, 1996.

[2] The full title of the Additional Model Protocol is "Model Protocol Additional to the Agreement(s) Between State(s) and the International Atomic Energy Agency for the Application of Safeguards."

[3] Ibid., Article 4(a).

[4] Ibid., Article 2(a)(i) et. seq.

[5] Ibid., Article 4(a)(i) et. seq.

[6] Ibid., Article 6(a) et. seq.

[7] Ibid., Article 18(f).

[8] Ibid., Article 18(g).

[9] The 18 states are Australia, Azerbaijan, Bulgaria, Canada, Croatia, Holy See, Hungary, Indonesia, Japan, Jordan, Lithuania, Monaco, New Zealand, Norway, Poland, Romania, Slovenia, and Uzbekistan. A 19th state, Ghana, had provisionally brought the protocol into force as of December 2000. The number of signatories includes the five nuclear weapon states. Source: IAEA Annual Report 2000, table A16, pp. 140–141.

[10] For a discussion of Algeria's nuclear program, and the possible role of INFCIRC/540 to resolve ambiguities, see David Albright and Corey Hinderstein, "Algeria: Big Deal in the Desert?" *Bulletin of the Atomic Scientists*, vol. 57, no. 3 (May/June 2001), pp. 45–52.

4

THE UTILITY OF WIDE-AREA ENVIRONMENTAL SAMPLING IN VERIFYING AN ABSENCE

It isn't the pollution that's harming the environment. It's the impurities in our air and water that are doing it.
-J. Danforth Quayle, Vice President of the United States, 1988–1992

THE ADDITIONAL MODEL PROTOCOL, INFCIRC/540, PROVIDES FOR environmental sampling to determine whether a state has acted in contravention to its obligations under the Non-Proliferation Treaty (NPT). Such sampling is perhaps the strongest technique of all, since positive findings can be termed to provide absolute evidence.

The Model Protocol refers to two kinds of environmental sampling—location-specific and wide-area. Article 5(c) provides International Atomic Energy Agency (IAEA) safeguards inspectors with access to any specified location to carry out "location-specific environmental sampling." The purpose of this sampling is to detect and verify activities that take place at a given site. Implementing this article needs no further approval, and the IAEA can begin taking location specific samples as soon as the Protocol has come into force in a given state. Indeed, under the Part I measures adopted by the IAEA Board of Governors in 1995 (see chapter 3), inspectors may take samples at strategic points at declared facilities under their current safeguards authority.

Article 18(g) defines "wide-area environmental sampling (WAES)" as "the collection of environmental samples (e.g., air, water, vegetation, soil, and smears) at a set of locations specified by the Agency for the purpose of assisting the Agency to draw conclusions about the absence of undeclared *nuclear material* or nuclear activities over a wide area." Unlike location-specific sampling, WAES suggests the establishment of a state-wide environmental sampling network whose purpose is to detect indicators of illicit nuclear materials or activities that are taking place within the boundaries of that state.

However, article 9 of the Model Protocol limits the implementation of WAES by requiring prior consultations with the inspected state and the approval of the Board of Governors. Part of the reason is the expected expense of such a system, if it were deployed in all non-nuclear weapon states party to the Protocol. Constrained by cost limitations, the effectiveness of WAES is still being debated.

Limitations of Wide-Area Environmental Sampling

The purpose of collecting environmental samples over a wide area is to detect any telltale indicators of illicit nuclear activities within a state. Location-specific sampling is more straightforward, because activities at the sampling site can be judged on their consistency with the sample results. However, wide-area sampling must consider whether the origin of the suspected activity is in the inspected state and, more specifically, where and when these activities took place within the inspected state.

Several factors could complicate the analysis of samples collected over a wide area. The sampling may detect the presence of nuclear material that was released to the environment at a time prior to the beginning of the environmental monitoring programs' activities. Environmental indicators of a state's declared nuclear material or activities at other sites may also be detected. Because environmental releases know no boundaries, sampling may also pick up indicators of nuclear materials and activities that are taking place in neighboring states, or from residual nuclear materials from reactor accidents or nuclear explosions. Ambiguous analysis will be a source of unending trouble.

A major flaw is that the apparent absence of nuclear material could have two meanings. First, it could mean that there is, in fact, no undeclared nuclear material or activity. It could also be a false-negative result, such that the environmental sampling has failed to detect the undeclared nuclear material or activity.

Assessing the Efficacy of WAES

To assess the efficacy of WAES, a design basis must be defined. It is generally accepted that uranium enrichment is more difficult to detect environmentally than plutonium production and separation, because the latter inevitably emits contaminants (gases and some volatiles) to the environment. The scale of the activities must also be taken into account in this design basis. Thus, the most difficult activity to detect is a small-scale uranium enrichment activity. Moreover, while the release of matter from a plutonium production activity could be almost continuous, the release from a well-managed, small-scale enrichment activity could be sporadic.

Wide-Area Air-Sampling Grid. The following is a generic discussion of a proposed method to conduct WAES that involves the placement of air monitors at fixed locations in a grid pattern. The grid constant (the distance between air samplers in a square grid) is the major factor affecting the ability of the system to detect possible releases from an unknown source located within or adjacent to the grid. A smaller grid constant will increase the system's ability to detect a release, and therefore reduce the probability of false-negative results. This model, and its shortcomings, are discussed in detail in appendix 1.

Environmental factors affect the efficacy of the sampling grid. For example, a small shift in the wind direction could take any release away from the sampler, thus negating the possibility of detection. If the release were continuous rather than periodic or sporadic, a much smaller grid would be necessary, because of the reduced air concentrations.

A wide-area air-sampling grid would likely be a very costly system to set up and operate. It could also be meddled with in a relatively easy manner. Should an air-sampling grid be installed before the state initiates illicit activities, the location of any future facility could be optimized, so as to minimize the probability of its detection. In the best of cases, taking everything into consideration, the false-negative probability could be upwards of 80 percent, even for a dense network. This is clearly unacceptable.

Surface Deposition Sampling. An alternative WAES model is based on manually taking surface samples (preferably dust smears), instead of relying on fixed air-samplers. Such a system has several advantages. It is versatile, because many samples can be taken without incurring high costs. Misleading the samplers also would be difficult, since the host state would not know the location of the sampled site in advance. Even if the state were to learn the location, it would not be possible to clean every surface.

The grid size could be much smaller than the air-sampling grid. Moreover, the grid system could be employed in one area and later in another area. Thus, a greater total area could be covered with an increase in the probability of detection of undeclared activities.

