VERIFICATION
TO THE YEAR
2000

by

Sidney Graybeal
George Lindsey
James Macintosh
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prepared for
The Arms Control and
Disarmament Division
External Affairs
and International Trade Canada
Ottawa, Ontario, Canada

Arms Control Verification Studies No. 4

Arms Control Verification Studies

Arms Control Verification Studies are issued periodically by the Arms Control and Disarmament Division of External Affairs and International Trade Canada. Their purpose is to disseminate the results of independent research undertaken for the Department as part of its ongoing work in this area.

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The background graphic on the front cover represents the ongoing dialogue on arms control and disarmament issues in Canada and between Canadians and the world community.

Vous trouverez un résumé en français de la présente étude à la page iii de ce document.

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CANADIAN CATALOGUING IN
PUBLICATION DATA

Main entry under title:

Verification to the year 2000

(Arms control verification studies,
ISSN 0828-3664; no. 4)
Includes abstract in French.
Includes bibliographical references.
ISBN 0-662-18347-9
DSS cat. no. E54-5/4E

1. Arms control — Verification — Forecasting.
2. Disarmament — Forecasting. I. Graybeal,
Sidney. II. Canada. Arms Control and
Disarmament Division. III. Series.

JX1974.V57 1991 327.1'74 C91-098517-0

External Affairs and International Trade Canada
February 1991
ISSN 0828-3664
ISBN 0-662-18347-9

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List of Acronyms

ABM	Anti-ballistic Missile
ADI	Air Defence Initiative
ALCM	Air-launched Cruise Missile
ALPS	Accidental Launch Protection System
ASAT	Anti-satellite
ATBM	Anti-tactical Ballistic Missile
ATTU	Atlantic-to-the-Urals
BMD	Ballistic Missile Defence
BW	Biological Weapons
BWC	Biological Weapons Convention
CBM	Confidence-building Measure
CD	Conference on Disarmament
CDE	Conference on Disarmament in Europe
CFE	Conventional Forces Europe
CFE IA	Conventional Forces Europe Follow-on Negotiations
COCOM	Co-ordinating Committee
CORRTEX	Continuous Reflectometry for Radius versus Time Experiments
CSBM	Confidence- and Security-building Measure
CSCE	Conference on Security and Co-operation in Europe
CTB	Comprehensive Test Ban
CW	Chemical Weapon/Warfare
CWC	Chemical Weapons Convention
ELINT	Electronic Intelligence
ENDC	Eighteen Nation Disarmament Committee
EOD	Externally Observable Difference
FROD	Functionally Related Observable Difference
IAEA	International Atomic Energy Agency
ICBM	Inter-continental Ballistic Missile
INF	Intermediate Nuclear Forces
ISMA	International Satellite Monitoring Agency
ITM	International Technical Means
JCG	Joint Consultative Group
JCIC	Joint Compliance and Inspection Commission
LIDAR	Light Detection and Ranging

MIRV	Multiple, Independently Targeted, Re-entry Vehicle
MTCR	Missile Technology Control Regime
MTM	Multilateral Technical Means
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological, Chemical
NORAD	North American Air Defence
NPT	(Nuclear) Non-Proliferation Treaty
NRRC	Nuclear Risk Reduction Centre
NTM	National Technical Means
OSI	On-site Inspection
PALS	Protection Against Limited Strike
PNET	Peaceful Nuclear Explosions Treaty
PPCMS	Portal and Perimeter Continuous Monitoring System
SAIC	Science Applications International Corporation
SALT	Strategic Arms Limitation Talks
SAM	Surface-to-Air Missile
SCC	Standing Consultative Commission
SDI	Strategic Defence Initiative
SIGINT	Signals Intelligence
SLBM	Submarine-launched Ballistic Missile
SLCM	Sea-launched Cruise Missile
SNDV	Strategic Nuclear Delivery Vehicle
SNF	Short-range Nuclear Forces
SNI	Short-notice Inspection
SPOT	Satellite pour l'observation de la terre
SSBN	Submarine, Ballistic Missile, Nuclear
SSI	Suspect Site Inspection
START	Strategic Arms Reduction Talks
SVC	Special Verification Commission
TOSI	Technical On-site Inspection
TTBT	Threshold Test Ban Treaty
UN	United Nations
WEU	Western European Union

Abstract

The role of verification in arms control during the last 40 years is outlined and trends are identified. Assumptions are stated regarding expected developments in arms control during the next 10 years, and the likely trends in verification during that period are forecast. Significant differences are noted between the verification of bilateral and multilateral agreements. It is suggested that the efficient implementation of multilateral agreements will require the parties to establish an organization in which some or all participants co-operate in the planning and conduct of monitoring and inspections, in the analysis and assessment of the results and in the decisions to register queries or accusations regarding suspected non-compliance. The study suggests that verification regimes will be increasingly synergistic, overlapping and enhancing each other. They will also take increasing advantage of co-operative and facilitating measures.

The study concludes with suggestions for further research. The most promising topics include: the multilateralization of verification; the synergistic effect of multiple verification measures; the potential sharing of monitoring resources with non-arms control activities such as peacekeeping and environmental monitoring; the verification demands of new arms control efforts (most notably naval arms control, defence transformation and military technology proliferation control); and the "exportability" of arms control and verification approaches to different political and cultural settings.

Résumé

La présente étude décrit le rôle qu'a joué la vérification au cours des quarante dernières années dans le contexte de la limitation des armements, et les auteurs y définissent les tendances à venir. Ils formulent des hypothèses sur les développements anticipés dans ce même domaine au cours des dix prochaines années et des prévisions sur l'évolution probable des efforts de vérification pendant la même période. Ils traitent des différences importantes entre la vérification des accords bilatéraux et celle des ententes multilatérales. Les auteurs déclarent que, pour garantir la bonne mise en application de ces dernières, les parties devront créer une structure au sein de laquelle certains ou l'ensemble des participants collaboreront pour planifier et mener les missions de contrôle et les inspections, analyser et évaluer les résultats et décider s'il y a lieu d'interroger un présumé contrevenant à un accord ou de porter des accusations. L'étude fait valoir que les régimes de vérification deviendront de plus en plus synergiques et complémentaires et qu'ils se renforceront les uns les autres. Ils miseront par ailleurs davantage sur les mesures de coopération et d'assistance.

Les auteurs terminent leur étude en proposant d'autres recherches. Voici les sujets les plus prometteurs : la multilatéralisation de la vérification; l'effet synergique des mesures multiples de vérification; le partage possible des moyens de contrôle avec des entités menant des activités non afférentes à la limitation des armements (par exemple, le maintien de la paix et la surveillance de l'environnement); les travaux de vérification que de nouveaux efforts de limitation des armements rendront nécessaires (plus particulièrement, la limitation des armements navals, la transformation des doctrines de défense, et l'endiguement de la prolifération des technologies militaires); et la possibilité d'appliquer dans d'autres contextes politiques et culturels les formules adoptées pour la limitation des armements et la vérification.

Disclaimer

The opinions expressed in this paper represent the personal views of the four authors, and should not be attributed to government agencies of Canada or the United States, or to Science Applications International Corporation.

The authors have had to work at separate locations and, although all of the contents of the chapters have been read and discussed by each, and there are no important disagreements about the contents, each chapter is the responsibility of the author or authors as indicated.

Preface

With the rapid evolution of events in Europe, a new climate of East-West co-operation on security-related matters has emerged as the hallmark of the last years of the 1980s and the early part of the 1990s. This spirit of collaboration has already marked the arms control and disarmament process as exemplified by the bilateral Intermediate Nuclear Forces (INF) Treaty of 1987 and the multilateral Conventional Forces Europe (CFE) Treaty of 1990. The Stockholm Document of 1986 and the Vienna Document of 1990, both dealing with confidence- and security-building aspects of arms control, add a further dimension.

As an essential element of arms control agreements, the process of verification cannot help but be affected by these dramatic developments; this will continue throughout the decade. Exactly how these ongoing trends in arms control are likely to evolve and their impact on verification remains to be seen.

The genesis of this research project was the desire to explore in an innovative manner the new requirements, challenges and opportunities likely to face the verification process in the 1990s. With this objective in mind, four distinguished scholars — two American and two Canadian — were invited to come together and focus on the following specific tasks:

- to identify trends with respect to the verification of arms control and disarmament agreements (including confidence building), both bilateral and multilateral;
- to outline how these trends may be expected to evolve to the year 2000; and
- to suggest profitable areas for further research in the field.

The following report is the culmination of their efforts. It represents an innovative, insightful and rigorous attempt to examine developments over the next 10 years with respect to verifying arms control and disarmament agreements in both the bilateral and multilateral fields.

This report is also significant as an example of Canadian and American co-operative research in this important area. In the past, the Verification Research Program has undertaken co-operative projects, on a government-to-government level, with several other countries including the United States. This project, however, represents one of the first times that representatives from Canadian and American industry, academia and government have come together under the auspices of the Verification Research Program. The results of this joint effort are, therefore, particularly interesting and satisfying.

The central objective of Canada's Verification Research Program is to contribute to the process of achieving verifiable arms control and disarmament agreements that will improve the security of Canada and its allies. As part of this objective, the program seeks to contribute to improved understanding of questions that relate to verification. With this goal in mind, the report is being made available to specialists in this field. It should provide useful guidance for what promises to be an exciting decade in terms of international security and arms control verification.

I The Scope and Purpose of the Study

George Lindsey

The recent improvements in East-West relations have established an atmosphere in which the prospects for arms control are extremely promising. There have been encouraging developments in the negotiations between the U.S. and the Soviet Union, and between the two former blocs in Europe. Should these conditions persist through the decade, the chief security concerns of the world are probably going to be centred in other regions. Arms control is likely to become more of a multilateral than a bilateral activity, and could become a global matter for the United Nations (UN).

The success of several existing arms control agreements has been closely related to their provisions for verification. However, the possibility of effective verification depends on the type of armaments concerned, the level of co-operation prevailing among the parties to the agreement, the technology used to obtain information and the arrangements for the implementation of the verification process.

Nearly all of the current efforts in arms control, including the aspect of verification, are being directed toward negotiations now in progress or immediately pending. In contrast, the purpose of this "Verification 2000" study is to assess recent trends in verification, to project them through this decade, to attempt a forecast of the prospects for verification to the year 2000, and to identify profitable areas for further research.

"Verification" will be interpreted broadly enough to encompass security-related measures beyond the strict limits of arms control or disarmament agreements. Other significant international agreements that could be in place by 2000, such as those to limit global pollution or resource depletion, may also require verification, but will not be analyzed in this study.

The study concludes with suggestions regarding research that may prove useful for facing future problems in verification, and that could be suitable for a concerned middle power such as Canada.

II Introduction: The Role of Verification

Sidney Graybeal and Patricia McFate

The prospects for a number of significant bilateral and multilateral arms control agreements increased in the period of *detente* following the democratic "revolutions" of 1989 in Eastern Europe and the changes within the Soviet Union initiated in 1990. Arms control has again become an essential part of the international security process, and the dialogue between the U.S. and the U.S.S.R. in their bilateral negotiations has extended to multilateral forums. The unified American/Soviet position in the UN Security Council concerning the Iraqi invasion of Kuwait has underlined the notion of co-operation between these countries and other nations allied against Iraq; the present war in the Gulf, however, would lead many to suggest that multilateral arms control agreements involving Third World countries may be less certain of success, and the present strife within the Soviet Union related to the Baltic republics may also impact upon the constructive relationship between the U.S. and the U.S.S.R.

The view of arms control as a **process** as well as a **product** has led to a recognition of its contribution to international security. The process and the agreements are important means of removing uncertainties and enhancing stability. The process alone can lead to greater openness and a better understanding of intentions and actions; it can provide a mechanism for managing changes in military postures. The agreements are building blocks that take into account what is practicable and possible in the limitation of certain weapons, within prescribed regions and within certain time periods. Arms control will not provide the solution for every international dispute, but it does play — and will continue to play — a dominant role in multilateral relations.

The agreements being negotiated in the 1990s have heavily emphasized verification. In the U.S., the insistence on the dominance of verification as a factor in evaluating agreements can be found in familiar slogans dating from 1987 to the present day: "Trust, but verify," "Verify, then agree," "Fly before you buy." *The New York Times* has proposed: "In verification, trust." Edward Shevardnadze has been quoted as saying: "Sufficiency in weapons, redundancy in verification." In 1990, verification has become the dominant factor in consideration of arms control agreements involving the U.S. and the Soviet Union, and is playing a major role in the emerging multilateral agreements.

The insistence on stringent verification flies in the face of the reality that the all-inclusive arms control agreement does not exist, and even if it did, it could not be verified with complete certainty. Certainly, although it might be technically feasible, counting and tracking every piece of treaty-limited equipment in a CFE accord would be a daunting job. Verification to the point of absolute certainty of a complete and total ban on any production of chemical weapons agents would be impossible. When all the resource costs for a stringent verification regime — dollars, personnel and equipment — have been added up, they may well exceed the total benefits.

It is necessary to put verification into perspective. It is an important aspect of arms control, but it should not be the central factor in evaluating the utility of agreements or of the arms control process. Arms control agreements should be judged primarily on their military and political significance and, in these days, their economic impact.

Discussions of verification often start with contrasts between it and the process of monitoring. Traditionally, the term "monitoring" is used to describe the process of collection and analysis of data by the U.S. and the Soviet Union using their respective national technical means (NTM). NTM include reconnaissance satellite systems using photographic, infrared, radar and electronic sensors, ground- and sea-based radars, seismographs, communications collection stations and under-water acoustic systems. Most arms control agreements include a prohibition on interference with NTM that are operating consistent with the generally recognized principles of

international law. **Monitoring** is essentially a function of intelligence collection and analysis using all information available concerning a particular activity; it includes the legitimate functions of diplomats, military attachés and scientists, and the analysis of commercially available journals and periodicals.

Verification, the favourite term of the 1980s, varies in meaning between speakers; its process involves but goes beyond monitoring and evaluation of data. It can include the determination of compliance with existing agreements; policy decisions about what constitutes adequate or effective verification; the design and negotiation of regimes to meet security requirements; the implementation of verification provisions of completed agreements; and the determination of appropriate responses to ambiguous situations or to clear non-compliance with specific provisions of the agreements.

Monitoring is often thought of as a unilateral method of gathering information for purposes that **may** (or may not) include determining compliance, whereas verification is considered a bi- or multilateral process intended specifically for the purpose of ascertaining that a commitment to an agreement is being met. Although both monitoring and verification are processes of gathering and analyzing information, permitting conclusions to be drawn on compliance, monitoring does not require the mutual acceptance of rules concerning access and resolution of mechanisms and procedures to handle compliance. Verification does require co-operation, in the form of mutual acceptance of rules concerning access and procedures, and mechanisms to handle issues of compliance. Verification regimes must be negotiated and implemented. In the multilateral arena, verification regimes initially may be formulated internally, but then they are co-ordinated with allies, negotiated with other parties, and implemented among all of the countries concerned.

The previous definitions and distinctions tend to break down in two areas: the category of on-site inspections (OSIs) and the mode typified by Open Skies. OSIs are part of the verification procedures that are incorporated in the agreed-on verification regime of an arms control treaty. They are generally included in a category termed "co-operative measures" because they require the sides of an agreement to co-operate — however uneasily, however reluctantly — in fulfilling their task. OSIs are a method of collecting data that are useful to verify compliance with an agreement.

Open Skies does not fit neatly into the conventional definitional categories. It is a co-operative venture requiring an agreement, and having as its main purposes transparency and confidence building, even though it could and probably will contribute to the monitoring and verification of multilateral arms control agreements.

One clear difference between monitoring and verification is the customary attachment of qualifiers to the latter term. Verification has to be "adequate," "effective," "rigorous," "extensive" — depending on the modifier found most appropriate by the negotiating party. (The term "effective" will be used in this discussion, although it is recognized that the word "adequate" is also found in literature on verification.) Although every negotiator may insist that an agreement must be verified effectively, few would agree on a comprehensive definition of what constitutes "effective" verification. When pressed, most people will refer to the criterion of military significance. In January 1988, Ambassador Paul Nitze described the INF verification regime as "effective," meaning that "if the other side moves beyond the limits of the Treaty in any militarily significant way, we would be able to detect such a violation in time to respond effectively and thereby to deny the other side the benefit of violation." However, arms control agreements are political instruments and any violation, major or minor, takes on political significance. Some argue, for example, that certain countries will only adhere to the limitations of a chemical weapons

convention if their governments believe that violations of the agreement will be detected by other parties and, once the violation is detected, the violating party will be subjected to meaningful penalties.

The criterion of **military significance** relies primarily on NTM for verification, complemented by co-operative measures, but it stops short of the highly intrusive and potentially destabilizing challenge inspections of suspect sites. The **politically significant** criterion, on the other hand, demands extensive, extremely stringent and highly intrusive verification provisions, including numerous challenge inspections. During periods in which there are constructive and co-operative international relations, all sides wish to see the arms control process advance in a mutually advantageous manner. The potential for mischief making is inherent, however, in the implementation of provisions that are rigorous; if the political climate turns cold, innocent oversights, late notifications or neglected assignments can be termed non-compliant, and they can be blown up into an expansive and controversial record of non-compliance.

In judging the effectiveness of an arms control verification regime, a factor to be considered is the incentive to cheat on one or more of the provisions of the agreement. Do the benefits exceed the costs and risks associated with the cheating? For example, if the covert production must be carried out at facilities other than those normally involved, there are likely to be increased costs, time delays and poorer quality control. In addition, there is always the possibility that the covert cheating will be revealed in the international arena by a "whistle-blower," a defector, an accident or through NTM, resulting in political embarrassment on the world stage. Thus, the cheating party must weigh the military advantages gained by the covert cheating against the costs in weapon system reliability and military effectiveness, extended time and resources, and possible political ramifications if the cheating is discovered and made known.

The question of "after non-compliance, what?" has yet to be answered satisfactorily. If issues of non-compliance cannot be resolved promptly in a designated compliance forum and they are militarily significant, then proportionate responses — either military or political — are required. If the violations are of real military significance, the options of withdrawal or abrogation of the agreement are available, although abrogation is not usually a politically desirable course of action.

According to a document of the UN:[1] "The form and modalities of the verification to be provided for in any specific agreement depend upon and should be determined by the purposes, scope, and nature of the agreement." Deep reductions — whether dictated by agreements or by reductions in military budgets — generate concerns about violations or circumventions that affect the security interests of the parties to the agreement. In the CFE agreement, for example, if there were a violation in the range of 20 to 30 per cent of aggregate treaty-limited equipment in the Atlantic-to-the-Urals (ATTU) region, the violation would be considered militarily significant, and the CFE verification regime would not be effective. On the other hand, in the Strategic Arms Reduction Talks (START) treaty, if the Soviets can legally exceed the 6 000 attributable warhead limitations by several thousand, it would be a waste of effort and resources to seek the ability to monitor the provisions of the agreement with sufficient precision to ensure that the U.S.S.R. could not cheat by adding dozens or even hundreds of illegal warheads. In any arms control agreement, determining what constitutes militarily significant cheating will depend on both the nature and scope of the agreement and one's views of what is necessary in order to preserve deterrence and stability.

Effective verification should also give warning of the ability of a side to "break out" of an agreement through illegal, covert actions or through steps permitted by the treaty (sometimes referred to as legal circumvention). Under some agreements, a legal military build-up may occur because the agreement cannot anticipate weapon systems

1 UN General Assembly Resolution S-10/2, June 30, 1978, (Final Document of the Tenth Special Session of the General Assembly), paragraph 31. See also UN General Assembly Resolution 45/65, December 4, 1990.

based on new technologies; the Anti-ballistic Missile (ABM) Treaty is an example of such an agreement. In other cases, the participants in an agreement may see it as mutually advantageous not to limit some weapon systems too stringently — and some not at all. One country may wish to preserve its superiority in some weapons technologies; other countries may also want to enhance their own capabilities in that or similar areas.

Verification functions include: demonstrating compliance, deterring non-compliance and clarifying certainty. The last named function is exceedingly important. An effective verification system will clarify ambiguous activity, allowing for the identification and rejection of false alarms. Agreements may need to be explicit about the commitment on the part of the signers not to use deliberate concealment measures, including encryption of telemetric information during testing and other means of denying telemetric information, which impede verification of compliance. Often, however, the basic conflict in designing a verification regime will be between the need to know more and the need to protect sensitive or proprietary data.

To perform these three functions, verification regimes employ co-operative measures in addition to NTM. The demand for ever-increasing numbers and types of OSIs has led to a perception that NTM and OSI are the sole modes of monitoring and verifying treaties. Often ignored are the mutual benefits of co-operative measures such as data exchanges and notifications regarding treaty-limited equipment and activities. Furthermore, the synergies achieved through the use of all four modes are often overlooked; the whole is greater than the sum of the parts.

Verification will continue to play an important role in both the arms control process and products. It serves to institutionalize expectations of conduct. It is a participative, co-operative activity, which should yield clear, convincing evidence of compliance or non-compliance, or provide examples of ambiguities in need of clarification.

How much verification is enough will remain a key question. The trade offs between benefits, costs and risks will continue to drive verification analyses. Political climates will determine both the nature and scope of verification regimes and the effectiveness of their implementation. Thus, to the extent that arms control can contribute to national and international security, verification will be an essential ingredient in that process.

III Assumptions, Constraints and Realities

Patricia McFate and Sidney Graybeal

In order to assess verification trends to the year 2000, it is necessary to develop a set of assumptions about international relations and about the arms control process in the coming decade. The assumptions must be more than wishful thinking; they must take into consideration geopolitical constraints and realities.

What follows is the set of specific assumptions used for this study, with some background commentary.

- **A continued, constructive relationship between the U.S. and the Soviet Union in the areas of arms control, trade and environmental concerns.**

- **Whole-hearted co-operation in the area of arms control among the developed states.**

  The prospects for a number of significant multilateral and bilateral agreements have increased in the emerging period of detente following the democratic revolutions of 1989 in Eastern Europe, major changes within the Soviet Union and the unification of Germany. In the decade ahead, we believe that the constructive relationship between the U.S. and the Soviet Union will continue, and that this dialogue will contribute to co-operation among the developed nations.

- **A shift in the "threat" from East-West to North-South, South-South and, less likely, North-North.**

  The threat has clearly shifted; a situation which will affect future arms control agreements and which may suggest that multilateral arms control forums involving Third World countries will be less certain of success, but offer challenging opportunities. The threat changed in 1991 from East-West concerns regarding an act of war to a South-South (Iraq-Kuwait) invasion resulting in a North-South war and the possibility of terrorism in countries allied against Iraq in the war in the Gulf. Future concerns will again involve South-South confrontations and North-North (primarily in Eastern Europe) regional tensions. Instabilities related to the internal economic and political restructuring of the Soviet Union and tensions produced by independent-minded U.S.S.R. republics will cause grave concerns in the U.S., Canada and European countries.

- **A number of regional, even global, multilateral agreements in place, with requirements for verification.**

- **The North Atlantic Treaty Organization (NATO), still a vital organization, possibly with increased out-of-area activities. It remains committed to additional CFE agreements. The Conference on Security and Co-operation in Europe (CSCE) playing a role in CFE II negotiations and implementation.**

  While NATO will remain a vital organization, it will need to adapt to new security arrangements. The CSCE will increase in importance, becoming an institutionalized diplomatic organization with some elements of collective security developed through its Centre for the Prevention of Conflict, and it may play a significant role in CFE II negotiations and implementation.

- **A treaty to eliminate short-range nuclear forces (SNF) accomplished by 2000.**

  An agreement to eliminate short-range ground-launched nuclear-armed missiles in Europe should be completed, or the weapons may have been withdrawn already. Verification of the complete elimination of all systems will be easier than counting permitted systems; however, ensuring the elimination of all nuclear warheads will be difficult. An agreement covering air-launched short-range nuclear weapons is less likely.

- **Strategic stability and nuclear deterrence will still be the cornerstones of the security policy of the major powers.**

- **Completion and ratification of START-I; START-II nearing completion. Efforts under way to bring British, French and Chinese ballistic missile forces into START-III.**

  The START process will continue, but the British, French and Chinese ballistic missile forces will have to be considered before a START-III agreement can be concluded.

- **The inherent linkage between strategic offence and strategic defence recognized.**

  Although there has been agreement to separate the START Treaty from a defence and space agreement, the inherent linkage between strategic offences and strategic defence will remain.

- **The ABM Treaty in force; negotiations under way to clarify its limitations.**

  The ABM Treaty will remain in force. Negotiations will be under way toward agreement on clarifying, modifying and expanding or relaxing certain defensive limitations, including discussions on permitted or prohibited test, development and deployment activities. Specifically, there will be clarifications and/or modifications to the ABM Treaty to facilitate achieving enhanced ATBM capabilities for engaging the emerging Third World ballistic missile threats.

- **The Strategic Defence Initiative (SDI) research program continues. No decision to deploy a space-based ballistic missile defence (BMD) system, but increasing concern over Third World missile capabilities.**

  SDI will continue as a research program with increased emphasis on providing a defence against the emerging threat posed by Third World tactical ballistic missiles.

- **Protection against limited strike (PALS) gaining momentum along with accidental launch protection system (ALPS).**

  The U.S. will continue to be concerned about an accidental strategic ballistic missile launch or a limited strike against which it would likely be able to defend, but economic factors may curtail such a deployment.

- **Minimum deterrence approach for U.S. strategic force planning, with desire to deploy limited defences for accidental and Third World launches.**

- **The U.S. wants effective defences against emerging missile threats for overseas bases and forces, and co-operation with allies and other nations in developing their defence without violating the ABM Treaty.**

  The U.S. will want to defend its overseas forces against emerging missile threats and to support its allies in developing a similar defence. Protection against tactical ballistic missiles is not limited by the ABM Treaty.

- **Increased attention to the Air Defence Initiative (ADI).**

  Advanced cruise missiles and bombers will generate a renewed interest in improving the air defence capabilities of the North American Air Defence (NORAD) command, and in additional co-operation among other states.

- **Anti-satellite (ASAT) limitations under consideration.**

  There will be increasing concerns over ASAT capabilities, leading to negotiations on possible limitations.

- **Pressures to avoid an arms race in space continue.**

  There will be continued efforts in the UN Conference on Disarmament and the Committee on the Peaceful Uses of Outer Space to prevent an arms race in outer space.

- **The Non-Proliferation Treaty (NPT) continues with essentially the same membership but enhanced International Atomic Energy Agency (IAEA) safeguards.**

  The NPT may be more important than many of the highly visible bilateral agreements; maintaining its continued viability will be a challenge.

- **Pressures for a comprehensive test ban (CTB) increasing, but being countered by willingness to reduce the Threshold Test Ban Treaty (TTBT) (150 kt) testing yields. Some reduction in yield. Methods for monitoring improved both from a technical standpoint and lessons learned.**

  The TTBT and the Peaceful Nuclear Explosions Treaty (PNET) have been ratified, leading to increased pressures for a CTB and the improved verification requirements associated with a CTB. In our opinion, testing thresholds are likely to be lowered further and there may be limits on the number of tests, but a comprehensive test ban is not likely to come into effect in this decade.

- **Pressures increasing for serious consideration of agreements for the cut-off in the production of fissionable materials, and for reprocessing and controlling the fissionable materials in the nuclear warheads of delivery systems that have been destroyed or converted.**

  With the completion of START-I and possibly START-II, along with an SNF agreement, there will be pressures to reprocess and control the fissionable materials from destroyed or converted delivery systems. There will also be renewed attention to a cut-off in the production of fissionable materials, which will need to be balanced against legitimate needs for nuclear materials for purposes of nuclear power.

- **Chemical and biological weapons widely available to virtually any country. Nuclear weapons and advanced delivery systems being developed or acquired by Third World countries.**

  The proliferation of weapons of mass destruction and advanced delivery systems will clearly be a major concern of all developed nations. Verifying biological weapons (BW) limitations will continue to pose difficult, if not impossible, problems.

- **The chemical weapons (CW) bilateral agreement completed. The Chemical Weapons Convention (CWC) negotiations on a worldwide basis making little progress, but some intermediate steps have been taken.**

  Chemical weapons have become a serious concern. The bilateral (U.S./Soviet Union) CW agreement is a significant step, but a worldwide CWC will remain the main goal. Several intermediate steps will have been taken toward this goal.

- **Naval arms control proposals receiving positive attention. Some limits on maritime weapon systems have been established.**

  Although the U.S. has yet to indicate any formal interest in naval arms control, serious proposals will be made in this decade by responsible people, and other nations will be pressing for limits on maritime weapons systems.

- **Measures to control the transfer of advanced weapons and associated technologies under way. The Missile Technology Control Regime (MTCR) expanded. The UN playing an active role.**

  Measures to control the transfer of advanced weapons will become important. The MTCR will expand its scope, role and membership.

The UN will play a key role. There will be no agreements to control laboratory research or development.

- **The UN's effectiveness greatly enhanced in both the arms control and peacekeeping areas. Other regional actors such as NATO, the CSCE and the Western European Union (WEU) playing a role also.**

  Recent events clearly indicate that the UN's effectiveness has increased greatly, which will benefit the arms control process. There will, however, be states that offer less than wholehearted co-operation, and even refuse all participation. NATO, CSCE and WEU will also play active roles in arms control, with the possibility of NATO multinational forces being called on by the UN in times of out-of-area conflict.

- **Arms control without agreements being discussed, but less desirable than formal agreements.**

  Attention will continue to be paid to the concept of arms control without formal agreement, such as unilateral reductions and mutual restraint. However, such actions will not be as desirable as formal agreements that solidify specific limitations.

- **"Military significance" continues to be the criterion for designing and evaluating verification regimes. Defining military significance difficult, but receiving constructive attention.**

  As in the past, arms control agreements will require "effective verification." The criterion for determining effective verification will continue to be military significance, although the definition of military significance will vary between persons.

- **Safeguards and hedges against militarily significant verification uncertainties becoming preferable to more extensive and intrusive verification procedures.**

  Safeguards and hedges will be preferred over more extensive inspections; however, to be effective, they must be funded continuously.

- **Arms control verification regimes beginning to rely more on NTM, aerial inspections/ Open Skies, data exchanges and notifications than on intrusive OSIs, tags, seals and portal and perimeter continuous monitoring systems (PPCMs).**

  Although OSIs have received major attention in recent years, future verification regimes will rely more on NTM (or international technical means (ITM), or multilateral technical means (MTM)), aerial inspections, Open Skies and co-operative measures than on intrusive inspections, devices or systems.

- **Pre-agreement inspections and invitational inspections gaining importance.**

  With continued improvement in international relations, invitational inspections and pre-agreement inspections will gain in importance in both bilateral and multilateral agreements.

- **Confidence-building Measures (CBMs) and Predictability Measures, and other measures that depend for their success on non-obligatory co-operative actions, gain in importance and vitality.**

  CBMs will be vital to continued improved relations and will contribute to further multilateral arms control progress. Common data sharing will become more desirable, and burden sharing in the verification of multilateral agreements will be expected.

- **Satellite imagery of medium-quality resolution available to virtually any country.**

  Availability of medium-quality satellite imagery will lead to greater transparency and contribute to the achievement of more comprehensive arms control agreements. One need only look at the satellite pour l'observation de la terre (SPOT) photograph of Manhattan in the 17 September 1990 issue of *Aviation Week* and the series of pictures in the brochure on the Canadian PAXSAT concept[1] to appreciate the impact of this advancing, unclassified technology. The title of the LORAL ad containing the photograph resonates: "No Place to Hide."

- **An Open Skies agreement gains acceptance more as a transparency measure than as a means of monitoring arms control agreements.**

  An Open Skies agreement will be achieved, but its main purpose will be transparency, even though it can contribute to monitoring arms control progress.

- **Economic factors dominate international relations; thus, arms control agreements and their verification regimes have to take into account economic relations and factors.**

  It is clear that economic factors will overtake military issues and will dominate the international scene. Future arms control agreements, including their verification regimes, will be bound by economic constraints. While arms control agreements currently being negotiated have laid heavy emphasis on stringent verification, when all their resource costs — dollars, personnel and equipment — have been totalled, they may exceed the benefits. How much verification is enough will remain a key question. What is not in question is that arms control agreements are, in the final analysis, tests of political relationships. The better the relationship, the higher the confidence in compliance. As East-West relations improve, the verification regimes of future agreements that involve the developed states should become simpler and less costly.

1 *PAXSAT Concept: The Application of Space-Based Remote Sensing for Arms Control Verification.* Department of External Affairs, Ottawa, 1987.

IV Differences between Verification of Bilateral and Multilateral Agreements

George Lindsey

Verification in Past Bilateral Agreements

Developments in verification of bilateral arms control treaties began with the Strategic Arms Limitation Talks (SALT) I and II agreements between the U.S. and the Soviet Union. These agreements called for limitations rather than reductions, and were negotiated during a period of considerable mutual suspicion and mistrust. The two nations had already equipped themselves with highly sophisticated NTM for gathering intelligence, and were able to use them to observe and analyze most of the installations and activities of the other that were central to strategic nuclear systems. A tacit understanding of the mutual need for verification motivated them to establish the limitations in terms of characteristics that were amenable to observation by NTM (in this case launchers rather than delivery systems), and to agree to abstain from active obstruction of the other's use of NTM for this purpose.

The INF Treaty called for elimination rather than limitation of weapon systems, and was negotiated in a cold war climate typified by the phrase "trust, but verify." Co-operative measures far beyond the simple acceptance of NTM, and intrusive to a degree never before considered to be acceptable, were necessary and were agreed. And, although the INF Treaty was bilateral, its provisions and implementation required, and are obtaining, the acquiescence of those states in whose territory the treaty-limited items were deployed.