A model involving a dense, but non-uniform, varying-site environmental deposition sampling grid has a better chance to detect low-level releases into the atmosphere, since:

- The grid can be dense in and around potentially capable sites. This would raise the probability of detection, since the patterns of atmospheric dispersion and ground deposition are very similar;
- The density of the deposition-sampling grid can enable some spatial mapping that could give an indication as to the source location. For an air sampler, the detection could be a single event that would be very difficult to backtrack, especially for long sampling periods. The backtracking is relatively easy for cases where a ground deposition pattern is discernible;
- The deposition data is integrating, and can come from several releases over a long period of time, while the air sample is representative of the period of sampling. Should the weathering effects be relatively mild, the probability of detection could become noticeably higher than that of air sampling;
- The data coming from deposition sampling is reproducible, since it is relatively simple to carry out a repeat sampling campaign where an anomaly has been found. Thus, deposition sampling enables a recheck in case of doubt, and also a further elaboration of the findings, in case the findings were true-positive;

- The deposition sample is relatively immune from inspected-state interfere, since the exact sampling location would not be well known ahead of time and can be decided on the spot; and
- Deposition sampling needs very little operational resources, and no installation costs.

Conclusion

There is no method of environmental monitoring that can assure its operators of avoiding false-negative results. It would be unlikely that an air-sampling grid would produce sufficient detection probability of randomly located, small-scale centrifuge enrichment production facilities, or other nuclear R&D facilities, materials, and activities. Should there be some prior reliable indication of the location of such a facility, and some knowledge of the prevailing meteorological conditions around the facility's site, it would be easier to identify and locate such an activity, mainly by deposition sampling.

Even a relatively high probability of detection is still not good enough. If the complement of such a probability—the probability of obtaining a false-negative result—is not negligible, there is a reasonable probability that the state being inspected could get away with illicit activities. Such a sampling system certainly cannot form the basis that enables us "to draw conclusions about the absence of undeclared nuclear material or nuclear activities over a wide area," as prescribed in article 18(g) of the Additional Model Protocol. At most, a general statement could be made concerning the absence of evidence to the contrary.

The fixed-point sampling, be it air or deposition sampling, always has a chance of missing out on the important evidence. A deposition WAES program, with the added feature of mobility, would have a significantly better chance of obtaining evidence, because of its integrating character, reproducibility, and the possibility of working on a smaller, varying grid constant. The final verification activity—that of locating the undeclared facility—would be aided greatly by the utilization of deposition sampling.

5

Verification of the CTBT

Unlike the Nuclear Non-Proliferation Treaty (NPT), which relies upon the independent International Atomic Energy Agency (IAEA) for verification, the Comprehensive Test-Ban Treaty (CTBT) creates its own verification organization. Moreover, the CTBT's governing bodies, the Executive Council and the Conference of States Parties, are accorded more powers than those of the IAEA.

The CTBT verification regime consists of an International Monitoring System (IMS) and on-site inspections (OSI). There are also opportunities for a state accused of carrying out a nuclear explosion to present its side of the story.

The technical verification system consists of the IMS, which is connected to an International Data Center (IDC), and the OSI mechanism. The IMS consists of worldwide arrays of seismographs, airborne radionuclide samplers, infrasound detection systems, and hydroacoustic detectors.

The purpose of the verification mechanism is divided into two functions: detection and verification. The IMS is to detect evidence of a nuclear explosion, which will be interpreted by the IDC. Once the event has been identified as a possible nuclear explosion (i.e., once natural causes or chemical explosions are ruled out), then on-site inspections may take place to verify the IDC's findings.

Unlike NPT verification, the CTBT allows states-parties to use intelligence information, or "national technical means" (NTM) of data collection, to inform its verification mechanism. The treaty states that "no State Party shall be precluded from using information obtained by national technical means of verification in a manner consistent with generally recognized principles of international law."[1] Furthermore, the Treaty states explicitly that OSIs may be triggered by "any relevant technical information obtained by national technical means of verification."[2]

Nevertheless, the CTBT has many checks and balances to protect an inspected state. For example, the Comprehensive Test-Ban Treaty Organization (CTBTO) is instructed to "conduct its verification activities…in the least intrusive manner possible."[3] Requests for information are limited, and the CTBTO is to "take every precaution to protect the confidentiality of information on civil and military activities and facilities coming to its knowledge."[4] At the same time, the inspected state has the right to "take measures to protect sensitive installations and locations and to prevent disclosure of [unrelated] confidential information."[5] The verification protocol provides that, during an on-site inspection, "the inspection team shall make every reasonable effort to fulfill the inspection mandate outside the declared restricted-access sites prior to requesting access to such sites."[6]

The CTBT requires that the verification mechanism be operational before the treaty enters into force. At the time of writing, setting up this mechanism is still underway, with some important issues still left unresolved.

Detection

The IMS carries out the majority of the detection activities. The system has several components:

- **A global seismic network**, which is aimed at detecting seismological events, including underground nuclear explosions, and locating their origin so as to try to identify where they occurred. The land-based network is composed of 50 primary stations and 120 auxiliary stations. Nationally contributed stations may also be added to this system.
- **A global atmospheric radionuclide sampling network**, which is comprised of 80 land-based stations. When operational, all stations will be capable of sampling particulate matter, and 40 stations will also be capable of sampling noble gases. This network is aimed detecting atmospheric releases of radioactive particulate or gaseous products that result from atmospheric, underground, and underwater nuclear explosions.[7]
- **A hydroacoustic network**, which is to include 11 "listening" stations dispersed underwater to detect oceanic nuclear explosions. The number of stations is small, because acoustic signals from undersea events have long ranges.
- **An infrasound network**, which is to detect the very low frequency acoustic signals that are emitted from nuclear explosions. This detection method was used during the period of atmospheric testing. Some 60 land-based infrasound signal detection stations will be established around the globe.

In addition, states are permitted to use NTM to assist the verification mechanism in detecting nuclear tests. In particular, evidence of tests or test preparations gathered by satellite imagery could be valuable.

On-Site Inspections

Once information is gathered and assessed, the CTBT's Executive Council may be requested to initiate an on-site inspection. The decision to do so is first and foremost political. Composed of representatives of the member states, the Executive Council may order an OSI if it decides by a special majority that such an inspection is in order. Such a decision is made only after the accused state is given an opportunity to explain the evidence and to try to persuade its accusers that an OSI is unnecessary.

An on-site inspection can last as long as 60 days and involve up to 40 personnel. The treaty allows these inspections to be extended for an additional

70 days. If the Executive Council decides to approve on-site drilling, the inspection could take up to a year and involve more personnel.

An on-site inspection under the CTBT regime is a major nuisance event. The inspected state would have to supply the inspection team with living quarters, food, medical care, and field vehicles. If the inspection team required them, the host country would have to provide not only an aircraft for over-flight activities and any available laboratory facilities, but also many other services and amenities, as well. The inspected state also would have to attach its own personnel to the various teams in order to assure itself that all was being done properly. In short, hosting an on-site inspection would be a horrendous logistical task—even more so if the inspected state was a developing country with few resources to spare.

Punishing a False Accuser

The CTBT is the first and only international nuclear treaty that addresses the issue of punishing a state that makes unwarranted accusations of cheating. If the CTBT Executive Council fails to approve an on-site inspection, or if an on-going inspection is terminated, because the Council believes that the grounds for the inspection are "frivolous or abusive," then the accusing state may be held accountable.[8] In particular, the state that made the frivolous request may be requested to pay the costs for the preparations for the inspection. The Executive Council may also suspend the rights of the false accuser to request on-site inspections, or even suspend the state's Executive Council membership.

The CTBT also reimburses the inspected state for some of the costs it incurs as a result of an inspection.[9] However, the reimbursement coverage is incomplete. Although the inspected state is to be reimbursed for costs directly related to the inspection—communication means, interpretation services, transportation, working space, lodging, meals, and medical care, for example—the CTBT offers no compensation for many other costs. These uncompensated costs include the state's own personnel costs or costs of other activities, such as carrying out independent measurements to ensure that the inspectors are acting in good faith.

Assessing the Verification Mechanism

Verifying the CTBT will be a difficult task. The purpose of the CTBT is to prohibit nuclear explosions. This falsely implies that the verification mechanism can detect all nuclear explosions. The CTBT has not set a "greater-than-zero" threshold on the yield of the nuclear explosion. During the treaty's negotiations, the "ball-park" figure of 1 kiloton was informally taken as the design basis for the IMS. The unwritten rationale was that this is the background noise level for detecting seismic events. Signals from much more frequently occurring earthquakes of equivalent or lower magnitudes, combined with the practicable number of IMS stations, contribute to the difficulty in identifying low-yield tests.[10]

Attempts are being made to lower the practical threshold limit below 1 kiloton, but doing so will have implications for both the installation and operating costs of the IMS components. The sensitivity of the various components—their ability to detect artificial events and distinguish these events from natural occurring events or background noise—will be determined by the number of sensing stations dispersed around the globe. The more stations there are, the lower the threshold of detection will be. However, there is a practical limit to the number of stations that can be deployed.

Each of the IMS components is imperfect. For example, there is no foolproof way to distinguish seismically, with 100 percent accuracy, between a low-yield nuclear explosion and a small earthquake. There have been several cases in the past when earthquakes were erroneously identified as nuclear explosions. States may take advantage of this ambiguity, and "decouple" nuclear explosions to conceal the true nature of the seismic waves detected by the system.

The atmospheric radionuclide sampling network also is not foolproof. While the detection of an atmospheric nuclear explosion can be taken for granted, detecting the releases from an underground nuclear test will take careful analysis, because few radioisotopes that could be released to the environment are unique to recent nuclear explosions. There is a considerable background of isotopes already in the environment because of old atmospheric explosions, and from routine and accidental releases from nuclear operations. The time factors involved—including the time it takes for the radionuclides to travel from their point of origin to the sampler, and the time it takes from the sampling to obtaining the final result—complicates the effort to find the geographic source of the release.

Accurately locating the "ground zero" of a suspect event, for the purposes of conducting an on-site inspection, is thus problematic. Accuracy is needed because an OSI is limited to an area of 1,000 square kilometers. A reasonable error in the calculations could misidentify ground zero, thereby leading the inspectors to the wrong area.

Moreover, the CTBT Executive Council is likely to be reluctant to call for an on-site inspection, except in the most compelling circumstances. There could be cases when taking such a decision would be easy; either the evidence is compelling enough that an explosion had taken place, or obviously frivolous. However, it is more likely that the evidence will be ambiguous.

The question of initiating on OSI quickly becomes a political issue. The CTBT's Technical Secretariat is to assist "the Executive Council in facilitating consultation and clarification among States Parties" when a suspect event has taken place.[11] Following such consultations, a decision to approve an OSI could be hard to achieve; after all, the IAEA has always been reluctant to request a special inspection.

On the other hand, the Executive Council could, for political purposes, approve an on-site inspection, even when the evidence was ambiguous. For example, if the request was founded on a seismic occurrence on the territory of an adversary, only a very resolute Executive Council could turn down a request for an OSI.

However, the use or abuse of OSIs could have disastrous effects on the CTBT. Inspections are costly and time-consuming affairs, and extremely burdensome to the inspected party, unless "success" is achieved within a short time. If the inspection team is unable to conclude quickly that a test has taken place, then the OSI activity could go on until the CTBT-prescribed time limits are reached. After one or two such inspections—particularly if the inspected state or states were found to be innocent—the CTBT organization would be in dire financial straits and its member states might start growing impatient. In addition, the inspected party or parties might seriously considering withdrawing from the treaty.[12] Such possibilities need to be taken into account by the Executive Committee before approving OSIs.

Consequently, there are no guarantees that either an obvious nuclear explosion will be explored, or a false accusation, initiated by a natural event, will not result in an OSI. It is also possible that a state may succeed in initiating an OSI in an adversary state based on weak evidence.

State parties have tacitly acknowledged the technical problems of the CTBT's verification mechanism. However, the value of the CTBT cannot be judged by this fact alone. The treaty is an extension to the Partial Test-Ban Treaty (PTBT). Although the PTBT did not utilize a verification mechanism, it was apparently fully implemented and upheld. This alone makes achieving the CTBT a great accomplishment.

Even without being totally efficient, the CTBT verification mechanism has one important *raison d'être*: The deterrent effect on those that wish to carry out nuclear explosions is great—even for low-yield explosions. Basing a request for an OSI on not only the IMS findings, but also on NTM, means that a delinquent state cannot rule out a possibility that it will be accused of having conducted a nuclear explosion, and that an OSI will be requested to confirm that information. For these reasons, the CTBT is verifiable for all practical purposes.

---

[1] Comprehensive Nuclear Test-Ban Treaty, Article IV(A)(5).

[2] Ibid., Article IV(D)(37).

[3] Ibid., Article (II)(A)(6).

[4] Ibid., Article II(A)(6).

[5] Ibid., Article IV(A)(7).

[6] Protocol to the CTBT, Part II: On-Site Inspections, Section E: Conduct of Inspections, paragraph 96.

[7] For underground and underwater explosions, such materials may "vent," or otherwise seep into the atmosphere.

[8] CTBT Article IV (D)(67).

[9] Protocol to the CTBT, Part II: On-Site Inspections, Section E: Conduct of Inspections, paragraph 106.