The INF Treaty may have marked two significant transitions in verification. One was from arms limitations that relied on NTM for verification to arms reductions that required a number of co-operative measures in addition to NTM. The other transition was from a bilateral agreement that limited strategic weapons threatening the territory of the Soviet Union and the U.S. to a (still bilateral) treaty that called for the elimination of weapons stationed in and threatening other countries.

It seems probable that the START negotiations will deal with substantial reductions rather than eliminations or numerical limits, and will provide for measures of verification similar to those in the INF Treaty that go well beyond reliance on NTM alone. It is also possible that the ABM Treaty could be clarified or modified to allow some defence against accidental or unauthorized launchings of ballistic missiles.

Verification in Past Multilateral Agreements

In sharp contrast to the bilateral treaties, and with one notable exception, the multilateral arms control treaties already signed have had few, if any, significant provisions for verification. The exception is the NPT, which involves the IAEA, a large and truly international body linked to the UN, to verify that the fissile products of nuclear reactors operated to produce electrical power or for research are not being diverted to manufacture nuclear weapons.

The IAEA could be a model for international verification in the future. However, it is distinctly intrusive, and does not function in several non-signatory countries that are suspected to be planning nuclear weapon capabilities. No similar arrangement for verification of other multilateral treaties has been instituted in the 20 years since the IAEA commenced its operations.

Basic Differences between Bilateral and Multilateral Negotiations

It must be recognized that there are a number of fundamental differences between multilateral agreements and bilateral agreements, especially when the latter are between the U.S. and the Soviet Union. One of the major differences is in the capabilities to provide effective verification.

One obvious feature of a multilateral negotiation is the different interests and concerns of the participants. They may or may not be grouped into blocs with similar security interests. Certain pairs or groups of participants may have a history of mutual hostility and unresolved

disputes. Or one or more may be more concerned about an adversary not party to the negotiations than about any participant.

Another characteristic of a multilateral treaty is the unequal strengths of the signatories, and the different capabilities that they can bring to bear on the tasks of verification. This is especially true when the U.S. or the U.S.S.R. participate.

NTM and Multilateral Treaties

Although the NTM of the U.S. and the Soviet Union are vastly superior to those of any other country, neither the main instruments of data collection nor the complete analysis capabilities of the U.S. or the U.S.S.R. will necessarily be made available for international verification of multilateral agreements. What is more likely is that the agreement will permit only the use of some data-gathering equipment that could be described as "international technical means," or "multilateral technical means," inferior in performance to the most advanced of the NTM of the U.S. or U.S.S.R. Collection and subsequent analysis of the data could be carried out by individual countries, or collectively.

In recent years, studies have been made to devise effective means of multilateral verification that do not rely on the most advanced U.S. or Soviet NTM. An example is the scheme for a worldwide network of seismic arrays able to detect and locate underground nuclear explosions, motivated by pressures to reduce the numbers and energy yields of (or possibly terminate absolutely) nuclear weapons tests. Other examples are the designs by France (the International Satellite Monitoring Agency or ISMA), Canada (PAXSAT) and Sweden (Tellus) of satellite systems to monitor activities on the ground, and the Open Skies proposal for airborne surveillance of military activity. These investigations are pertinent to the CFE negotiations to reduce conventional forces in Europe. We can expect continuing research on improved means of surveillance that would be internationally available.

The ability of the surveillance systems permitted by the agreements will be limited and, in the case of some, such as overflights by aircraft or OSI visits, quotas will be established regarding the numbers and locations of the sorties and OSIs. As a result, problems will arise about the selection of targets and the scheduling of sorties and OSIs, especially when verification is performed or co-ordinated by an international organization rather than by individual countries.

If some of the sensors are based in satellites, there may be no, or only a very limited possibility of, scheduling the times and places of overflights. However, depending on the design of the system, it will probably be necessary to program each satellite to direct its sensors to survey certain swaths as it progresses over the area covered by the agreement, and possibly beyond. It is easy to imagine differences in the preferences of the various countries about the priorities to be agreed on to observe different regions, likely including some outside of the territory of the parties to the agreement.

Analysis and Interpretation

Collection of data is only the first step in the process of verification. Analysis and interpretation may prove to be more difficult, and more contentious, than collection. In 30 years of satellite photography, the U.S. and the Soviet Union have accumulated a vast experience of analysis and interpretation, the most advanced aspects of which they will not be willing to share with the rest of the world. As other nations launch and operate surveillance satellites with capabilities somewhat inferior to those of the U.S. and U.S.S.R., they will slowly build up competence on analysis and interpretation, but there will be a strong motivation to reserve the best personnel and to retain the most effective equipment and methodology for national rather than international use. Such considerations suggest that, in some cases, the prospects are better for regional than for worldwide arrangements.

When it suited its purpose, one of the better-equipped countries could use its nationally obtained intelligence to cue one or more of the others, or the collective organization, about good targets to investigate, whether or not the informing country was party to the multilateral agreement. In many cases, it could be more important to know where, and when, to look than to be able to discern fine details.

Agreement about co-operative measures of verification will need to reconcile the desire to be able to detect non-compliance, and possibly to acquire other wanted intelligence, with unwillingness to expose national secrets, both military and commercial. The participants are likely to differ in their willingness to grant access to national facilities for foreign inspectors.

V Recent and Current Trends in Bilateral Verification

Sidney Graybeal and Patricia McFate

From the mid-1950s until the 1987 INF Treaty, verification of arms control proposals and agreements relied primarily on NTM. During this period, the dominant theory was that no arms control agreement could be based on trust alone; there must be adequate or effective verification and, in the U.S., many people equated effective verification with extensive OSIs. Despite this assumption, efforts during negotiations to achieve co-operative measures, particularly OSIs, generally met with negative responses. Because of this, some opponents of arms control proposed and supported extensive OSIs as a means of defeating arms control initiatives while at the same time appearing to be in favour of arms control.

In the 10-nation 1958 Surprise Attack Conference, the United States proposed manned radar stations on the territory of the U.S. and the Soviet Union to provide warning of a surprise attack. The Soviets showed no interest in the proposal. In 1964, the U.S. proposed in the Eighteen Nation Disarmament Committee (ENDC) a strategic nuclear delivery vehicle (SNDV) freeze, which would be verified by very extensive and intrusive OSIs of known SNDV production facilities and sampling OSIs of facilities capable of producing SNDVs. The proposal was rejected by the Soviets, who charged that it was intended more for intelligence collection than for arms control verification. Efforts to achieve a CTB treaty during the late 1950s and early 1960s foundered over the OSI issue, although many people believed that the real reason for failure was strong pressure to continue testing; such pressures still exist today.

In the mid-1960s, the U.S. shifted its major arms control efforts to proposals and agreements that could be verified adequately by NTM alone. Around this time, U.S. NTM, particularly space-based collection systems, were providing valuable information, much of which could be used to monitor certain arms control limitations. Thus, the U.S. positions in SALT I (1969-1972) were to limit activities that could be monitored by NTM, such as inter-continental ballistic missiles (ICBM) and submarine-launched ballistic missiles (SLBM) launchers, ABM launchers and radars, and flight test ranges and activities. This same basic approach carried through SALT II (1972-1979), although some co-operative measures and counting rules were added to enhance NTM and to strengthen the verification regime.

Although some arms control agreements in this period did achieve limited OSIs (e.g., the 1959 Antarctic Treaty, the 1967 Outer Space Treaty and the 1971 Seabed Treaty), none involved intrusive OSIs on the territory of the other side. The 1968 NPT did result in effective IAEA safeguards to detect and deter the diversion of nuclear materials from peaceful to weapons uses.

Also during this period, there was some progress in the area of CBMs. The 1955 Open Skies proposal was labelled a CBM, but little interest was generated at that time. However, there was significant progress in a variety of areas that could be considered CBMs. They include: the 1963 U.S./U.S.S.R. Direct Communications Link Agreement (commonly called the "Hot Line"); the 1967 U.K./U.S.S.R. Hot Line; the 1971 Accidents Measures Agreement; the U.S./U.S.S.R. Agreement on Prevention of Incidents On and Over the High Seas; the establishment in 1972 of the Standing Consultative Commission to implement the SALT I and Accidents Measures Agreements; and perhaps most significantly, the CBMs achieved in the CSCE from 1974 through 1979 and the Conference on Disarmament in Europe (CDE) agreement reached in 1986 in Stockholm (the Stockholm Document).

With the advent of the Reagan years, the U.S., and to a large extent NATO, began pressing for very extensive and intrusive verification provisions; NTM alone was not considered sufficient for "effective" verification. This was particularly true in the INF negotiations, but it was also apparent in the START, CFE and CWC verification proposals and in the verification protocols to

the TTBT and the PNET. Some of those insisting on elaborate OSIs did not expect the Soviets to change their long-held opposition to OSIs on their territory. However, to the surprise of most people, the Soviets did accept co-operative measures, including OSI, in the INF Treaty, ushering in a new era in arms control verification and establishing significant new verification trends.

The verification regime of the INF Treaty contains the most stringent provisions in arms control history: an unprecedented exchange of data on the systems limited by the treaty, including numbers, locations and technical characteristics of all INF missiles and launchers; inspections at INF sites to confirm the data exchanged and to help monitor elimination of the weapons; short-notice OSIs at INF-related sites during the three-year reduction period and the next ten years; permanent on-site inspectors at a key missile production facility in each country; and a prohibition on interference with verification by NTM, which includes satellite imagery.

The START verification regime will build on that negotiated for INF, but it will be more comprehensive because weapon systems are being limited rather than eliminated, as in INF. The regime under development is reported to include: a data exchange on the numbers, locations and technical characteristics of each side's strategic offensive arms; 12 kinds of OSIs, as well as continuous monitoring of mobile ICBM production facilities; a series of co-operative measures including extensive notifications to enhance the effectiveness of NTM; a ban on interference with NTM; except for strictly limited exemptions, a ban on any practice, including the use of encryption, encapsulation or jamming, that denies full access to telemetric information; a comprehensive agreement on the manner of deployment of mobile ICBM launchers and their associated missiles, and appropriate limitations on and notifications of their movements to ensure verification of adherence to the numerical limitations of the treaty; and an agreement that the number of non-deployed ICBMs for mobile launchers will be limited and mobile ICBMs will be subject to identification through the application of unique identifiers or tags.

The CFE verification proposals are following the same patterns used for START and INF but, because of the multilateral nature of the agreement, there have been many complications in their formulation, negotiation and implementation. The aerial inspections proposed for monitoring a CFE agreement are a new and potentially very valuable verification trend that will be pursued in the CFE follow-on negotiations (CFE IA). The CFE regime as presently conceived is reported to include verification measures consisting of an extensive exchange of information on land and air forces, including organization, personnel, location and other military information; stability measures involving limitations on military exercises, call-up of reservists, movements of forces and monitored storage; inspections of declared sites; baseline inspections; elimination monitoring; verification of aircraft and helicopters; and "recategorization" inspection. The regime places equal emphasis on transparency — for the purposes of promoting stability and eliminating the threat of surprise attack and large-scale offensive actions — and technical compliance.

In the CW bilateral agreement, destruction of chemical weapons stocks will pose technical problems, but verification concerns will not be a serious issue. Verification of the CWC, however, will be a demanding and extremely complex task. It should be possible to verify chemical weapons declarations and commercial activities reasonably well, especially with on-site access, but the location and identification of undeclared, illegal activity will be very hard to achieve. Effective verification will be difficult to accomplish because of the scope of the agreement, the nature

of the limited agents and the worldwide aspect of the agreement. To monitor compliance the draft treaty calls for a wide-ranging regime of routine OSIs run by an international inspectorate on the model of the IAEA. Mandatory short-notice inspections of suspected illegal activity have been proposed. The treaty will also rely heavily on continuous monitoring of declared facilities with instruments. NTM will bear a large part of the verification burden, particularly to identify and locate suspect CW activities.

Very comprehensive verification protocols for TTBT and PNET have been completed, and the two treaties have been ratified. The verification protocols include OSIs involving hydrodynamic yield measurements, numerous notifications and extensive seismic monitoring. NTM will continue to monitor all nuclear explosions.

There will be increasing pressures for a CTB, but such an agreement is unlikely by the year 2000. However, it is likely that the TTBT and PNET threshold will be lowered, placing some additional demands on the verification regimes, and there may be limits placed on the number of nuclear tests.

With the reductions in nuclear delivery systems resulting from INF, START I and II, and SNF, there will be pressure to reprocess or control the fissionable materials from the destroyed or converted warheads, and to re-open the proposal for the cut-off in the production of fissionable materials.

Although Open Skies appears to be promising, both as a transparency (confidence-building) measure and to monitor future arms control agreements such as CFE II and CWC, Soviet concerns will require some compromise on issues related to sensors, aircraft, flight patterns, data reduction and sharing, and overflight quotas. Progress in this area will have to await the outcome of the CFE IA negotiations.

The events that have taken place in Eastern Europe and the Soviet Union while the START and CFE agreements have been under negotiation raise questions about the extensive verification regimes being proposed. In an era of a diminishing Soviet threat, why should verification requirements continue to increase? At the same time, events in the Middle East suggest that verification of multilateral agreements involving the Third World will require an effective international framework. The increasingly important role being played by the UN in international crises suggests that it may well be the appropriate institution to ensure effective verification of many future multilateral arms control agreements.

Apparent Verification Trends

1. NTMs will remain the key element for verifying U.S./Soviet Union bilateral agreements. Sharing U.S. data related to verification with allies will increase. There will be significant emerging requirements for MTM or ITM.
2. Co-operative measures are considered a necessary part of verification regimes but, over time, the emphasis on specific measures will shift:
   - less emphasis on intrusive OSIs, particularly on suspect site ("anywhere, anytime") inspections;
   - more emphasis on data exchanges and notifications;
   - greater use of invitational inspections and "fly before you buy" inspections.
3. Future verification regimes will result in requirements for new technologies and different applications of existing technologies for NTM/MTM/ITM sensors and data processing, passive and active tags, advanced seals, CW sniffers/sensors, radiation detectors and motion detectors.

4. CBMs are becoming increasingly important for both stability and arms control verification.
5. Aerial inspections are becoming a part of verification regimes.
6. Open Skies will have to await the outcome of CFE on aerial inspections, but the concept is gaining acceptance as both a transparency measure and as a verification tool.
7. The TTBT and PNET verification protocols and resulting monitoring capabilities will increase pressures for a CTB treaty. Although these pressures may result in lower thresholds or fewer tests, they are unlikely to result in a CTB treaty.
8. Clarifications of the ABM Treaty and possible new agreements on naval arms control, ASAT limitations, and controls on sea-launched cruise missiles (SLCMs) will generate new demands on verification regimes.
9. The UN is gaining increasing credibility and becoming an effective forum for handling international and regional problems, resulting in a greater potential in the arms control verification area.
10. Verification regimes will be seen as performing significant complementary roles such as early warning, predictability, transparency and CBMs.
11. Effective verification will remain essential to achieve useful arms control agreements, although the criteria for determining what constitutes effective verification will become less stringent.

VI Recent and Current Trends in Multilateral Verification

James Macintosh

Trends in Multilateral Arms Control

The present multilateral arms control menu is growing more complete and progress has been heartening in several cases. An initial confidence-building agreement (the Stockholm Document) has been negotiated and an expanded version has been completed recently in Vienna. A significant conventional arms reduction treaty for Europe (the CFE) has also been completed in Vienna. Already dubbed by many as "CFE I," it promises to spawn at least one follow-on negotiation (CFE IA) to formalize seemingly inevitable major personnel reductions throughout Europe. In addition, the Open Skies negotiations have made some progress, although just now most of the attention and effort of the 22 participants is being directed toward the successful conclusion of the CFE talks. The negotiators at the CWC are continuing with their deliberations, but they are attempting a very difficult enterprise of arms control, one that may not bear fruit on the multilateral level for some time. Some related bilateral and multilateral side arrangements such as the recent Soviet-U.S. agreement may be negotiated.

Other existing multilateral discussions (both formal and informal) include those looking at ballistic missile proliferation (the MTCR) and at the "Prevention of an Arms Race in Outer Space" (in the Geneva-based Conference on Disarmament), as well as more informal efforts to establish "zones of peace," "nuclear weapon free zones" or "nuclear free zones" in various parts of the world. Nordic, Arctic, Mediterranean, Pacific, Balkan, North-East Asian, South-East Asian, South Atlantic and Indian Ocean zones have been suggested thus far. Efforts to develop some of these zones may become integrated with and superseded by the negotiation of regional confidence- and security-building regimes.

The nuclear NPT continues in effect, and has been subject to a recent review session. This could lead to an expansion in the existing treaty, or the development of an adjunct treaty or agreement. Recent Brazilian decisions suggest that zonal agreements might be negotiated on a wider scale. This could also expand the role of the largely successful IAEA. In a related vein, there almost certainly will be further efforts to develop a CTB treaty, although this is a longer-term prospect and is likely to await extension of the bilateral TTBT to include limitations on frequency of testing and energy yield.