[10] An earthquake of magnitude 3 on the Richter scale is roughly equivalent to a one kiloton underground nuclear explosion. Magnitude 3 earthquakes are quite common in certain areas of the globe, and distinguishing between these natural events and possible nuclear explosions can be difficult.

[11] CTBT Article II (D)(43)(e).

[12] Ibid., Article IX(2): "Each State Party shall, in exercising its national sovereignty, have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized its supreme interests."

6

THE IAEA'S ENFORCEMENT AND VERIFICATION TASK IN IRAQ

THE CASE OF IRAQ AFTER THE GULF WAR INVOLVES THE MOST INTRUSIVE and hostile verification regime known to date—probably the most intrusive regime that will ever be known, short of a military conquest and the imposition of martial law by the victors. The mandate for inspections was first set by UN Security Council (UNSC) resolution 687, adopted in April 1991. Subsequent Security Council resolutions—707, 715, and 1284—set further responsibilities on Iraq. As such, the mandate for verification came not from a negotiated treaty, but rather a cease-fire agreement.

The provisions detailed in the Security Council resolutions include a list of actions required by Iraq, and a very comprehensive list of rights bestowed on the International Atomic Energy Agency (IAEA). The resolution obligates Iraq to present a complete statement concerning its nuclear program. It requires Iraq to dismantle and turn over to the UN all weapons-usable nuclear materials (separated plutonium and highly enriched uranium (HEU)) and primary-use equipment. It also commands Iraq to fully cooperate with UN and IAEA personnel and to give inspectors access to all places, personnel, documentation, and other assets related to its proscribed weapons of mass destruction (WMD) programs.

Monitoring the dismantlement of Iraq's pre-Gulf War nuclear weapons program, and assuring that Iraq does not reconstitute this program, has been a difficult task. The responsibility fell to the IAEA in 1991 with little warning or time to prepare.[1] The IAEA was mentally and technically ill-equipped to inspect a state that only recently had been deemed in full compliance with its safeguards agreement. Moreover, as time went on, the political backing by the UN Security Council of the IAEA inspections weakened, making it easier for Iraq to resist inspections. This development points to the prerequisite of firm political support for successful verification.

The Inspection Mandate in Iraq

Security Council resolution 687 set the mandate for the ensuing inspection and monitoring activities in Iraq. Under resolution 687, Iraq is to "unconditionally accept the destruction, removal, or rendering harmless, under international supervision" of all of nuclear, chemical and biological weapons-related assets, and longer-range (greater than or equal to 150 km) missile programs.[2] In particular, resolution 687 obligates Iraq to "unconditionally agree not to acquire or develop nuclear weapons or nuclear-weapons-usable material," or any facilities for the production of nuclear weapons or weapons-usable material.[3] To provide a baseline for inspection of Iraq's pre-Gulf War nuclear program, resolution 687 called on Iraq to submit a "full, final, and complete declaration" (FFCD) to the IAEA.[4]

Resolution 687 created a UN Special Commission on Iraq (UNSCOM) to carry out the tasks related to biological, chemical, and proscribed missile programs, and designated the IAEA to carry out the tasks related to Iraq's nuclear program. The IAEA created the Action Team as a special unit to carry out these tasks.

The IAEA Director General was requested to develop a plan for future on-going monitoring and verification (OMV) activities in Iraq to ensure that Iraq did not reconstitute its nuclear weapons efforts. The Security Council approved the IAEA's plans for OMV in resolution 715 in October 1991. An export-import mechanism, which includes lists of items subject to monitoring, as well as items that are banned altogether, was approved in March 1996 (resolution 1051).

In August 1991, after Iraq had failed to meet the initial deadlines established by resolution 687, the Security Council adopted resolution 707. This resolution required Iraq to "halt any nuclear activities of any kind, except for the use of isotopes for medical, agricultural, or industrial purposes" until the relevant obligations under resolution 687 are met.[5]

The final piece of the inspection mandate was put into place in December 1999 with the Security Council's adoption of resolution 1284. This resolution, adopted one year after IAEA and UNSCOM inspectors were forced out of Iraq, intended to provide Iraq with incentives to allow inspections to resume. Resolution 1284 provides that sanctions imposed on Iraq would be suspended for 120-day renewable periods, once "reinforced" OMV systems have been established, and after Iraq has complied with "key remaining disarmament tasks" needed to fulfill the disarmament obligations under resolution 687.[6] This resolution further states that Iraq's obligations in allowing OMV and in complying with the remaining disarmament tasks are to be "clearly defined and precise."[7] Resolution 1284 also established the UN Monitoring, Verification, and Inspection Commission (UNMOVIC) as the successor organization to UNSCOM.

The Plan for On-Going Monitoring and Verification

The IAEA's OMV plan was approved by the UN Security Council in October 1991.[8] The plan covers almost all possible aspects of verifying the absence of nuclear activities in Iraq. It is not a "plan" in the usual operational meaning of the word. Rather, the OMV document details the rights of the IAEA and the obligations of Iraq.

Under the plan, the Agency is to "monitor and verify Iraq's compliance with its obligations under resolution 687." The plan grants the IAEA the right to inspect any site, facility, area, location, activity, material, or other item in Iraq. In addition, the Agency is empowered to request and retain any records, documentation, and information deemed necessary to the purposes of OMV. Inspectors are also given the right to interview Iraqi personnel and officials connected with the nuclear program.

The Iraqis were required by the plan to perform many activities, and to accept and cooperate with the IAEA in many important areas. Iraq is obligated to provide IAEA inspectors with immediate and unimpeded access to all locations that are deemed necessary for inspection. They also are required to provide an inventory of all nuclear and relevant non-nuclear materials, and of all relevant facilities, installations, and equipment.

The plan states clearly that the verification work will be carried out in two phases. The first phase is devoted to the destruction, removal, or rendering harmless of Iraq's existing nuclear weapons facilities, equipment, materials, and items. The second phase concerns the monitoring and verification of Iraq's compliance with its obligations, specifically "not to acquire or develop nuclear weapons or nuclear-weapons-usable material, or any subsystems or components, or any [related] research, development, support or manufacturing facilities."[9] However, the IAEA could not implement these phases separately, and aspects of the second phase were being implemented even as the first phase remained incomplete. When the inspectors left Iraq at the end of 1998, the first phase had not been completed, and the second never fully implemented.

Forming the IAEA Action Team

It was not a simple matter for the IAEA to implement the role assigned to it by the Security Council. Although the IAEA affirmed in 1991 that "the approaches and techniques to be used under the [OMV] plan draw upon the Agency's safeguards experience," the plan's requirements did not resemble the safeguards activities that were part of the IAEA daily activities.[10] Verifying material balances was only one minor aspect of all the essential activities that the Action Team had to carry out in Iraq. In forming the Action Team, the Agency lacked personnel with the necessary expertise in many areas, and therefore had to recruit experts from member states. In addition, the equipment was not immediately available and, more importantly, the procedures that were essential for efficiently searching and uncovering the Iraqi nuclear weapons program were not in place. Moreover, the attitude needed for enforcement work, in which the opponents have to be assumed to be guilty, was not there.