It is no revelation that it is difficult to predict what new multilateral arms control forums will develop or expand in the next 10 years. This will be very much a function of the way the world evolves with its complex regional and global relations. Consider these cases, for instance:

- significant regional conflict within the Middle East and South Asia;
- increasingly tense relations in most other regions of the world (Africa, Latin America, South-East Asia and North-East Asia);
- increasingly combative relations, triggered primarily by trade and financial issues, among the U.S., Europe and Japan (each with its own constellation of associated regional actors);
- declining political and social order and increasingly difficult economic conditions in Eastern Europe; and
- the gradual and only semi-controlled dissolution of the Soviet Union, leading to the creation of a number of new European and Asian actors, many with significant armed forces and poor relations with at least one of their neighbours.

An international state of affairs of this type could seriously impair progress in many arms control efforts during the next 10 years. Despite such a gloomy overall assessment, however, arms control and confidence building tailored to specific regions might still prove to be possible and productive. This is most likely to be the case in the Asia-Pacific and Latin American regions.

An alternative assessment suggests that tension within several habitually conflict-prone regions may not spill into the international

system in a negative way. Quite to the contrary, the desire to address these problem areas may lead to a concerted effort by many states to develop useful, non-partisan, multilateral solutions, probably through the UN. Despite trade-related tensions, the three principal corners of the modern international system (North America, Europe and Japan) are likely to continue to act co-operatively in their attempt to deal with international security problems, presumably with the acquiescence of the Soviet Union and China (both increasingly absorbed by their own development difficulties). This suggests a future of bountiful opportunities for multilateral arms control.

The point is obvious but easily overlooked in our attempts to anticipate the future. The nature of the international security environment may vary dramatically during the next 10 years, ranging between, at one extreme, increasingly hostile relations, marked by increased regional conflict involving many international actors and, at the opposite extreme, a period of substantial improvement in security relations among most international actors. The most probable course of the next 10 years is an uneven path between the two basic extremes, hopefully tending toward the latter. The middle road is captured by the present study's collection of "future assumptions."

Moving beyond the broader scope of the period under study and looking at probable near-term developments, several outcomes seem likely. Assuming that events continue on a moderately co-operative level, it is very probable that the CSCE process will be expanded to incorporate integrated Confidence- and Security-building Measure (CSBM) and CFE-type conventional force negotiations. These "expanded talks" will almost certainly involve all 34 CSCE states, although the neutral and non-aligned states may participate in a restricted form (by preference) and the Warsaw Treaty states may function only as a loose political group. The main idea, however, will be to conduct both reduction and CSBM talks in a forum that includes all 34 CSCE states (35 if Albania joins).

After further CSBM and CFE-type reduction packages have been developed, dropping national holdings to perhaps 50 per cent of their post-CFE levels, the CSCE arms control process may take some tentative steps toward the difficult issue of "defence transformation." The co-operative structural and behavioural adjustment of existing forces to impose a "less-offensive" character on them will doubtless be extremely difficult to put into practice, but this is a natural focus for an extended CSCE security process. There are also strong indications that the CSCE will address maritime arms control and confidence-building issues as well, although success remains problematic due to resistance by Western maritime powers. There is some chance that the U.S., the Soviet Union and perhaps some other major maritime powers may develop a regime to denuclearize their surface navies. This may be accomplished on a bilateral or a multilateral basis, possibly before the turn of the century. The removal of all surface-based tactical nuclear weapons would have a profound impact on the structure and character of the major surface navies, and would indirectly affect the security situation in many regions of the world where naval forces can play a major role.

Also associated closely with the CSCE process is the possibility of developing a multilateral monitoring agency capable of providing all of the CSCE states with information sufficient to permit the independent verification of various CSCE-related accords. No such independent capability exists today, leaving many participating states dependent on information gathered by the intelligence resources of the U.S. or U.S.S.R. Whether a monitoring organization is more likely to be developed as an explicit adjunct to the CSCE process or under other auspices (as has been suggested repeatedly by the WEU) is unclear. What is clear is that a satellite or aircraft monitoring system, or both, similar to but more extensive than Open Skies, will be necessary for the CSCE states if all are to be full partners in the transformation of traditional East-West-dominated relations. Such an organization might include

some CSCE-oriented communication and data management functions as well. This might be a natural way to initiate the development of a multilateral CSCE monitoring organization that could evolve into a monitoring agency.

Beyond some progress toward a CWC, nothing else on the multilateral level is even close to probable during the next 10 years. A possible development would be the establishment of CSCE-type regimes in other regions of the world — in the Pacific, South-East Asia and Latin America, for instance — featuring CSBM packages patterned very generally on the Stockholm Document, rather than actual arms limitations. In some cases, maritime-oriented CBM packages might be more likely, particularly in Asia-Pacific sub-regions dominated by issues of maritime access and usage. Negotiations for force reductions of the CFE type may also be attempted in regions having histories of conflict and suspicion, but it will probably require a long time to develop the necessary regional political support for this kind of agreement. Nevertheless, some constrained reduction regimes might be possible before the turn of the century, perhaps in Latin America or sub-regions of the Asia-Pacific area.

Soviet-Chinese (regional force reduction and CSBMs) and Soviet-Japanese (a "Northern Island" settlement and the establishment of an associated Okhotsk maritime confidence and security region) accords are definite possibilities, but they would probably be on the bilateral regional level. The two Koreas also offer a tantalizing possibility for major CSBM- and force-reduction progress, although much will depend on political events in North Korea. Africa and the Middle East are not promising locales for any progress in arms control. South Asia is only marginally promising. A wild card in this view is the potential role of the UN and its adjunct negotiating forums such as the Conference on Disarmament (CD). Events associated with the Iraq crisis have demonstrated in compelling fashion how quickly the UN can assume an important role in international affairs in the post-cold war era. It is intriguing to consider the potential directions that globally organized international efforts might take to address difficult problems of regional conflict.

If the international security environment develops in the generally positive manner assumed in this study, then a healthy range of multilateral negotiations are likely to be undertaken during the next 10 years. They include:

- post-CFE 1 personnel and equipment reduction and Stockholm Document refinements in Europe,including the introduction of regional maritime CSBM accords under the CSCE umbrella and the first steps toward formal defence transformation negotiations, also under the CSCE;
- the extension of the NPT and the continued pursuit of a CTB treaty; the NPT extension could be associated with the establishment of an international seismic network to detect underground explosions;
- efforts to develop control and inspection regimes to restrict harmful key technologies (a category that would include such diverse examples as critical missile guidance technologies and bio-engineering technologies); these efforts could include a second generation BW convention;
- the development of a multilateral communication centre for risk reduction and information management associated directly with the CSCE as well as the possible export of this idea to at least one other application area; the possible expansion of this type of body to include multilateral monitoring in support of existing and new CSCE treaties;
- the completion of an Open Skies treaty and the development of at least one parallel monitoring regime, either in the Asia-Pacific area or in Latin America; (a similar regime could also constitute part of a peacekeeping arrangement in the Middle East);

- some control over the deployment of anti-satellite weapons, and of space weapons beyond the restrictions of the Outer Space Treaty, including an extended space object registry;
- attempts to negotiate first-generation CSBM regimes in Latin America and at least one sub-region of the Asia-Pacific area, perhaps with major maritime components in the latter case; these efforts would be complemented by bilateral CSBM and possibly force reduction agreements between the Soviet Union and China, the Soviet Union and Japan, and possibly the two Koreas; and
- progress toward completion of a comprehensive CWC, possible establishment of a UN agency to investigate charges of chemical warfare and an effort to develop a second-generation regime to deal with less than fully co-operative states suspected of manufacturing chemical weapons.

Regardless of how co-operative the international security environment becomes in the next 10 years, it is far from clear whether any multilateral (global or regional) efforts could be developed (or expanded, in the case of the MTCR) to control the proliferation of the technologies necessary to deliver weapons (rocket propulsion and missile guidance, for instance) and other critical weapons-related technologies. The inherent inability to control many technologies (due to the global dispersion of multipurpose technological capabilities, the capacity to develop indigenous industrial capabilities independently and the highly competitive tendencies of at least some industrial actors) makes this type of approach very difficult to pursue effectively. This leaves as a more workable solution a focused effort to specifically prohibit by treaty the production of certain types of weapons, even though many states possess the technological capacity to make them. This is more or less the logic underlying the NPT and the proposed CWC. It could be applied in other cases, too. One example would be a second-generation biological weapons convention, especially one that concentrates on weapons possibly developed through genetic engineering. The whole problem of technology constraints and dual-use technology remains an issue that warrants close study, however, because it may prove possible to develop methods to control some key weapons-building technologies. The verification lessons derived from the CWC and NPT/IAEA examples would set some precedents for these related applications.

Trends in Multilateral Verification

One can discern a certain universality, at least in principle, about many aspects of future multilateral arms control efforts and their technical verification requirements. For example, to the extent that any land-force-oriented agreement called for numerical limits on main battle tanks (as most would), verification will require the ability to detect main battle tanks. A participant directly involved in such an agreement must be able to detect tanks (and distinguish them from generally similar equipment such as trucks) or there is no firm compliance assurance possible. Indirect monitoring methods (e.g., those that concentrate on detecting changes in the organizational elements associated with armoured forces, including changes in radio traffic and ammunition logistical support activities) can assist, but cannot substitute for a relatively high level of direct monitoring capacity. The same is true for combat aircraft and helicopters, and in their case the speed with which they can be introduced into a restricted area makes early and reliable detection even more important. Naval vessels are considerably easier to detect, but one still needs a relatively sophisticated aerial or space-based sensor to observe them and discover examples of non-compliance because it may be necessary to do more than simply detect and count ships. Some maritime accords could focus on limiting certain types of vessel according to capabilities (e.g., anti-submarine, air defence or general surface-to-surface sea control capabilities

on generally similar naval platforms). To distinguish among such vessels would require sensors that possess relatively high resolutions, certainly more refined than those that are able to "detect" but not characterize ships now.

The following point is important. The technical monitoring requirements for most imaginable conventional military arms control and confidence-building agreements are demanding, and generally similar across many arms control types, objects and sets of participants. **Where the actual verification standards associated with individual arms control accords can vary significantly is at the political level.** Depending on a wide variety of considerations, senior decision makers may be comfortable with standards of compliance assurance that fall considerably short of those that might be considered to be ideal. This underlines the importance of the political environment in which arms control accords are negotiated. It also emphasizes how monitoring and verification standards can vary according to the idiosyncratic circumstances of a given negotiation, its place in time and the international security environment, its participating states and their special concerns. For example, we can also add the mitigating role of differing psychological perspectives and the way they influence the political culture of the participating states, and the views of political elites. We should not expect senior decision makers from Japan, France, India, Saudi Arabia, Malaysia and Peru to see all compliance issues and decisions about trust, intentions, non-compliance and requests for OSIs in the same way, even if the "facts" are objective and there for all to see. Thus, although we can make general observations about basic types of arms control and confidence-building approaches, there is the very real need to appreciate the unique circumstances of each accord as defined by environment and participants.

Although the requirement can be muted appreciably by political and perceptual considerations — and appropriately so — it is necessary, from a rigorous technical perspective, for the states participating in almost any type of force reduction or serious confidence-building agreement to have, or have reliable access to, a high-capacity monitoring system capable of detecting and identifying tank-size objects, ideally in all weather conditions and at night. The typical adjunct to this requirement, and the one that has been and will continue to be built into most arms control agreements, is the provision for OSI and related forms of on-site monitoring, either transitory or permanent. The intrusiveness of OSIs of various types creates objections that must be balanced against their usefulness. Again, this is where political decisions can seriously alter the standards that might be demanded by purely technical considerations. The costs of enduring inspections in domestic military and commercial sites may be seen to be too high when compared with the information that might be garnered about the activities of other states. Although this is more likely to be true for nuclear and chemical arms control agreements, it could also be an important consideration in the negotiation of other types of accords. This reversal in conventional thinking — the larger the number of OSIs the better — may not occur early in the span of non-European negotiating processes. However, it could easily emerge as the general level of confidence rose in the intentions and good will of other participating states and concerns about cheating declined. This relationship is difficult to anticipate and warrants further study.

The following discussion presents a simplified overview of monitoring approaches available for multilateral arms control (including confidence building). First and foremost, there is unlimited NTM (with or without the co-operative participation of the observed — and the distinction matters). This includes national surveillance satellites, but is not restricted to them; it also includes, a wide variety of surface and airborne observation devices, as well as undersea devices. Although other states can employ some types of NTM (such as electronic listening devices) to varying degrees, the use of monitoring satellites is directly available only to the U.S. and the Soviet Union, particularly if we impose realistic

technical minimal limits for evaluating their effective performance. Several other states have rudimentary satellite-borne monitoring capabilities but, at their present state of development, they are inadequate for many meaningful verification purposes.

This has an obvious implication for the proposed use of **MTM or ITM** (again, with or without the co-operative participation of all of the observed states, but presumably with the active co-operation of most states party to an arms control agreement). Although there are reasons for treating it separately, some variations on the Open Skies theme could be included in the MTM category, especially if they were truly multilateral in operation. The existing Open Skies proposal, with participant states operating in an essentially bilateral manner, would not count in this class of multilateral monitoring approaches. The principal distinguishing characteristic of a truly multilateral monitoring effort would be the existence of a special body, either composed directly of participating state representatives or formed of specialists to act in the collective interests of the participating states, responsible for the operation of collectively owned monitoring devices and the distribution of the resulting data. The collectively owned equipment could include optical and radar satellites, high and low altitude aircraft equipped with a wide range of potential sensors (optical, infra-red, synthetic aperture radar, electronic intelligence [ELINT], but probably not signals intelligence [SIGINT]), as well as ground- and sea-based monitoring platforms.

The critical facet of multilateral monitoring is the collective operation of monitoring resources sufficient to permit all participating states to acquire independently the data necessary to make informed decisions regarding compliance. It remains an open question whether this type of multilateral body ought to undertake any higher-level data processing, analysis or evaluation. This is clearly moving into the realm of verification where compliance judgements are made. Many states might be uncomfortable with a multilateral organization carrying out this added function. Certainly, states regard decisions over compliance to be a national rather than a multilateral or international prerogative. As agreements of increasing complexity, refinement and rigour are explored in various multilateral contexts, it will probably become evident that the MTM route — combined, of course, with selective OSIs — will be the best way to go for most states and for the general success of those multilateral arms control efforts.

The other dominant category of verification activity incorporates co-operative measures, including OSI. These quintessentially co-operative activities include primarily OSIs of facilities and activities, either on a previously scheduled basis or on demand with short warning (and quotas). This category also involves aerial inspections. The facilities and activities include:

- destruction or conversion of weapon systems;
- weapon system limits (by type and/or number within limited geographic areas), including the determination of the accuracy of supplied baseline data, the accuracy of post-reduction force composition data (position, numbers and types of equipment as well as placement and numbers of personnel) and the inspection of stored equipment to determine types, numbers and operating conditions; and
- the absence of prohibited forces, structures and/or activities (including the testing or construction of prohibited weapon systems) in restricted or specified areas.

Co-operative verification measures also include the constant on-site monitoring of:

- constrained activities (i.e., production limits or bans on specified weapon production or related activities);
- equipment and/or personnel movements into, out of or through limited zones at designated points; and
- stored equipment (whether or not stored in a "disabled" condition).

Finally, they include the observation of constrained activities (i.e., manoeuvre observation as required in the Stockholm Document).

It is not clear how some verification techniques such as "tagging" and the use of functionally related observable differences (FRODs) should be handled in the attempt to categorize verification approaches. Primarily, they are adjunct measures that facilitate monitoring, with tagging being especially useful for OSI and FRODs most useful for facilitating remote monitoring. They represent a potentially expandable category of techniques, intended to permit the credible distinguishing of "legal" from "illegal" systems that are limited in terms of numbers, functional characteristics or geographic placement. They might best be characterized as "technical verification facilitators."

An associated category of verification-enhancing activities serving a similar function is the class of actions that facilitate directly the operation of NTM or MTM. The opening of missile silo hatches during overflight periods is a classic example; however, there are numerous other examples of existing or possible actions that would make it easier for a satellite or an aircraft to see or otherwise sense treaty-related items or activities. In addition, generally similar types of activities can be used to assist in the smooth and fully effective operation of ground-based and aerial inspections. Seemingly minor, these are nevertheless important technical verification facilitators that can make a huge difference in the successful operation of a demanding monitoring regime. They also contribute to the general level of confidence that participating states have in each others' good intentions. In principle, these types of facilitating activities can be made a formal part of an agreement (typically in a verification protocol) or they can operate on an informal or undocumented level.

Information exchanges (including notifications) constitute an additional important category of verification-related arms control activity that is becoming a critical adjunct to the traditional elements of verification activities: OSIs, co-operative aerial inspections, and the use of NTM and MTM. The formal exchange of information, very often a key element in confidence building packages, is also a key facilitator for the successful conduct of different types of NTM and MTM, aerial inspection and OSI. Beyond its confidence-building dimensions, it represents a very concrete baseline of "provided" information against which countless activities and force structures can be checked. It is vital to the success of verification but is not directly a part of the monitoring process.

Other activities sometimes are treated as verification measures or steps but really represent some sort of formal or informal CBMs. Some "predictability measures" fall into this category (e.g., invitations to observe activities in specialized military research labs) as do optional or voluntary unilateral invitations to other parties to inspect or observe activities that might be misperceived as threatening or otherwise misunderstood. The same could be said of "practice inspections" and other experimental approaches that seek to explore and develop new and more efficient ways of monitoring and verifying increasingly complex and difficult arms control agreements. In addition, many traditional CBMs actually represent specific types of monitoring activity or information exchange, but they are accommodated in the previous categories.

VII Overview of Technology Requirements

Patricia McFate and Sidney Graybeal

This chapter provides an overview of the technology requirements associated with the verification of current and future arms control agreements.

Effective verification of future conventional, nuclear, biological and chemical weapon treaties will pose major technological challenges. Devices and technologies will have to be developed, tested, evaluated, produced and implemented as part of the verification regimes consisting of NTM supplemented by extensive co-operative measures, including some OSIs. State-of-the-art management information systems will also be needed to handle the data acquired by the OSIs and the comprehensive information on weapon system characteristics, movements and facilities called for by the Memoranda of Understanding, Data Exchanges and Notifications provisions being incorporated in emerging verification regimes.

Implementing OSIs will require both inspectors and a variety of monitoring systems, including measurement, weighing and sensing devices, and tags and seals. Some of these devices may adapt existing technologies to new uses, while others may require entirely new technologies. A variety of sensors have potential applications in monitoring treaty compliance. Some examples of the pertinent technologies associated with current and future verification regimes follow.

Portal and perimeter continuous monitoring systems (PPCMS), derived from the Sandia Technical On-site Inspection (TOSI) facility, are useful to monitor weapon production and storage facilities. These systems involve a number of integrated sensors feeding into a central on-site data collection and processing centre. Infrared breakbeams and common road scales can measure and weigh vehicles entering or exiting the site. X-ray imagers can examine closed containers; the "Cargo-scan" (Copyright, Bechtel) device, for example, is being used at Votkinsk for INF verification.

Another device, which is part of the INF verification regime, is a radiation detection device used to measure fast neutron flux intensity emanating from the single warhead SS-25 in its launch canister to ensure that the canister does not contain a prohibited SS-20 missile with its three nuclear warheads.

A variety of passive and active tagging methods has been proposed to provide unique identifying signatures for certain treaty-limited items. One method involves the use of epoxy resin infused with reflective particles. When illuminated from different angles, the particles in the resin create light patterns that cannot be replicated. Random cavity tags, which consist of a small hole drilled in the surface of a treaty-limited item and sealed with a tamper-proof bolt, allow the cavity to be mapped and verified by ultrasound. Electronic identification devices storing unique electronic codes permit authentication, either on-site or remotely by a special reading device.

Tagging may also be a useful way to distinguish between weapons that are externally indistinguishable (e.g., conventionally- and nuclear-armed cruise missiles). Whatever type of tag is used, it must have built-in characteristics that ensure that it cannot be reproduced clandestinely, cannot be transferred to an illegal item, cannot be spoofed and cannot make the item to which it is attached targetable (a concern for systems such as mobile ICBMs).

Treaty provisions may require that treaty-limited items, on-site monitoring equipment, restricted facilities or storage areas not be tampered with or entered; if tampering or unauthorized entering takes place, records must be made of the events that are immune to forgery and replacement. Security seals are a way of meeting these requirements. Special adhesives that disintegrate on removal, fibre optic loops with continuous electronic signals and "cup-and-wire" seals are examples of sealing technologies that satisfy these monitoring requirements. Technologies for tags and seals involve the following possible

alternatives: adhesive barcode labels, photomicroscopy of intrinsic features, casting/weld image processing, subsurface ultrasonic imaging, polyvinylidene fluoride ultrasonic surface tags, electronic identification devices, unattached electronic buddy tags, tamper-proof fibre optic tags, reflective particle tags, holographic correlations, moire pattern correlations and crushable acoustic seals.

The CWC will require technologies based on chemical analysis. Preconcentrators, for example, could sift for minute amounts of prohibited chemicals diluted in other media such as air or water. Gas chromatography/mass spectrometry devices could facilitate on-site analysis of suspect chemicals. Genetically engineered bio-organisms with an affinity for controlled substances might be used as close-range detectors. Laser-based spectroscopy and cloud-vapour tracking systems such as light detection and ranging (LIDAR) might provide the capability of remotely monitoring smoke stack effluent.

The Biological Weapons Convention (BWC) has no mechanism for verification. Furthermore, verification of the BWC, always a difficult task, has been significantly complicated by recent progress in biotechnology that increases the ease of concealment of illicit manufacturing plants, particularly for biologically derived chemicals such as toxins. Because of the difficulties of distinguishing between potential offensive and defensive (e.g., disease control) uses of the various biological agents, verification will be an extremely difficult, if not impossible, task. CBMs have been proposed to create greater openness about biological activities; at the Second Review Conference of the BWC in 1986, for example, delegations called for an annual exchange of information and data on each party's research facilities, activities and outbreaks of infectious diseases, and similar occurrences caused by toxins.

Seismic signals provide the most important data for detecting underground nuclear explosions, and seismic data combined with a hydrodynamic yield measurement technique called CORRTEX (continuous reflectometry for radius versus time experiments) will be used for monitoring compliance with TTBT and PNET treaties limiting the yields of nuclear weapons tests. Science Applications International Corporation (SAIC) has developed the Intelligent Array System, which automates the analysis of seismic data for treaty monitoring by integrating signal processing, distributed processing across wide-area and local-area networks, expert systems, computer graphics and database management systems.

An Open Skies agreement and the inclusion of aerial inspection as part of a verification regime for CFE IA or CFE II could authorize airborne platforms containing a wide variety of sensors (other than SIGINT collectors, which will be prohibited). The aerial inspections anticipated for CFE IA, which likely will precede Open Skies, could involve cameras, radar and heat-detecting infrared sensors for monitoring production, storage and movement of treaty-limited items. However, it appears that only cameras will be included with "place-holder" language to facilitate later permission for other sensors. Open Skies platforms could contain a similarly wide variety of sensors, but also include air-sampling techniques for monitoring nuclear effluents and chemical weapons production, storage, deployment and elimination. SIGINT sensors will not be permitted in CFE aerial inspections or Open Skies.

Future agreements, such as START II, and the removal of SNF in Europe, may call for the dismantling, storage and/or destruction of nuclear warheads, and the storage or disposal of their fissile materials under international safeguards. The verification regime associated with the elimination of warheads will need to ensure that the warheads and their associated payload hardware presented for elimination are in fact the items agreed on; that all items scheduled for destruction are in fact destroyed; and that none of the nuclear material from the warheads to be dismantled is diverted to unauthorized purposes.

Such procedures will pose major technological challenges, both for monitoring and to meet environmental considerations.

SLCMs have been the subject of a number of technical studies because of problems in distinguishing nuclear from conventionally armed versions of the missile. Two proposed methods of verification use devices for detection and analysis of radiation emitted by fissile material inside the warhead. One method depends on passive detection of spontaneously emitted neutrons or photons. In the other, the warhead area is irradiated with gamma rays or neutrons, which will produce scattered, transmitted or induced radiation from whatever material is inside. Tags on SLCMs could simplify monitoring if they were installed during a baseline inspection of deployed missiles, or at the production facility. Seals could deter or indicate installation of nuclear warheads into non-nuclear SLCMs.

The challenges and opportunities for future technology will be determined by the nature and scope of the verification regimes associated with the numerous arms control agreements that are on the horizon. Each will have a verification regime that will probably include some forms of OSIs. Development, testing, production and implementation of these technologies may indeed be a "growth industry," but like all industrial products, there are certain general requirements to be met if use of the items is to be practical.

The technologies must be practical (in some cases, portable), reliable, durable, robust, stable and above all user friendly, because they will have to be used under field conditions, by many different inspectors. Automation is desirable in some areas.

The technologies must be exportable: the technologies underpinning the device must be transferable under Co-ordinating Committee (COCOM) restrictions. The core list of technologies that will continue to be controlled will be written with reference to the following eight categories of strategically critical items: electronics design, development and production; advanced materials and material processing; telecommunications; sensors and sensor systems, and lasers; navigation and avionics systems; marine technology; computers; and propulsion systems. Exact items to be included in the core list are to be identified by the end of 1990.

They must be worth their cost. The two PPCMSs that incorporate expensive sensors such as "Cargo-scan" have been estimated to cost $500 million over the 15-year duration of the INF agreement. Short-notice inspections (SNIs) of facilities monitored by PPCMS may be equally effective and far less expensive, provided entry into a facility does not pose major security or proprietary concerns. Implementing the use of CORRTEX to confirm the yield of a single nuclear test is estimated to cost $10 million.

Technological challenges exist in many areas. How can synergies among NTM, OSI, Open Skies, and aerial inspection be optimized? How can treaties be "netted" together in terms of verification modes and objectives? What are the trade-offs between advanced technologies and their exportability? Between implementing treaty provisions and protecting sensitive and proprietary information? When all the resource costs for "effective" verification — dollars, personnel and equipment — have been totalled, will they exceed the benefits?

A number of factors will limit the scope of verification technology as a growth field. Increasingly stringent limits on the defence budgets and the decreasing threat have generated a growing wish to simplify and curtail OSI regimes. Nevertheless, there should be research and development programs to ensure the availability of usable technologies for the OSI regimes of the emerging agreements, and these agreements should contain provisions that permit the updating of OSI technologies as new approaches are developed. OSI technologies may not be a major growth industry, but they will continue to play an important role in verification regimes for most future arms control agreements.

VIII Likely Evolution of the Trends in Bilateral Verification over the Next 10 Years

Sidney Graybeal and Patricia McFate

As outlined earlier, significant fluctuations in arms control verification approaches and results took place between the mid-1950s and the 1980s, but a major revolution in verification only began in the late 1980s. How current trends in arms control verification are likely to evolve over the next 10 years is the subject of this and the subsequent chapter.

This chapter will address the likely evolution of these trends in the bilateral U.S./U.S.S.R. arms control endeavours. The prospects for the more complex and broader multilateral arena will be considered in Chapter IX.

Bilateral U.S./U.S.S.R. Arms Control Verification Endeavours

This study assumes a continued, constructive relationship between the U.S. and the Soviet Union, with several areas of mutual co-operation in bilateral negotiating and implementing forums including the START II and ABM Treaty or Defence and Space negotiations, the SALT Standing Consultative Commission (SCC), the INF Special Verification Commission (SVC) and the START Joint Compliance and Inspection Commission (JCIC), and international forums such as the CFE Joint Consultative Group (JCG) and the U.N. and its committees.

A change in this relationship and a return to the cold war mentality of the early 1980s would have major adverse effects on both the implementation of existing agreements and on the prospects for achieving further limitations. The verification regimes for INF and START I are extremely complex and comprehensive. In a period of co-operation, their implementation should proceed smoothly; however, in an adversarial relationship the mischief-making potential in their implementation would be unlimited and could result in hundreds of compliance issues being raised. Such an environment would undermine the arms control process and the viability of existing agreements.

In a co-operative environment, with the increased budgetary pressures in both countries, there are likely to be additional limitations placed on military forces. Some of these limitations could be labelled "arms control without agreement"; they are apt to be unilateral or mutual restraints in certain areas. Verification of such actions will not be an issue, although many of these actions could be accompanied by CBMs such as invitational visits or inspections, transparency measures, and official statements, legislative testimony and budgetary data.

In the strategic arms control area, the inherent linkage between strategic offences and strategic defences will be a key factor in formulating future agreements — START II and III, ABM treaty modifications and/or separate defence and space treaties, and possible ASAT limitations. As strategic offensive forces are reduced further, the stability and deterrence implications of strategic defences become more important. These reductions and the limitations on strategic defences affect the verification requirements; conversely, the effectiveness of the resulting verification regimes will affect strategic stability.

Envisioning a (theoretical) future bilateral agreement limiting strategic offenses and strategic defences provides a mechanism for determining the likely evolution of verification trends over the next 10 years.

Basic Elements of a Theoretical Future (1995-2000) Comprehensive Bilateral Strategic Arms Control Agreement Limiting Both Strategic Offences and Strategic Defences

In this agreement, strategic offensive forces would be reduced to 2 000 to 3 000 **deliverable** warheads, from the 6 000 **accountable** and 9 000 to 10 000 actual warhead limits of START I. Heavy ICBMs and MIRVed mobile ICBMs would be banned, simplifying the verification requirements. ICBM and SLBM warhead counts would be the maximum tested, permitting verification by NTM. Aggregate ICBM and SLBM

throw-weight would be reduced to approximately 50 per cent of START I totals, which would be a specified agreed number, thus removing the baseline uncertainty factor.

Heavy bombers equipped to carry nuclear weapons would be made distinguishable from non-nuclear heavy bombers. Air-launched cruise missile (ALCM) carriers would be charged the maximum carrying capacity. Nuclear ALCMs would be distinguishable from non-nuclear versions. Such distinguishability features and carrier-counting rules would simplify the verification requirements. FRODs and externally observable differences (EODs) would be useful but would need to be confirmed by OSIs to ensure that they reflect significantly different functional and observable features.

Nuclear-armed SLCMs would be banned. Ensuring that SLCMs do not contain nuclear warheads would be accomplished by devices for detection of radiation emitted by the warhead fissile material or by exposure of the warhead area to gamma rays or neutrons to measure the scattered, transmitted or induced radiation. This would be accomplished at the SLCM production facility and before deployment on a naval vessel. Tamper-proof tags and seals would be applied as the SLCM left the production facility.

Non-deployed missiles would be limited to approximately 10 per cent of respective deployed forces. There would be no denial of telemetric data from flight tests of treaty limited offensive forces, which would greatly facilitate the monitoring of system characteristics, warhead loadings and certain distinguishability characteristics.

Modernization and replacement would be permitted. Replaced systems would be destroyed or converted to permitted systems. The nuclear materials from the warheads of the destroyed or converted systems would be reprocessed and placed under IAEA control. The dismantling and destruction of nuclear warheads will pose security, technical, and monitoring problems. Determining the difference between a "modernized" missile and a "new" missile will continue to pose major difficulties for verification.

On the strategic defensive side, the theoretical agreement would continue the basic limitations on the deployment of nationwide ABM systems contained in Article I of the ABM Treaty. However, in view of the emerging tactical and strategic ballistic missile threats from the Third World, the ABM Treaty constraints against giving anti-tactical ballistic missiles (ATBMs) and anti-tactical missiles an ABM capability would be relaxed to facilitate greater protection of overseas forces and facilities, and to facilitate cooperation with other nations facing tactical ballistic missile threats. In view of these current tactical and future strategic ballistic missile threats, along with the possibility of accidental or unauthorized strategic ballistic missile launches, the ABM Treaty would be modified to allow the deployment of a ground-based ABM system consisting of 200 to 400 non-MIRVed interceptors on fixed, land-based launchers with no rapid reload capability, at no more than five designated deployment locations.

Directed energy BMD systems would be limited to ABM test ranges. Flight testing of sea-, air- and space-based ABM systems would be prohibited, although basic research could continue. There would be no limits on air- and space-based sensors not capable of substituting for ABM radars; space-based sensors for early warning and intelligence would be unlimited regardless of their capability. Verifying that space-based sensors are not capable of substituting for ABM radars would require increased NTM capabilities and possibly some type of OSI prior to launch.

The ABM Treaty and the modifications to the treaty would continue to be verified by NTM, which would be enhanced by Predictability Measures and CBMs, including data exchanges, visits to laboratories and observations of field tests.

This theoretical agreement would also include separate limitations on ASATs. The sides would be limited to one mobile land-based direct-ascent or co-orbital system capable of engaging low- and medium-altitude satellites. Deployment would be limited to 25 ASATs and associated launchers with no more than 25 non-deployed ASATs. Denial of telemetry from ASAT tests would be prohibited, and ASATs would not be given a significant ABM capability. There would be a ban on testing ASATs capable of reaching satellites in high or synchronous orbits. All directed energy ASATs would be banned. Verification of these limits would be primarily by NTM, which would be enhanced by predictability measures similar to those being developed for the ABM Treaty and Defence and Space negotiations, and possibly some type of OSI before launch.

This theoretical agreement would place no limits on surface-to-air missiles (SAMs) for air defence, except that they could not be given a significant ABM capability or tested in an ABM mode. Air defence fighters and air-to-air missiles, along with civil defences would not be limited.

The verification regime for this theoretical agreement would be based on the criterion of military significance. NTM would remain the key element, complemented by co-operative measures, including data exchanges, notifications and OSIs of declared facilities and possibly some space launch vehicles. With the continued improvement in U.S./Soviet relations, there would be far more comprehensive exchanges of data and more extensive notifications of numerous activities. It would be recognized that OSIs deter violations at declared facilities; they are unlikely to detect an actual violation at either declared facilities or suspect sites. The "anywhere, anytime" suspect site inspections (SSIs) would no longer be necessary or acceptable. OSIs would be focused on either short-notice inspections (SNIs) or PPCMS of **declared** facilities. OSIs would be used to monitor conversion or elimination of treaty-limited items. Invitational inspections would be used to remove ambiguities and to enhance confidence in the agreement.