The IAEA also decided to organize only a small team of inspectors, rather than conduct a much larger effort. It was, in the long run, a modest operation that lacked the capacity to perform the extensive job warranted by the situation. In hindsight, this decision was a mistake. The UN Security Council did not set a minimal level of obligations on the IAEA in performing its duties, nor did it put a ceiling on such activities. Expenses were to be paid from frozen Iraqi accounts. Therefore, the IAEA could have devoted unlimited staff and used all resources at an enormous rate of expenditure.

The Abyss Between Plan and Reality

The investigative role of the IAEA, with the need for aggressiveness at times, was difficult to implement. There were many instances of personal bravery and sacrifice on the part of the inspectors, but such isolated events could not overcome Iraq's systematic concealment of its nuclear program. The main problem, which went unacknowledged by the IAEA, was that there were no set rules and duties that the IAEA had to follow.

The beginning was auspicious. At that time, confusion reigned in Iraq. The IAEA made many important discoveries, and uncovered serious evidence. However, as time went on, the Iraqis started implementing a system of concealment and obstruction. Iraq reduced its degree of cooperation with the Action Team, and the concealment mechanism became more effective over time. The Iraqis increasingly imposed one-sided interpretations on their obligations, which made life for the inspectors much harder.

The IAEA Action Team was not up to dealing with this problem, and its attitude towards Iraq was not all that tough. According to one observer: "the IAEA was too easily satisfied with a non-political, technocratic routine. Its consciousness was clouded to the fact that its task consisted of strictly a central arms control agreement, particularly in 'suspect states.'"[11] This made it easier for the Iraqis to conduct their concealment activities and hinder the inspectors from assessing the real situation.

The Action Team was further hindered by a lack of support from UNSCOM. In many respects, the IAEA was the poor brother of UNSCOM. Under UN Security Council resolution 687, UNSCOM controlled the budget, the logistics, and the authority to grant or deny permission to visit Iraqi sites that the Action Team had not previously visited. Combined with some friction between the IAEA and UNSCOM, these factors prevented the IAEA from performing at the full capacity that it needed to in order to arrive at the full truth about Iraq's aspirations, and bring its nuclear weapons efforts to an end.

Unlike UNSCOM, which ultimately took a confrontational approach towards Iraq, the IAEA over time applied a policy of behavioral non-belligerence. The Agency reasoned that such a philosophy would reap more rewards. However, Iraq took advantage of this situation, and began to demand that the IAEA prove any accusation it made. Iraq would not accept any situation where it had to prove that its hands were clean. The burden fell on the IAEA to prove that Iraq did not supply all information, that it had retained materials and equipment, and that it did not abandon its ambition and program to produce nuclear weapons. This shift in the burden of proof from Iraq to the inspectors was contrary to the UN Security Council resolutions, which condemned Iraq and demanded that it comply with all its obligations. This compliance was eroded until very little remained that the IAEA could do without hindrance, limitations, or open denial.

There were many instances where the IAEA was unable to fulfill its mandate, and where Iraqi cooperation was not forthcoming. For example, the

Iraqis evaded making a "full, final, and complete" declaration of its activities to the IAEA. The first edition of the Iraqi FFCD, issued shortly after the inspections began, was a very short and disgracefully incomplete document. It was rejected by the Agency, and over the next several years Iraq presented five major revisions of the document. The most recent version has many sections, and encompasses more than 1,000 pages.

Iraq did not voluntarily make these revisions. Rather, the additions to each sequential "edition" were made following either a disclosure of the facts to the inspectors, or after the Iraqis were convinced that there would be no benefit in further concealment.[12] Because of Iraq's on-going concealment efforts, as evidenced by successive false or incomplete declarations, there can be no assurance that the most recent version of the FFCD presents the complete story or is full of lies.

A second diversion between plan and reality concerned the destruction of materials related to Iraq's nuclear weapons program. The Iraqis were obligated not to destroy or render harmless any piece of equipment or material unless IAEA inspectors were present. On many occasions the Iraqis disregarded this demand, and declared that they had unilaterally destroyed pieces of equipment or transformed critical materials. Unfortunately, in many cases the Iraqi claims could not be verified, leaving the strong possibility that equipment and materials still exist. In several instances, the inspectors found items or materials that the Iraqis claimed to have previously destroyed.

The Iraqis also failed to provide the inspectors with unimpeded access to sites, personnel, data, and documentation. There were many incidents where access was denied, and when documents were prevented from reaching the inspectors' hands. The Iraqis tried, and often succeeded, in denying or delaying access to installations, buildings, information, and personnel. In many cases, as evidenced by the movement of personnel and vehicles from the site by another route, the delay enabled the Iraqis to remove incriminating evidence and personnel from the site.

Although the IAEA reported many of Iraq's preventive activities to the Security Council, the Security Council took only verbal action. For example, in 1998, the IAEA reported that Iraq would not allow the Action Team to interview personnel, saying that these personnel had left government service and entered the private sector; thus, the Iraqi government no longer had jurisdiction over them.[13] Rather than question Iraq's explanations, the world community tacitly accepted this stand.

Kamel's Defection had Little Impact on the Action Team's Operations

The revelations about Iraq's nuclear weapons program that came to light following the defection of Hussein Kamel in 1995, points to the failure of the IAEA's senior leadership in that it readily accepted Iraq's declared version of its nuclear weapons efforts. Until Kamel's defection, the IAEA was beginning to think that the first stage of its effort was nearing completion. In an April 1995 report to the Security Council, the IAEA Director General reported confidence that "the essential components of Iraq's past clandestine nuclear program have been identified and have been destroyed, removed, or rendered harmless. …[and] the scope of the past program is well understood. Areas of residual uncertainty have been progressively reduced to a level of detail, the full knowledge of which is not likely to affect the overall picture."[14]

The IAEA's conclusions were shown to be premature following Kamel's defection, when Iraqi authorities "discovered" a cache of documents and materials that Kamel had purportedly hidden at the Haider House chicken farm. These documents held a wealth of information, and disclosed much more about the Iraqi nuclear weapons development program than was previously known. In addition, the IAEA was given specific information related to Iraq's "crash program" to produce at least one atomic bomb, just before the onset of the Gulf War, by using safeguarded HEU contained in hitherto unused and slightly irradiated reactor fuel.