Bilateral Naval Arms Control

During the late 1980s, several proposals for naval arms control were put forward by the Soviets and by U.S. non-governmental sources. Although SLCMs will not be constrained in the START I treaty, each side will provide the other with a politically binding unilateral declaration of its policy concerning nuclear SLCMs, and annual declarations regarding its planned deployment of nuclear long-range (over 600 km) SLCMs; this deployment will not exceed 880 missiles.

This temporary solution to SLCM concerns did not preclude other more sweeping proposals. For example, Ambassador Paul Nitze and former Central Intelligence Agency Deputy Director Admiral Bobby Inman have called for a ban on all tactical naval nuclear weapons, including SLCMs. Long-range SLCMs can fulfil both tactical and strategic roles, which makes them both unique and ambiguous when they have to be categorized. Many U.S. strategic planners believe that banning nuclear armed SLCMs would be of greater benefit to the U.S. than to the Soviet Union. In fact, many such planners would agree with Vice Admiral Henry Mustin, former deputy chief of naval operations, who stated in April 1989 that "the concept of a nuclear war at sea is a concept whose time has passed," and they would ban all sea-based nuclear weapons except for SLBMs on submarine, ballistic missiles, nuclear (SSBNs). Such a ban would be much simpler to verify than attempts to distinguish between nuclear and non-nuclear SLCMs, and to limit and count permitted nuclear-armed weapons.

With the reduced bilateral tensions and the increased pressures for naval arms control, there are likely to be formal agreements in this area

during the 1990s. Such agreements probably will ban all naval nuclear delivery systems on all naval vessels except for SLBMs on SSBNs; they might also limit the numbers of nuclear powered attack submarines. CBMs will probably be applied to naval capabilities, forces and operations; naval exercises could be subject to measures involving prior notification, information exchanges and the presence of observers during the exercises. In addition, there will probably be further agreements to prevent incidents on or over the high seas, similar to the 1972 U.S./Soviet Incidents at Sea Agreement and the Dangerous Military Activities Agreement concluded in 1989.

It is unlikely that there will be any limitations on anti-submarine capabilities other than a ban on nuclear-armed anti-submarine weapons. Neither will there be any limits on SSBN operational areas; proposals for SSBN sanctuaries are also unlikely to be acceptable to the U.S.

Bilateral Implementation Forums

The verification regimes associated with future arms control agreements will require effective forums for their implementation, similar to those for the ABM, INF and START I treaties. These will be the mechanisms for implementing dismantlement or destruction procedures (in the U.S., the SCC for the ABM Treaty and the OSI Agency for the INF and START agreements); resolving compliance ambiguities and concerns (the SCC for the ABM Treaty, the SVC for INF, and the JCIC for START); and handling the comprehensive data exchanges and notifications (the Nuclear Risk Reduction Center [NRRC] for INF and START I). In the future, it would be more cost effective and efficient to combine the SCC, SVC and JCIC into one body, which would also be responsible for handling implementation and compliance issues for all future bilateral agreements with the Soviet Union. The purposes and functions of these three bodies are essentially the same. The NRRC would be the channel used to exchange data, and transmit and receive notifications. Effective compliance diplomacy requires special skills and institutional memory that can be developed best in a single body staffed by seasoned professionals.

IX Likely Evolution of the Trends in Multilateral Verification over the Next 10 Years

James Macintosh

Although the international security environment may range between highly co-operative and distinctly conflictual, it will not necessarily influence basic verification requirements. Technical remote monitoring standards — the capacity to detect tank-sized objects under most observation conditions is a good general example of these standards — may not be dependent on variations in the security environment. Roughly similar standards could be said to exist for evaluating the effectiveness of OSI regimes, and they also define a technical standard that is unlikely to vary appreciably with changes in the security environment. Of course, political decisions about what level of compliance assurance is acceptable — how far it is safe to stray from those remote monitoring and inspection standards and with what degree of assurance that nothing is being missed — can change, and typically will change within a "zone of political and technical comfort." However, the technical requirements themselves may not change very much. What changes is the ability to live with certain types of ambiguity and uncertainty.

The future international security environment assumed in this study and any reasonable variation on that theme (either more co-operative or more conflictual), although producing different arms control possibilities, would be unlikely to yield very different verification approaches. **The different futures would presumably have their greatest impact on the political willingness of decision makers to live with uncertainty and relax technical standards for the sake of some agreements.** In an increasingly benign and positive international security environment, this is much more likely to happen. In a conflict-prone world, with rising animosities and high levels of suspicion, such a politically inspired relaxation of verification standards is implausible. Instead, most decision makers would insist on intrusive measures, concentrating on challenge OSIs, with aerial inspections as a backup. This, of course, would reduce the number of negotiations undertaken and completed.

To some extent, the degree of rigour and thoroughness seen to be necessary in a given verification regime may be influenced by the number and type of other arms control agreements already in existence, and the nature of their respective regimes (i.e., the extent to which their coverage overlaps). This is a result of what could be called **verification regime synergy.** Each one of a number of arms control and confidence-building agreements, along with its package of verification measures, may supply information that is of some value for the monitoring and compliance evaluation of other arms control agreements. This is already evident in the mutually reinforcing effect of the emergent CFE and the existing Stockholm Document. Observations, inspections, data exchanges and calendars from the latter will prove to be very helpful in verifying compliance in the former. Within the context of a single agreement, it is already the case that each measure of monitoring or verification can assist its associated measures in yielding a constructive overall result. **In many cases the combined effects of two, three, or more arms control agreements, and their unique but overlapping measures of verification, will magnify this effect significantly. During the next decade this may be the most important developing trend in verification.** If recognized, it will probably mute the potential impact of different judgements about the rigour to be demanded of any individual verification regime.

The verification trends associated with arms control in the realms of chemical and biological weapons, and of limits to technology transfer and space non-weaponization agreements, will likely share many of the characteristics relevant to agreements on conventional land and maritime forces. These potential agreements will, however, make special demands that may establish unique trends. It is most likely that OSI will remain particularly important in these cases, due to the character of the agreements. The very difficult trade-off between thoroughness and intrusiveness that is inherent in any OSI will

prove to be very difficult to resolve in these cases, and may help to propel some states to advocate the creation of one or more international monitoring agencies to handle these special limitation regimes. The alternative may be to accept minimal verification regimes as the only way of achieving any agreement at all, and then to rely primarily on expanded national or multilateral technical means operating outside the confines of the existing treaty. In the case of the most technologically advanced states, this is likely to happen in any event. It is no understatement to note that in the case of attempts to constrain widely available dual-use technology with both civilian and military applications, the most challenging problems of verification will arise and the most creative approaches will be necessary.

On the basis of the preceding speculative analysis, the dominant multilateral verification trends that we can expect to see in the next 10 years are:

1. The linkage of CBMs (notifications, calendars, information exchanges, observations) with both unilateral and multilateral co-operative means of inspection and observation (NTM, MTM and OSI) to create increasingly comprehensive verification regimes. Here, a complex web of distinct monitoring and monitoring-facilitating measures and understandings will reinforce each other and yield a powerful, synergistic effect.
2. The development of multilateral verification and/or monitoring organizations to operate, co-ordinate and deploy in a meaningful way the information resources necessary for making verification decisions by states that presently lack the independent resources to make crucial judgements. This critical development in verification must take place in the next 10 years if multilateral arms control is to make significant progress. The first steps in this direction could easily be the creation of small organizations, perhaps initially associated with specific arms control agreements, designed to manage various types of treaty-specific information, treaty-associated communications and, possibly, some consultative functions.
3. The development of increasingly effective remote monitoring methods, primarily aerial inspection and MTM satellite and aerial measures. This will be particularly necessary for maritime accords and for reduction or CBM agreements in regions with difficult terrain.
4. The continued use of various types of OSI, a process likely to be moderated by experience and limited to relatively narrow applications. Given its double-edged quality, OSI will never become a panacea, although it will remain useful for the final resolution of many instances of potential non-compliance uncovered by remote monitoring approaches.
5. The increased reliance on technical verification facilitators such as tagging and FRODs to permit the reliable tracking of weapon systems in reduction regimes.
6. The recognition that multilateral satellite monitoring (one type of MTM) offers at least one major advantage over aerial monitoring regimes — if the international or regional political climate suffers a set back. Aerial inspection rights can be withdrawn or interfered with quite easily, something that is not true of satellites. To be weighed against this advantage is the consideration that satellites are extremely costly (particularly if they are to possess the levels of resolution truly required by most arms control accords) and necessarily travel in predictable orbits with relatively slow revisit rates. They cannot compete with aircraft for cost-effective, flexible monitoring of limited areas.
7. Probably a "reasonable ceiling" for how many OSIs of various types should be built into arms control agreements of different types (and the

numbers would vary), beyond which states risk introducing counter-productive effects. General levels of confidence can be undermined by creating an institutionalized level of suspicion. In addition, at least some states can lose more than they gain by having inspectors from other states able to inspect military and civilian facilities.

8. The use of elaborate and/or extensive arrays of on-site monitoring equipment. This use also may have a reasonable limit, one defined not just by the possibly counter-productive confidence-degrading results of excessive monitoring (institutionalized suspicion) and difficult sovereignty issues, but by the monetary costs associated with establishing large and complex on-site monitoring regimes. Effective aerial and satellite monitoring, backed up by fast-reaction OSIs, tagging programs, and monitored storage and destruction facilities, should be sufficient to serve any likely multilateral conventional arms control agreement during the next 10 or more years.

A possible exception to this observation is the CWC, and any generally similar type of accord that focuses on the production of high-value weapons in facilities that can also be used for commercial or research purposes.

Verification-related problems that have not yet received much attention, but that will need to be addressed, are:

1. the verification of defence transformations (co-operative movements toward non- or less-offensive defence structures); and
2. the verification of meaningful limits on maritime forces (whether CSBMs or reductions, but more likely the former).

Thus, during the next 10 years, multilateral arms control negotiations will probably continue to refine existing trends in land-based force reduction and CSBMs, certainly in Europe and perhaps in new regions (Asia Pacific, Latin America or the Circumpolar North). New efforts will probably be undertaken to deal with co-operative defence transformation, maritime military activities, and the development and export of dangerous military technologies (nuclear, chemical and biological). They can be expected to place an increasing premium on a **synergistic** collection of monitoring approaches that employ various types of national and multilateral remote technical means; comprehensive but carefully targeted OSI packages; monitored storage; and comprehensive facilitating measures, including information exchanges, notifications, tagging approaches and a wide array of supporting CBMs. Standards of compliance performance and detection will likely vary within modest margins according to the political environment, although the development of good quality multilateral monitoring means (and organizations) will facilitate the verification of even the most demanding arms control accords to suitably high standards by all potential participating states.

X The Implications of the Trends

George Lindsey

Changing Threats

The developments of 1989 and 1990 give reason to expect substantial reductions in the levels of armaments maintained by the members of the North Atlantic Alliance and the former Warsaw Pact. However, they are not the only well-armed nations in the world, and it is by no means as likely that the countries of the Middle East, Africa, Asia, and South and Central America are going to divest themselves of their means of offence and defence. Moreover, a diffusion of increasingly sophisticated weaponry is occurring, which could allow a comparatively small but well-equipped country to obtain a decisive superiority over a larger rival not so well prepared.

The implications of this for verification to and in the year 2000 can be analyzed against two backgrounds. One is that of the former adversaries from the developed East and West, among whom the future climate is expected to be more co-operative and the levels of armament lower. The other is among all of the world's nations, where there is likely to be continuing animosity between regional rivals, and also between adversaries from developing and developed countries. There could be nonco-operation between belligerents and the UN, with the UN wishing to exert some control.

Verification of Arms Control between East and West

Insofar as strategic nuclear weapons are concerned, the primary objective of the U.S. and the Soviet Union will be to preserve strategic stability and deterrence. This requires that they retain a force of long-range nuclear weapons, together with a control system with sufficient survivability to absorb a counterforce attack and still be able to deliver unbearable retaliation. As the numbers on both sides are reduced, the survivability of those that remain becomes more important. The composition of the forces presently deployed provides a wide margin of survivability, so that it is not a matter of vital importance today to be able to count the numbers on the other side with great precision. The capabilities of NTM and the character of the forces presently deployed make it possible to estimate their size quite accurately enough to have no reason to fear that either stability or deterrence is in any danger under present circumstances.

As the number of strategic nuclear weapons is reduced, it will become increasingly important to ensure their survivability. Because fixed sites are the most vulnerable, a large portion of the reductions are likely to be made from the inventory of static ICBMs, with the number of mobile land-based missiles probably being increased. These pose a much more difficult problem for verification, but with co-operative behaviour an acceptable measure of confidence should still be obtainable.

Other factors that will threaten the survivability of the deterrent will be the increasing accuracy of MIRVed SLBMs, stealth (of bombers and cruise missiles) and the possibility of guiding long-range missiles from real-time observations made by satellites. It does not seem likely that agreements would be made regarding the prohibition of technical developments of the nature described. Thus, the problems of monitoring technical developments in offensive systems are likely to become more rather than less important and difficult in the case of U.S. or Soviet strategic nuclear weapons, and will continue to depend primarily on NTMs. This would not be a matter of verifying an agreement or detecting a violation, but of assessing the stability of deterrence.

There is another technical factor, apart from vulnerability, that could reduce the effectiveness of the deterrent: the development or deployment on a large scale of effective strategic defences. There will certainly be a continuing interest in the monitoring of such a possibility, using NTM. Depending on the future of the ABM Treaty, which may be clarified and modified during the next 10 years, ensuring continued compliance with its limitations could be a matter of major importance.

The development of BMD and other advanced military technology begins in the laboratory, with research into basic principles, the full applications of which cannot be foreseen at the time. The work at this stage is usually performed inside buildings, and cannot be detected by NTM. Monitoring by NTM only becomes possible at later stages, when demonstrations, field testing and operational evaluations are carried out where they may be observed. The wisdom of attempting to make agreements to curb any type of basic technology is very doubtful. However, to be practical, any such agreement should avoid attempts at intrusive verification of laboratory research, and confine its provisions for verification to the **applications** of the technologies, which occur in the later stages necessary in the development and production of weapons and are likely to be observable by NTM.

It appears probable that there will be further reductions in tactical nuclear weapons in Europe. This could extend to complete removal of all U.S. and Soviet land-based nuclear weapons, but it is less likely that air-delivered, or British or French, nuclear weapons will be withdrawn. Confirmation of the destruction of missiles should pose no serious problems, but monitoring the number of air-to-surface missiles and ensuring the total removal and subsequent continuing absence of small objects such as artillery shells will be very difficult.

In all cases of destruction of nuclear weapons, a very important question is the disposal of the fissile material. Refabrication of highly enriched uranium 235 for ship propulsion, and of enriched uranium and plutonium (possibly diluted from weapons-grade quality) for fuel in civilian power reactors seems economically desirable and eminently sensible. The problem for verification will be to keep track of where the fissile material from withdrawn warheads goes, and what is done with it.

The reduction in the number of intermediate and short-range nuclear weapons in Europe does not present the same urgent problem for the monitoring of qualitative developments that exists for U.S. and Soviet intercontinental nuclear weapons. Preservation of deterrence against the threat of counterforce attack, which is the key to strategic stability, is not as great a requirement for medium and intermediate range forces as for the strategic intercontinental forces. Also, it is much easier to verify total absence of a type of weapon (as is required in the INF Treaty) than to establish that, when a certain number are permitted (as in START), the total number in service is no more than the agreed legal maximum, and that none have been replaced by a new type of weapon disallowed by the treaty.

Substantial reductions to the conventional forces in Europe are likely to dissipate any legitimate fear of surprise attack on that continent. If the climate of *glasnost* and co-operation continues, it will be virtually impossible for the huge effort required to prepare an offensive in Europe to go unnoticed. This will make it less important for verification of reductions and for compliance to be very stringent or precise. It does not, however, address the problem as to whether the potential victims of the offensive will be able to take the necessary steps to provide themselves with an adequate defence.

As (and if) trust builds up between East and West, with decreasing suspicion that agreements are being violated, it is probable that use of the most intrusive measures of verification will decline. Challenge OSIs will be expensive, suggest suspicion and run a risk of unpleasantness even if no violation is discovered. The information that can be picked up from spaceborne and airborne sensors will improve and, when confirmed by the evidence of a modest number of routine OSIs, will probably suffice to maintain confidence. The tagging of weapons with individual labels that cannot be removed or altered

without detection is likely to ease the problems of counting and identification, probably reducing the requirement for frequent OSIs.

The level of verification activity (e.g., the number of challenge OSIs allowed in a given time period) could be set and kept at a low level as long as no evidence of non-compliance was produced, but with the provision for an increased level should this be demanded at some time in the future. Long-term treaties should provide sufficient flexibility to permit relaxation of measures of verification if experience persuades all parties that they are unnecessary, unduly intrusive or more expensive than warranted by their usefulness.

The combination of increasing trust and the desire to reduce defence expenditures may lead to reductions that are decided unilaterally, rather than being negotiated and formalized in treaties. These might be reported to potential rivals in the hope of stimulating reciprocal reductions. The major powers would want to confirm that such reductions were actually occurring, using NTM supplemented by whatever evidence might be gratuitously offered by the initiator. Because no formal agreement had been undertaken, such activity would not fall within the strict definition of verification of arms control.

Verification of Global and Regional Measures of Multilateral Arms Control

Between 1990 and 2000 it seems likely that the legitimate fear, and quite possibly the actual fact, of the acquisition of nuclear, biological and chemical (NBC) weapons by a number of states will be a cause of major and growing concern throughout many parts of the world. Ironically, as the powerful states that have substantial stocks of NBC weapons are moving to get rid of them, weaker countries that have not had such armaments may now attempt to so equip themselves.

A new form of polarization could appear, pitting a majority of states that wish to maintain peace without recourse to arms of any kind, and especially to NBC weapons, against a minority who are prepared to use armed force and hope to increase their chances of success by the use of such weapons. Because some, perhaps most, of the latter group will represent poor and undeveloped countries, they will attract sympathy and support elsewhere. They will accuse the more developed states of attempting to retain control of advanced industrial technology. Their backing from other members of the UN may make it impossible for that body to take concerted action against NBC weapons, or could result in international treaties that a number of member states abstain from signing. It may be that multilateral treaties will be regional rather than global in scope, and may not be associated with the UN.

There may be occasions in a country or region when order has broken down, to the extent that there is no governing body with authority sufficient to undertake a meaningful international agreement that it could enforce throughout its own territory. Its forces, or international forces working with its approval, could conduct searches for weapons or for evidence of CW or BW agents. Although such activity may not fall within the definition of verification of an arms control agreement, it would probably make use of many of the same methods and much of the same technology.

If a significant number of developed countries agree to a treaty banning NBC weapons, and include provisions for verification, they may not be able to persuade others that concern them to join. In this case, the former group would have a strong motivation to use any of their non-intrusive verification equipment, which does not depend on co-operation to monitor non-signatory states for evidence of development of NBC capability. Examples might be the use

of seismic instruments to detect underground nuclear explosions, or of airborne and satellite platforms to detect the traces of chemicals in the atmosphere or in factory effluents indicative of CW production. Because of this possibility, there could be a preference for ITM or MTM for verification over means dependent on the co-operation of the party under observation. Such a preference could motivate the most advanced nations to help provide high technology to their partners, and could make satellite-borne sensors more attractive than airborne. If international law is to be respected, verification methods that depend on aircraft will need permission to overfly the inspected countries, while satellites, which make repeated crossings without requiring any agreement, can be provided with highly sensitive and versatile sensors.

The verification of multilateral arms control agreements introduces a number of significant complications not present in bilateral pacts. So far there is little evidence of progress toward the establishment of organizations or procedures to permit multilateral verification to approach its potential effectiveness. Each participating country can plan its own inspections unilaterally, conduct them with their own equipment and personnel, study and analyze the results unaided and make its own assessments and decisions about filing complaints or accusations. But far more effective and efficient verification could be obtained with co-ordination and co-operation among some or all of the participating states in each of these activities, although the potential would be introduced for disagreement and obstruction.

If several treaties for control of different types of armaments are negotiated by groups of countries with the same or nearly the same membership, the possibility arises that one agency could be created to perform verification for all of the treaties. This would allow considerable efficiencies to be made in use of satellites, aircraft, inspection teams and tagging, and, unless these were handled by individual countries, in the organization of analysis and interpretation. Possibly the U.N. could provide such a service. It would, however, involve additional problems of allocation of priorities, and would likely require a greater degree of trust, funding and co-operation among the participants than might be necessary for a single treaty.

Although the developed countries with significant military forces may agree to divest themselves of NBC weaponry, they are much less likely to give up other advanced armaments such as guided missiles. However, there may be agreements to restrict the sale of certain items of advanced equipment to countries unable to manufacture them domestically. Verification of such a ban could receive co-operation in some or all of the producing countries party to the agreement. But, to be complete, the verification should extend to potential recipient states, some of whom would probably not be party to the agreement and would have no obligation to co-operate in verification. In fact, monitoring of the activities of non-party producers and non-party recipients would not come under the current strict definition of verification, although its absence would leave the agreement incompletely verified.

If effective restrictions are established to prevent the transfer of sophisticated weapons to Third World countries unable to manufacture them domestically, there will be good reason to negotiate regional arms control agreements that ban certain types of weapons completely. As already indicated, a complete ban is much easier to verify than a numerical limit. However, for smaller weapons it is probable that initial (and probably uncertain) detection by remote sensing would need to be followed up by challenge OSI.

If a multilateral agreement was reached to limit the freedom of movement of submerged submarines (such as a keep-out zone) it is probable that several maritime states would be able to

use anti-submarine detection systems to monitor intrusions into areas near their own coasts, or at nearby choke points connecting large ocean areas. But only a few of the best-equipped maritime powers would have a capability to monitor the larger expanses of the open ocean. Efficient verification would require effective co-ordination of the information gathered by the systems operated by several states.

Although it has been customary to define verification in terms of a specific arms control agreement, the combination of changing threats to society and the increased capability of modern sensors make it quite probable that the equipment and perhaps the organizations designed for the verification of arms control agreements will begin to be used to aid in peacekeeping operations. They may also be used to monitor non-military threats such as pollution, depletion of resources and other environmental concerns that may give cause for international protest. Moreover, the information derived from the sensors is likely to prove extremely useful for many other purposes in which many or all countries have a common interest, such as weather prediction, monitoring of ice movements, progress of agricultural crops and forests, and possibly control of shipping and air traffic.

XI Suggested Subjects for Future Research on Verification

James Macintosh

A major objective of the Verification to the Year 2000 project is to identify promising areas of verification-related research that may warrant closer study. The intention is to identify verification or verification-associated issues that will or can play an important role in arms control efforts in the future. The presumption is that research efforts expended now will facilitate the best, most successful application of verification ideas in future arms control and confidence-building negotiations.

To achieve this project goal, the authors have looked speculatively into the possible events in arms control during the next 10 years, to generate a broad range of observations, trends and questions. Although not exhaustive, the exploration of bilateral and multilateral trends in a number of existing and anticipated forums has revealed a variety of interesting and promising research areas. The research areas discussed below represent collections of questions related to a common subject or identify single subjects of sufficient interest to warrant special attention.

Broadly speaking, the research areas identified in the Verification to the Year 2000 project fall into the following basic categories:

- the multilateralization of verification;
- conceptual issues;
- verification and the confidence-building process;
- new approaches for the verification process;
- synergy — the interaction of verification techniques and approaches;
- technology and the verification process;
- the verification of new BMD limitations;
- the verification of ASAT and space weapon limitations;
- the verification of new or non-traditional forms of arms control and confidence-building agreements;
- monitoring and verification of activities other than those subject to an arms control agreement;
- verification in new political-cultural contexts;
- the legal dimension; and
- domestic politics and verification.

The conclusion of this chapter contains a short list of specific research issues drawn from this comprehensive collection of topics.

The Multilateralization of Verification

What are the advantages and disadvantages of developing multilateral monitoring organizations? Are there things that a multilateral monitoring organization can do that are presently impossible? Are those tasks worthwhile? Are there hidden dangers and costs as well? Is there any other way to ensure uniform access to relatively high-quality monitoring information? Is it best to divide verification judgement functions and monitoring functions? How do alliances operate within such potential organizations? How is the development of these organizations to be initiated? Should one be created for each individual agreement, or could one organization come to serve the monitoring needs of a number of distinct arms control agreements? Could they (should they) serve the monitoring needs of other regional or international agreements and requirements (e.g., as resource management, pollution control, the control of drug smuggling)? What is the ideal range of functions for a multilateral verification organization in terms of monitoring, information processing, data analysis and compliance judgements?

Does it matter if the U.S., the Soviet Union, or both, are unhappy with the creation of multilateral monitoring or verification organizations? How could their interests be accommodated in the design and operation of a multilateral organization? How would (and could and should) Soviet and U.S. NTM interact with MTM?

Is the notion of using a multilateral verification or monitoring organization an ethnocentric artifact of Western thinking? Would it have the same meaning (and effectiveness) in other political cultures? Could this potential ethnocentric design bias or undermine efforts to develop regional and global verification or monitoring organizations? What could be done to "universalize" the idea and the approach?

Should arms control and confidence-building agreements be designed from the beginning to incorporate multilateral verification approaches and techniques? How would this make a difference compared with an accord that initially assumed non-multilateral verification approaches? To what extent are arms control agreements influenced by the verification regimes that might be attached to them?

What are the implications for an alliance such as NATO in the development of a multilateral verification or monitoring organization within the CSCE framework? Can NATO play a constructive role within a CSCE monitoring organization? If an effort was made, could this type of participation be turned to the advantage of a constructively evolving NATO? Must the creation of CSCE organizations necessarily mean a diminishment of NATO's importance?

How does NATO in its present form deal with the determination of the arms control compliance of other states? Does an effective mechanism currently exist within the NATO organization for monitoring and compliance judgements? What are the lessons to be drawn from the NATO experience for the future design of multilateral monitoring and verification organizations?

How will the development of a European Community-specific security consciousness affect the development of the CSCE, NATO and the WEU? How will it affect the participation of various NATO states in CSCE-mandated arms control and its verification in a multilateral context?

Would all state groupings (e.g., NATO, WEU, European Community, Warsaw Treaty Organization) be similarly affected by the development of regional multilateral verification organizations? Might there be differential impacts? Would this have negative implications for the general security relations of a region?

Could the development of a multilateral verification organization create new opportunities for formal and informal security-related groupings? Would this promote or retard the integration of the larger community participating in the various agreements serviced by the multilateral organization? Should this be a design consideration in the thinking associated with the creation of a multilateral verification organization?

Conceptual Issues

Is the quality of contemporary thinking about verification sufficiently sophisticated and comprehensive to permit the design of genuinely successful verification regimes? Does contemporary thinking adequately recognize that verification is not a singular activity, but is instead a process composed of a number of discrete activities including the collection of information, its analysis and the making of judgements about compliance? Does it recognize that these stages have distinctive psychological and technical aspects? Is this view of verification as a multistage process a useful way of understanding the phenomenon? Does its adoption yield conclusions different from those flowing from the use of simpler models? How would the failure to appreciate this process view affect verification designs?

Should analysts attempt to sharpen their language and be more precise about the distinct stages or aspects of "the verification process"? Here, the principal concern is to note and then explore a wide range of implications associated with the major distinction separating monitoring — which is hypothetically limited to "looking" —

and compliance assessment — which is hypothetically limited to "judging" — as well as the grey area between them where various types of data collection and information management occur. All of these together, according to this view, are part of the verification process. Does this fundamental bifurcation of "verification" have unexpected implications for some verification enterprises, particularly when undertaken in the multilateral or collective context? Does it depart appreciably from common practice and professional usage?

What is the best way to think about and categorize the whole idea of the verification process? Should analysts try to develop an abstract theoretical account of the process, or should they try to identify or create general categories that can accommodate existing and imaginable verification approaches and techniques? How do they do that? How should categories be designed — according to a generalized understanding of what verification means or inductively, based on existing approaches?

Does the way in which analysts and policy makers structure their thinking about verification categories impose unnecessary constraints on the development of new verification ideas and approaches, or the extension and elaboration of existing ideas in new contexts? Are the usual efforts to develop verification solutions handicapped by too much conventional thinking (i.e., by too much thinking about verification that is tied to existing examples)?

Should the specific needs of arms control agreements structure the thinking of analysts in developing verification "solutions" or should analysts focus more directly on verification itself (in preparation for and in anticipation of a specific negotiation's requirements), and attempt to provide a rich menu of possible approaches, techniques and ideas for policy makers?

Should verification (or, more narrowly, monitoring) as a distinct activity ever be separated from the verification function of specific arms control agreements? Does it make sense to talk about a monitoring regime that is not directly associated with an arms control or confidence-building agreement and a political context? Is the Open Skies proposal an exception or can other similar types of stand-alone verification/confidence-building/monitoring arrangements be imagined? Can they accomplish anything constructive as a general class or are they distractions that risk reducing the effectiveness of arms control agreements with attached verification regimes?

What purposes do arms control agreements really fulfil and how can verification regimes constructively contribute to those agreements (and purposes)? Implicit in this question is the possibility that arms control negotiations and agreements may serve purposes other than those normally associated with the traditional goals of arms control, such as developing force limitations. For instance, can arms control negotiating be viewed as a confidence-building process? Might the purposes change in the future? Might "stability" rather than force limitation come to be an increasingly important goal? How would verification regimes contribute to that? Are stability-enhancing ideas from the world of strategic nuclear arms control in any way transferable to the conventional military arms control sphere? Does current thinking about verification even recognize the importance of various types of stability, or is it narrowly fixed on measuring force reductions or ceilings?

What is an "effective" level of verification performance? What does the concept really entail? What are minimum (least rigorous) standards of verification performance and how can they change depending on other considerations? What are those "other considerations" and how might they make a difference? In particular, what is the role played by the psychology of decision makers and their perceptions of threat (or its absence) in the verification process? Is verification as much a psychological phenomenon as it is a technically informed one? What does this mean for the design of verification regimes? What does it mean for the development of a "theory" of the verification process?

What is meant by the term "verification regime" and does the term "regime" have any special meaning in this application? Is a regime more than just a collection of similar measures or requirements? What are the implications associated with a complex regime concept? These questions flow from the existence and continued utility of the formal regime concept employed in international relations theory.

What is the most effective and useful way of ascertaining what arms control efforts are likely to be undertaken in the future and what types of verification approaches might function with them best? This is a question about the conduct of futures research, with a special focus on verification. Are potentially useful but unorthodox or unusual approaches and techniques for verification likely to be missed because "futures thinking" is too conservative, inflexible or limited? How important a role should this type of futures thinking play in decisions about research and more current policy?

Verification and the Confidence-building Process

What is the relationship between the confidence-building process and the verification process and how can they help (or hinder) each other? How do they interact — or, more accurately, how do different types of CBM interact with the verification process? Does the fact that both involve poorly appreciated psychological processes make their interaction even more difficult to understand and more difficult to predict? Do important trade-offs exist in the pursuit of these two activities? How can they be resolved?

Does the verification of an arms control agreement differ appreciably compared with the verification of a confidence-building agreement? Is the concern with psychology and decision-maker perception sufficiently dominant in the confidence-building process that verification efforts must be muted in order to preserve or enhance the confidence-building effect?

What are the possible relationships between confidence-building and agreements for arms limitation? What (if any) are the synergistic relationships among various arms control and confidence-building agreements (existing and possible), and their verification regimes? The CFE and the CDE are good illustrations of this potential interaction and synergy. Would other possible combinations of arms control and confidence-building agreements demonstrate the same effect? Could agreements be designed to maximize this overlap and synergy in verification regimes?

New Approaches for the Verification Process

To what extent can ideas developed for the verification of bilateral strategic nuclear agreements be used for the verification of multilateral arms control and confidence-building agreements? Are there likely to be unanticipated negative consequences due to their origins, and to the original subjects associated with their adoption?

How much scope is there for the development of "facilitating measures," various measures intended to make the verification of arms control agreements easier? (This category includes such measures as information exchanges, co-operative measures to make remote monitoring either easier or possible, voluntary invitations to inspect and observe activities of potential concern, etc.) How broad can this category be and what new measures might be added to it? What types will be most useful in various possible arms control and confidence-building agreements?

Are there ways of designing inspection regimes (ground and aerial) so that the probability of detecting undeclared, non-compliant activities is enhanced without increasing the number or intrusiveness of the inspections? Should a certain fraction of inspections be conducted on a selective, random basis within broad areas more likely to contain examples of non-compliant activity? To what extent ought inspection regimes to employ randomness? What statistical and other analytic techniques (including game theory) might assist in the design of such regimes?

Can consultative bodies (patterned roughly on the SCC model) improve dramatically the performance of verification regimes and arms control agreements? Are some types of verification approach better suited than others to facilitating the operation of consultative commissions? Should every arms control agreement and verification regime create its own consultative commission, or can one commission service several agreements?

To what extent is economy of operation currently a driving concern in the design of verification regimes? Is this likely to change in view of the dramatically increasing costs of verifying compliance in new generation arms control and confidence-building agreements? How might the concern to economize influence the design of arms control verification approaches? Have verification regime designers been careless in trading off cost versus performance? In practical terms, is there a trade-off between cost and verification performance?

Synergy — the Interaction of Verification Techniques and Approaches

Are there ways of designing verification regimes so that no single technique or approach crosses an "intrusiveness threshold" but collectively they yield a highly reliable composite image of military activity? Is this currently a design consideration in arms control and confidence-building negotiations? What is the best way of creating this overlapping coverage? Is this approach susceptible to unravelling if a key component or technique is denied or its performance degrades?