Thus, the IAEA's activities prior to Kamel's defection were shown to be ineffective. Its apparent readiness to accept Iraq's pre-defection declaration was unwarranted. However, the IAEA did not learn from this experience: subsequent events would show that the Haider House revelations did not lead the IAEA to drastically or systematically change its approach towards Iraq. Things went on as they did before the defection, since any other course of action would have been an obvious admission of failure on the part of the IAEA. Such an admission is anathema to any organization, most of all to an international organization. Moreover, by 1995, the atmosphere had changed from the immediate post-Gulf War era, when many things would have been possible.

Why Did Verification Fail in Iraq?

In Iraq, two preconditions led to the inevitable failure of verification. The first was the incomplete victory by coalition forces over Iraq in the Gulf War.[15] The second was the Iraqi regime's determination to hold onto as much of its WMD production capability as possible, despite the inspections.

When the Action Team inspectors left Iraq for the last time in 1998, they had, according to the IAEA Director General, compiled a "technically coherent and complete" picture of Iraq's pre-Gulf War nuclear weapons program. The Director General noted, however, "'no indication' of prohibited equipment, materials, or activities in Iraq is not the same as a statement of their 'non-existence.'" At the same time, he wrote, "resolution of the few remaining questions and concerns…would undoubtedly contribute to the confidence in the completeness of the technically coherent picture."[16]

It is unfortunate that the Action Team failed to get to the bottom of Iraq's nuclear weapons ambitions. Proving a negative, in the case of Iraq's nuclear weapons program, was far beyond the IAEA's capabilities. An inspection organization (in this case, the IAEA Action Team) can reach a positive conclusion of positive verification activities. However, it can reach only a *relatively strong* statement regarding the results of its negative verification activities, if and only if the inspected state (in this case, Iraq) has nothing to hide and is fully transparent.

Iraq's lack of transparency and cooperation casts doubt on the IAEA Action Team's findings. If Iraq had wanted to make a complete disclosure, abandoned its wish to develop WMD, adopted and applied a policy of transparency, and fully cooperated with the IAEA Action Team and UNSCOM, it would have been forgiven long ago. It could have returned to full nuclear activity within a relatively short time.

When verification activities encounter non-technical difficulties, the presence or absence of political backing will determine the fate of verification. The most important factor that influenced the eroding situation in Iraq was the Security Council's declining political support for the verification effort. The Iraqi regime used incidents to test the willingness of the UN and U.S.-led coalition to accept confrontation. For example, during the second IAEA mission, inspectors were fired upon, and there was no in-kind reaction; during the sixth mission, the inspectors returned documents to Iraqi authorities, without having retained photocopies.[17] The inevitable conclusion drawn by the Iraqi authorities was that, under most circumstances, they could call the shots. And so they did.

The differences in mentality, the differences in moral values, and the inaccurate understanding of Iraq's motivation during the early days led to what the Iraqis correctly read as the Security Council's unwillingness to tackle confrontational situations head-on. Throughout the period of inspections, Iraq did not fulfill its obligations and the IAEA did not, and later on could not, utilize all of its rights. This resulted in the weakening of the verification regime.

The IAEA behaved according to its best traditions of observing both propriety and confidentiality, and did not report on many of the Iraqi infractions. IAEA reports of Iraqi transgressions were reported in the most impersonal and "objective" way. For example, once the Haider House documents came to light, the IAEA should have reported that Iraq was incapable of being fully transparent and, absent of such transparency, there was no way to certify that any Iraqi "full, final, and complete" declaration was the complete truth. The IAEA did not do so, and by this omission lost much credibility.

Another strong piece of evidence of the declining political support, or perhaps even the lack of will by the IAEA to make very strong statements by accepting Iraq's declarations, was the IAEA's acceptance of Iraq's unilateral destruction of equipment. The IAEA should have declared that, as long as there was no proof of the destruction, the equipment and materials should be considered as being present in Iraq.

Once the Iraqis managed to turn the tables on the IAEA, they turned the verification from a semi-positive one to a completely negative verification activity, with very little chance of success.

[1] For several first-hand accounts of the early IAEA Action Team and UNSCOM inspections, see the proceedings of the ISIS Conference "Understanding the Lessons of Nuclear Inspections and Monitoring in Iraq: A Ten-Year Review," Washington, DC, June 14-15, 2001 <http://www.isis-online.org/publications/iraq/june01conf.html>.

[2] UN Security Council resolution 687, April 3, 1991.

[3] Ibid.

[4] Ibid.

[5] UN Security Council resolution 707, August 15, 1991.

[6] UN Security Council resolution 1284, December 17, 1999.

[7] Ibid.

[8] UN Security Council resolution 715, October 11, 1991. The plan itself is detailed in "Revised plan submitted by the Director General of the IAEA for future monitoring and verification of Iraq's compliance with the requirements of Security Council resolution 687 (1991) for the destruction or removal of specified weapons and with the requirements of resolution 707 (1991) for full disclosure, access to inspection sites and compliance with international obligations," S/22872 / Rev. l, September 20,1991 and Rev. 1 / Corr. 1, October 10, 1991.

[9] UN Security Council, S/22872 / Rev. l, September 20,1991 and Rev. 1 / Corr. 1, October 10, 1991, paragraph 12.

[10] Ibid., paragraph 6.

[11] Erwin Haeckel and Gotthard Stein,(ed.), *Tightening the Reins: Towards a Strengthened International Nuclear Safeguards System*, (New York: Springer Verlag, 2000), pp. 12 – 13.

[12] The most outstanding initial concealment was of the fact that Iraq had a nuclear weapon development project. It was only following the sixth mission, when a "smoking gun" document (the first documentary evidence to the existence of a nuclear weapon development program) came to light, that the FFCD began to present factual evidence.

[13] UN Security Council, "Fifth consolidated report of the Director General of the International Atomic Energy Agency under paragraph 16 of Security Council resolution 1051 (1996)," S/1998/312, April 5, 1998, paragraph 6.

[14] UN Security Council, "Seventh report of the Director General of the International Atomic Energy Agency on the implementation of the Agency's plan for future ongoing monitoring and verification of Iraq's compliance with paragraph 12 of Resolution 687 (1991)," S/1995/287, April 11, 1995, paragraph 6.

[15] This should not be taken as criticism. It is a statement of fact that the Gulf War did not end in a complete victory over Iraq, i.e., Saddam Hussein's overthrow. Had it been so, things might have been different.

[16] UN Security Council, "Report of the Director General of the International Atomic Energy Agency in connection with the panel on disarmament and current and future on-going monitoring and verification issues," S/1999/127, February 9, 1999, Enclosure, paragraphs 32 – 33.

[17] It is possible to defend the absence of UN action in the first case by arguing that since no one was hurt, a retaliatory use of force would have not been appropriate. In the second case, one may defend the inspectors' actions by stating correctly that, after having bravely stood their position, they had no choice but to give in to Iraqi demands, since they had nothing more than moral outside support.

7

Regional Arrangements

People have discovered that they can fool the devil, but they can't fool the neighbors.
-Edgar Watson Howe, American Editor, Essayist, and Novelist

REGIONAL ARRANGEMENTS—IN THIS CASE, NUCLEAR-WEAPONS-FREE zones (NWFZs)—differ from global/international arrangements in many ways. The most obvious difference is their area of applicability. The Nuclear Non-Proliferation Treaty (NPT) and the Comprehensive Test-Ban Treaty (CTBT) both seek global adherence. In contrast, regional arrangements cover only the territories of their member states.

Regional arrangements are born of the unique circumstances of a particular region. Their establishment generally reflects the need of the region's component nations to find a solution that will allay their common fears and build a basis for future existence. Such arrangements may be difficult to achieve because of the possible enmities between a small number of members. Therefore, the first step towards concluding a NWFZ or similar regional arrangements is for the regional state parties to find the necessary level of trust. However, once this basis is achieved, regional arrangements could emerge as a natural outcome of mutual and common respect.

Despite differences among regions, there are many common elements among regional NWFZs. Many rely on International Atomic Energy Agency (IAEA) safeguards as their main verification tool to ensure that nuclear programs are wholly peaceful. In most cases, this reliance is due to expediency, a lack of resources, and a lack of expertise.

In dealing with issues of noncompliance, regional arrangements attempt to deal with disputes internally, rather than turn to international organizations. Such disputes may not ordinarily be of the type that IAEA safeguards would cover. For example, the IAEA has no power to ensure that a state from outside the NWFZ has deployed nuclear weapons within a state party. Only after these means have been exhausted, or after it has become clear to all parties that there is a real danger to international security, are international bodies approached.

Table 7.1 (page 38) presents a summary of the important features of the regional nuclear non-proliferation treaties.

EURATOM

The earliest regional nuclear arrangement is the European Atomic Energy Community (EURATOM), which was established in 1957. As the European Community has grown and matured into the European Union, the membership of EURATOM has grown.

Table 7.1: Summary of the Main Features of Regional Nuclear Nonproliferation Treaties

Treaty/ Region	Entry into Force	Challenge/ Special Inspections?	Regional Control or Verification System?	Development of Nuclear Weapons in the Zone?	Authority to Take Custody of Nuclear Materials?
EURATOM/ Western Europe	1957	No	Yes + IAEA	n/a	Yes*
Tlatelolco/ Latin America	1968	IAEA	Yes + IAEA	No	No
Rarotonga/ South Pacific	1986	Regional	Yes + IAEA	No	No
Bangkok/ Southeast Asia	1995	Regional	IAEA	No	No
Pelindaba/ Africa	1996	Regional/ IAEA Possible	IAEA	No	No

*Article 2 of the EURATOM Treaty states: "In order to perform its task, the Community shall, as provided in this Treaty: 2(f) exercise the right of ownership conferred upon it with respect to special fissile materials."

EURATOM is not a regional nuclear verification regime per se, nor does it create a NWFZ. All of the non-nuclear weapons state-members of EURATOM are also members of the NPT, and are obliged to place their nuclear materials under IAEA safeguards. However, EURATOM acts as the main point of contact with the IAEA for its members, and thus plays the role that national state systems of accountancy and control play for other non-weapon states around the world. In contrast, France and the United Kingdom, which are recognized as nuclear weapon states under the NPT, are not subject to full-scope IAEA safeguards. Even so, both France and the United Kingdom possess significant amounts of nuclear material that are subject to EURATOM safeguards.

The main role of the EURATOM Treaty is to provide a regulatory framework for the development and growth of nuclear industries in Europe. Its initial objective was to internationalize nuclear power in Europe, so as to minimize national competition. In many ways, it complemented the other supranational institutions that were formed after the Second World War and have since grown into the European Union.

However, the EURATOM Treaty also includes a proviso that safeguards be applied to its nuclear material. The agreement directs the European Commission to ensure that ores, source materials, and special fissile materials are not diverted from their intended uses as declared by the users. It requires that states declare the basic technical characteristics of nuclear fuel-cycle facilities that produce, separate, or otherwise process source or fissile materials. EURATOM also inspects facilities in member states to ensure that they are in compliance with the terms of the agreement. Moreover, EURATOM ensures the compliance of any safeguarding obligations assumed by the European Community in the event that nuclear materials or facilities are exported to third parties.

Latin America

The nations of Latin America formed the first regional NWFZ. Completed in 1967, the Treaty of Tlatelolco served as the model for subsequent NWFZ negotiations and agreements. Much later, a subsequent bilateral arrangement between Argentina and Brazil, which did not immediately join Tlatelolco, strengthened the Latin American NWFZ.

Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco). The Tlatelolco Treaty obligates its contracting parties to limit their nuclear activities exclusively to peaceful uses, and to prohibit nuclear weapons research, development, testing, storage, or deployment on their territories. In keeping with the goal of creating a zone free of nuclear weapons, the contracting parties are further obligated to prohibit countries from outside the area from carrying out such activities in the area covered by the treaty.

To oversee the compliance, the treaty relies on IAEA inspections, but it also established the Agency for the Prohibition of Nuclear Weapons in Latin America, known by the acronym "OPANAL." OPANAL is responsible for verifying that peaceful nuclear facilities are not used for the testing or manufacture of nuclear weapons, and that no such activities are carried out in the territory of the contracting parties with nuclear materials or weapons introduced from abroad.

The Treaty of Tlatelolco deals with the issue of noncompliance in a forthright manner. The treaty establishes a General Conference of member states, which is to take note of all cases in which a contracting party is not complying fully with its obligations. Under such circumstances, the General Conference is to confront the accused state and "make such recommendations as it deems appropriate."[1] If the matter cannot be resolved, and if the General Conference decides that the noncompliance might endanger peace and security, then it is to report the case to the UN Security Council, the UN General Assembly, and to the Organization of American States. The General Conference also will report any issues relevant to the IAEA.

ABACC—The Argentina-Brazilian Model for Regional Verification. Despite the presence of the Tlatelolco Treaty, the risk of nuclear proliferation in Latin America remained. Argentina and Brazil, the two largest countries in Latin America, both possessed unsafeguarded nuclear programs. Moreover, neither country was a full contracting party of the Tlatelolco Treaty. Regional and international concerns about their specific intentions and a growing nuclear rivalry increased, particularly after Brazil sought to obtain key nuclear fuel cycle facilities from Germany in the mid-1970s.

Beginning in the late 1970s, Argentina and Brazil began to engage in a nuclear rapprochement that ultimately led to the formation of a bilateral inspection regime.[2] In turn, this regime was integrated into the international regime by virtue of a special agreement with the IAEA.

The Argentina-Brazil bilateral agreement, concluded in 1991, is wholly unique.[3] It created the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC), whose main function is to administer and apply bilateral safeguards. These safeguards are based upon a unique Common System for Accounting and Control of Nuclear Materials (SCCC) that Argentina and Brazil developed, and which are applied to all nuclear materials and activities in the two countries. The SCCC thus provides a basis for ABACC to verify that all nuclear activities subject to the SCCC are for peaceful purposes.

ABACC verification is concentrated at the nuclear fuel-cycle stages that involve the production, processing, use, or storage of nuclear material from which a nuclear weapon could be made. The verification activities cover 68 facilities in both states, including some 12 power and research reactors. Verification efforts should be sufficient for ABACC to achieve the objective of the safeguards: timely detection of any diversion of significant quantities of nuclear material.

The procedures for applying the implementation of safeguards include nuclear material accounting, measurements made at key points in nuclear facilities, and containment and surveillance methods. The verification process may be described as having three distinct stages: The *examination* of information, the *collection* of information by ABACC, and the *assessment* of information supplied by the country and collected by the inspectors. Through this process, ABACC seeks to determine whether the information supplied by the country is complete, correct, and valid.

The Quadripartite Agreement.[4] The Quadripartite Agreement between Brazil, Argentina, ABACC, and the IAEA entered into force in March 1994. Under this agreement, Brazil and Argentina agreed to accept the application of full-scope IAEA safeguards.

The Quadripartite Agreement established some important principles concerning the relationship between ABACC and the IAEA. In particular, the Agreement clearly states that both ABACC and the IAEA should draw independent conclusions and that IAEA verification shall include measurements and observations taken independently of ABACC. On the other hand, the Quadripartite Agreement calls upon ABACC and the IAEA to coordinate their activities in order to avoid unnecessary duplication of efforts, and to work together, as much as possible, according to compatible safeguards criteria issued by both agencies. The tensions inherent in these principles—independent conclusions versus cooperation and coordination—have not always been easy for ABACC and the IAEA to work out in practice.

ABACC and the IAEA have equal status under the Quadripartite Agreement. However, of the two agencies, the ABACC inspectorate potentially has the capability of conducting a more in-depth and thorough verification activity; this fact makes ABACC a strong organization.

The Strengths of ABACC. There are several reasons for ABACC's strength. First, ABACC inspectors are citizens of the two states, are nominated by their respective governments, and have to be approved by the ABACC Commission. Such mutuality does not exist at the IAEA, where inspectors are drawn from all parts of the world.

Second, under the ABACC system, the inspections in one state are carried out by nationals of the other state. Under the NPT system, there is no "other side"; unlike ABACC inspectors, IAEA inspectors lack the personal or national stake in verifying the "other side's" nuclear program.

Among the ABACC inspectors, many are drawn from the nuclear programs of the two states. Their salaries are paid by their own governments, and not by ABACC. They are brought together whenever necessary, and care is taken to assure that all needed qualifications are represented on these teams. Moreover, the inspectors will usually be assigned to inspect facilities that contain technologies that they know best. In this way, the inspectors' efficiency will be greater than that of newcomers to the field.

In contrast, many IAEA inspectors do not come from nuclear weapon states, or from states with fully developed peaceful nuclear programs. They are also full-time civil servants, rather than professional nuclear scientists.

Finally, sample analysis is carried out in the laboratories of the inspectors' state. ABACC does not have its own R&D laboratories, and relies on other countries, regional organizations, or on the IAEA to provide new methods and technologies and to assist in the training of the inspectors in the application of these new methods and technologies. However, the evaluation of inspection results is carried out at ABACC headquarters.

The South Pacific

The South Pacific Nuclear Free Zone Treaty, or Treaty of Rarotonga, was concluded in 1985. The Rarotonga Treaty's control system relies on IAEA safeguards to verify that all nuclear activities are peaceful. The treaty also provides for reports and exchanges of information, consultations among member states, and a set of procedures for addressing complaints. To address a complaint, the treaty first convenes a Consultative Committee. If discussions do not resolve the complaint, then the Committee is to appoint a team of three special inspectors, none of may be drawn from the "complained" and "complaining" parties. However, the treaty goes no further in designating possible actions.

Southeast Asia

The Southeast Asian NWFZ Treaty, known as the Bangkok Treaty, was concluded in 1993, and is similar to the Rarotonga Treaty. The Bangkok Treaty relies on IAEA safeguards for its basic verification mechanism, but also includes the possibility of an internal "fact-finding" mission to resolve compliance issues. Specifically, the treaty permits a state party to request such a mission in order to clarify "ambiguous situations," or situations "which may give rise to doubts about compliance with the provisions of this Treaty."

Africa

The Treaty of Pelindaba, which establishes a NWFZ for the African continent, was concluded in 1994. It is wholly dependent on the IAEA for verification. As almost an afterthought, at the end of Annex IV, the treaty also states that the treaty's commission (a body equivalent to the IAEA Board of Governors) "may also establish its own verification mechanisms."

In resolving disputes, the Pelindaba Treaty permits state parties to bring complaints to the Commission, which in turn is empowered to request the IAEA to launch a special inspection. The results, if condemning any party, can be presented at a special session of states parties. This session can decide to refer the issue to the Organization of African Unity. This organization can, if necessary, refer the issue to the UN Security Council.

The Mongolian NWFZ

In 1998, the UN General Assembly adopted a resolution giving Mongolia nuclear-weapon-free status. It is the first and, as of 2001, only state to achieve such a status recognized by the United Nations. No special verification systems are attached to ensure Mongolia's compliance.

---

[1] "Treaty for the Prohibition of Nuclear Weapons in Latin America," Article 20.

[2] For a more complete discussion of this process, see Argentina and Brazil: The Latin American Nuclear Rapprochement, proceedings of the conference sponsored by the Shalheveth Freier Center for Peace, Science, and Technology and the Institute for Science and International Security, May 16, 1996, Nahel Soreq, Israel <http://www.isis-online.org/publications/israel96/isr_toc.html>.

[3] Much of this sub-section is drawn from the ABACC web site, < http://www.abacc.org/quem1.html >.

[4] The full title of the Quadripartite Agreement is "Agreement of 13 December 1991 between the Republic of Argentina, the Federative Republic of Brazil, the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials, and the International Atomic Energy Agency for the Application of Safeguards." The Quadripartite Agreement is circulated by the IAEA as INFCIRC/435.