Is there a certain point in the evolution of a region's security environment where several distinct arms control and confidence- building agreements (and their verification regimes) collectively yield a degree of monitoring performance and compliance assurance that exceeds the sum of their parts? Can this threshold be identified beforehand? Does this suggest that a larger number of smaller, more modest agreements, each with a relatively modest verification package, is better able to structure a security environment than one to two larger ones?

Is there such a thing as "verification synergy"? If there is, what is the best way of developing it? Do arms control reduction agreements in association with extensive confidence-building agreements covering approximately the same forces and activities naturally produce this effect? Is it the same basic effect as that produced by a combination of overlapping verification regimes developed for several arms reduction agreements?

Can there be such a thing as too many OSIs permitted in an arms control agreement? Are there natural limits to the number and type of short- or no-warning OSIs? At what point do they become counter-productive? How does the number and type of OSIs interact with the confidence-building qualities of arms control?

Technology and the Verification Process

Are there new technologies identifiable but as yet not employed in existing arms control and confidence-building agreements that could play a role in the operation of monitoring and verification regimes (in the planning, monitoring, processing, analysis and distribution phases)? What is the best method of matching monitoring and processing technologies with various arms control needs? How has this been done thus far? Are the lessons of the past useful for future applications?

Is there one dimension of the verification enterprise that is particularly amenable to technological leverage? Is monitoring less likely to benefit from various technological developments than, say, the management of data developed by monitoring? Where will technological breakthroughs have their greatest impact? Will some regions be more likely (more able or more willing) to take advantage of new verification technologies? What besides availability might influence this?

What are the relative advantages and disadvantages of aircraft versus satellites for different types of monitoring of verification regimes, both bilateral and multilateral? Are there considerations beyond cost that militate against the development of either national or multilateral satellite resources? Are air- or satellite-based remote monitoring approaches applicable in all global regions or is one approach better than the other in some regions?

Are there technologies for data and information processing, such as expert systems and "artificial intelligence," that will reduce the expected burdens of handling massive increases in monitoring data? Will this make multilateral monitoring organizations better able to function? Will the availability of artificial intelligence and expert systems promote interest in creating fully functioning multilateral or international verification organizations?

Will political and economically motivated decisions in certain countries or regions encourage the development of verification-related technologies (including satellites, sensor suites for aircraft and information-processing equipment) more or less regardless of the actual technical need for the equipment or the economic viability of the effort? Will this introduction of national or regional industrial strategies into arms control and verification complicate the arms control process?

Will maritime verification regimes require technologies and approaches not currently used for the verification of terrestrial arms control and confidence-building? Will these be available to most potential participating states, or will the situation parallel the current one, with only a few states possessing first-rate monitoring technologies? Will multilateral monitoring be the only practical answer to this limitation? Will regional maritime regimes have significantly different technological requirements than global regimes?

Will developments in military technology create new arms control and verification problems? Will these problems be profoundly different from contemporary difficulties (with, for instance, cruise missiles)? Can (and should) considerations of arms control and verification play an important role in shaping weapons system research, development and acquisition decisions? How large a priority should — and can — such a concern play in weapon acquisition decisions?

Will the development of sophisticated monitoring instruments by countries such as Japan, and the possible second-generation commercialization of monitoring resources, alter the anticipated trends in the verification of various types of arms control and confidence-building agreements? In what ways might these trends be altered? Will this commercialization process undercut multilateral and international developments or foster them?

The Verification of New BMD Limitations

Will adjustments in the existing ABM Treaty be necessary to accommodate new technological and political developments? (Are they necessary already?) Will these changes require new verification approaches and techniques? How will changes in the structure and operation of the strategic bilateral BMD arms control relationship interact with the possible development of BMD systems by other states or groups of states? Will regional arrangements for defence against tactical ballistic missiles interfere with the control of Soviet and U.S. strategic defence systems? Will new and demanding verification requirements emerge if strategic BMD systems are to be controlled while "tactical" ones are not? Should the introduction of potentially ambiguous exotic technologies into either strategic or sub-strategic BMD systems be controlled and, if so, will new verification approaches be necessary?

The Verification of ASAT and Space Weapon Limitations

Would a new treaty or agreement dealing specifically with ASATs pose special technical and/or organizational verification difficulties? How would such an agreement interact with existing treaties (such as the ABM Treaty) and possible new multilateral treaties dealing with the non-weaponization of space? Would this potential interaction create unique verification problems or would it simplify the verification task? Does it even make sense to talk about a separate ASAT agreement given the potential coverage of a revised ABM Treaty and a non-weaponization of space agreement?

Would the potential use of exotic technologies in the design of ASAT systems create special verification problems, particularly if the technologies could be seen as dual or multi-purpose and useable in BMD and air defence roles as well? Is there any practical way of dealing with this type of problem?

Would the presumed multilateral nature of an agreement for non-weaponization of space create special verification problems beyond those associated with terrestrial multilateral arms control agreements? Would a special-purpose multilateral verification organization be the only feasible organizational response?

The Verification of New or Non-Traditional Forms of Arms Control and Confidence-building Agreements

Will agreements for maritime arms control and confidence-building include measures that are appreciably different than their ground-based relatives? If so, in what way will they be different? Will they require new approaches to monitoring and verification? Will maritime agreements be served best by unique verification structures and organizations, or can they be integrated into existing or land-oriented organizations? Will maritime regimes operating near or in coastal areas create different needs and problems for verification than open ocean regimes? How will such regimes interact with land-based arms control and confidence-building regimes? Will some regions be more likely to develop maritime-oriented rather than land-oriented arms control and confidence-building agreements, given their geographic circumstances? How will this (and possible cultural factors) affect the design and operation of verification regimes, including possible verification organizations?

How can the co-operative movement toward non- or less-offensive defence regimes be monitored and verified? Are there some approaches to this general objective that will be easier to monitor and verify than others? Should this concern for verification guide the initial efforts to develop "defence transformation" regimes? How might this be done? Is the attempt to move toward defence transformation regimes the most sensible course to pursue, or are there other ways of addressing conventional concerns regarding military stability? Would they be easier to verify?

Does it make sense to talk about monitoring or verification conducted in the absence of or separated from a specific arms control agreement? Are there "verification regimes" that could serve useful purposes even though not formally attached to a specific arms control agreement? Would it be useful to develop a series of regional Open Skies-type monitoring arrangements? Would it be useful to transfer the general notion of stand-alone monitoring or verification regimes to the maritime realm? Should such an effort be confined to surface and air activities or could it also include sub-surface activities? How would these two basic models of "Open Seas" work? How would they interact with existing international legal undertakings and norms? Could this idea be extended to outer space, as well? Do existing efforts to develop global seismic nets to monitor underground nuclear tests fall in this same basic category?

Are there ways of developing verification regimes for use within or in association with "nonco-operative arms control regimes" that

would permit the international community (or portions thereof) to detect reliably the development of weapon systems that were deemed intolerable — primarily NBC weapons by non-signatories of existing or future conventions (NPT and CWC)?

How should monitoring and verification resources (both technical and organizational) be used to deal with activities of states that are not party to existing arms control and confidence-building agreements? There are a number of issues involved. The basic activities of interest include arms transfers; the development of nuclear weapons; the development of chemical weapons; and the development of "restricted" or "dangerous" technologies (e.g., ballistic missiles). Can this type of regime only be operated effectively by the UN? Could a regional bloc develop such a regime?

Will the removal or conversion of fissile material from nuclear weapons create any special verification difficulties? Will any special technologies need to be developed or applied for this task? Could this best be handled through the IAEA? How will the verification of this compare with the verification of other procedures for the destruction of weapons? Could common protocols be developed for all destruction measures?

Would the development of "reactive arms control" agreements meet concerns about excessively intrusive verification regimes? These are agreements in which specified monitoring and inspection measures can become increasingly rigorous, but only in reaction to the crossing of certain thresholds of worrisome military behaviour. How could this type of approach be operationalized? Are there any obvious drawbacks to the basic concept?

What additional types of arms control negotiation and agreement (beyond the examples of existing forums) might come into existence in the next 10 or so years? What types of forces and activities not currently addressed by arms control agreements need to be addressed by arms control and confidence-building measures? What kind of verification demands will these new forums make?

Monitoring and Verification of Activities Other than those Subject to an Arms Control Agreement

"Verification" is usually associated with arms control and confidence-building agreements. Are there other national and international activities, problems or concerns in addition to the verification of arms control and confidence-building agreements to which technologies and/or organizations for monitoring and compliance evaluation can contribute — peacekeeping support; environmental monitoring; resource monitoring and development; weather forecasting; natural disaster relief; the detection of drug smuggling and illegal immigration; early warning of conflicts among non-participant states; international terrorism; media support and so on? Does this approach effectively require the creation of multilateral or international bodies to manage these resources? This idea of associating a number of separate uses with verification resources could be significant, because these other uses could help to make the costs of monitoring and processing information seem more bearable and worthwhile. There are also a number of difficult political, operational and legal issues that would need to be examined before endorsing this sort of dual or multi-use approach to the creation and use of resources primarily intended for the monitoring of arms control.

Working in the reverse direction, are there — or might there be — information-gathering resources associated with non-arms control activities that could be employed for verification purposes? To what extent might they be made more feasible if the arms control and confidence-building verification function was attached to them? As mentioned previously, what types of legal problems might be associated with this approach?

Verification in New Political-Cultural Contexts

To what extent are contemporary ideas about arms control, confidence building and the verification of agreements a creature of Northern European and North American thinking? If this thinking is significantly ethnocentric, what might happen if it is (mis)applied in parts of the world that do not share the same intellectual and cultural history, social norms or political culture? Does this mean that arms control and confidence building (and their verification measures) — or some types of them — are ethnocentric and thus not easily transportable to other regions with other cultures? What can be done about this, if it is true?

Could cultural differences lead to unanticipated problems — or opportunities — in the use of what are seen to be standard verification approaches in the Soviet-American and CSCE context? For instance, might the whole notion of challenge inspections create serious political difficulties in cultures that view trust, honour and truthfulness in non-Western ways? Would other dimensions of the verification enterprise meet similar unanticipated problems? Would the cultural characteristics of some regions create new opportunities for verification approaches that might not seem obvious to Western observers?

Where might arms control and confidence-building efforts be undertaken next in terms of geography? Are there conflict- and tension-prone regions of the world where existing or new arms control and confidence-building approaches might be applied? What are the new or non-traditional approaches? How might existing verification approaches serve those efforts? Would new verification approaches be necessary to complement region-specific arms control and confidence-building agreements? What new considerations might interfere with the smooth application of existing ideas and approaches?

The Legal Dimension

To what extent does the current generation of verification regimes for arms control and confidence-building create legal problems or difficulties for national governments? Does this vary depending on the type of arms control agreement, its subject matter and the participating states? To what extent is this likely to change in the next generation of arms control agreements and verification regimes? Will this be a more difficult problem for multilateral forums than for bilateral forums? Will some multilateral and international agreements pose more problems than others? What issues of international law will emerge in the design of the next generation of verification regimes? Will maritime arms control and confidence-building agreements encounter unique and troublesome legal difficulties? Will multilateral arms control efforts in space encounter special legal difficulties?

Domestic Politics and Verification

What impact do domestic politics (i.e., "bureaucratic politics" and partisan legislative politics) have on the design and operationalization of arms control and confidence-building verification regimes in various countries with different political systems? Does the impact vary according to the type of agreement or the type of verification measure? Does it vary according to the number, type or size of states participating in an agreement? Does it vary according to the type of government system? Are there ways of insulating the design and operationalization of verification regimes from the negative effects of domestic politics?

Conclusion

As the preceding discussion amply demonstrates, there is a rich menu of questions available to guide research into the role of verification

in the future. The issues cover a wide range of technical, organizational, political, operational and theoretical dimensions. Many of the possible research issues have to do with applying existing approaches in generally similar contexts. However, some of the research possibilities identified here suggest that genuinely new thinking about verification and how to achieve it may be in order and that new possibilities for effective verification may exist. It will require, however, unconventional and rigorous thinking to uncover many of these possible insights.

From the preceding extensive discussion of verification-related research issues, the following questions deserve special attention:

1. Would it be desirable to share the use of monitoring and compliance evaluation technologies and/or organizations between traditional arms control regimes and unrelated activities with similar requirements? Examples of potential associated activities include: peacekeeping support; environmental monitoring; resource monitoring and development; detection of drug smuggling; and detection of illegal immigration.
2. Can multilateral monitoring and verification organizations operate effectively within multilateral arms control and confidence-building regimes and regional organizations? Are they the only way to guarantee effective verification for every participating state? What do they offer and what do they risk?
3. What is the relationship between the verification process and the confidence-building process? How do CBMs strengthen the verification process and can verification measures undermine the confidence-building process?
4. Can combinations of verification measures (and CBMs) in separate agreements collectively produce verification synergy, a verification product that exceeds that of the component parts? Can the verification measures in a single agreement, if properly designed, yield a similar overlapping synergy?
5. Will the verification of maritime arms control and confidence-building agreements, whether global or regional, pose special problems? Will they be difficult to resolve?
6. How extensively can the use of co-operative and facilitating measures (voluntary inspections, the removal of concealing structures, data exchanges) assist in the effective functioning of a verification regime?
7. How could nuclear weapons material cut-off agreements be verified? Would there be insurmountable or grave technical difficulties in doing so?
8. To what extent is the contemporary understanding of the "verification process" an ethnocentric or culturally limited one? Can the concept and practice of using a verification regime be exported to regions with different political cultures and habits of thought? As a corollary, do analysts and policy makers fully understand what is entailed in the "verification process"?
9. Will a multilateral outer space non-weaponization agreement prove necessary and would it pose any special verification problems?
10. As conventional force sizes continue to decline, will a greater interest develop in "defence transformation" agreements that seek to confer on those forces a more defensive character? How could such transformations be monitored and verified?

XII Summary and Conclusions

All nations involved in the arms control process recognize the critical importance of verification. No arms control agreement will be based on trust alone; effective verification must be ensured for the continued viability of the arms control process and the resulting agreements.

Verification, like arms control itself, can be both a product — a regime spelled out in a treaty document — and a process. Verification includes the design and negotiation of regimes to meet security requirements; policy decisions about what constitutes effective verification; the implementation of verification requirements of completed agreements; the evaluation of compliance with existing agreements; and the determination of appropriate responses to ambiguous situations or clear non-compliance with specific provisions of agreements. The requirements for verification and verification regimes themselves vary with the international climate. The better the political relationship among the negotiating parties, the higher the confidence in compliance and the simpler (and less costly) the regime.

To assess verification trends to the year 2000, it was necessary to develop a set of assumptions that take into consideration geopolitical constraints and realities about international relations and the arms control process. This study assumes a continued and constructive relationship between the U.S. and the Soviet Union, and whole-hearted co-operation in the area of arms control among the developed states. It recognizes a shift in "the threat," away from East-West and toward North-South, South-South and possibly North-North. This shift leads to the prediction that multilateral agreements will become more complex and more significant than bilateral treaties.

Other assumptions regarding the arms control process during the coming decade include the following: CFE I and II will be completed; an SNF treaty will either be overtaken by events or completed; a START I agreement will be negotiated and START II will be nearing completion; and efforts will be under way to bring the British, French and Chinese forces into START III negotiations; the ABM Treaty (clarified) will remain in force and SDI research will continue but there will be no decision to deploy a space-based system; interest will grow in tactical ballistic missile and cruise missile defence; the NPT will remain an important multilateral agreement with major efforts expended to maintain its continued viability; the CWC negotiations will continue; there will be mounting pressure for naval arms control; there will be pressure for a complete test ban, a cut-off in production of fissionable materials and more effective measures to control the transfer of advanced weapons and associated technologies; and, finally, NATO, the CSCE and the UN will play increasingly important roles in developing and implementing verification regimes and CBMs.

In the area of evolving verification trends and their implications, several key findings emerge from this study. NTM will continue to be the dominant factor in the verification of bilateral agreements. Multilateral agreements will require the development of multilateral or international technical means (MTM or ITM), to be employed under regional or UN auspices. Co-operative measures, including data exchanges, notifications and on-site inspections (OSIs) will remain an essential part of future verification regimes; however, there will be significantly less emphasis on the very intrusive forms of OSI (such as anywhere/anytime suspect site inspections). The important synergistic effects among these various modes of monitoring and verification will be recognized increasingly. There also will be increased emphasis on CBMs and transparency measures, including an Open Skies agreement. However, military significance will continue to be the criterion for determining effective verification, even though people will differ over the

definition of military significance. NTM/MTM/ITM will remain the foundation for effective verification, although co-operative measures, aerial inspections/Open Skies and CBMs will continue to play increasingly important roles.

New requirements for verification will be generated by emerging areas of concern and possible future agreements such as lower thresholds for the TTBT and limits on the number of tests, naval arms control, more effective measures to control the transfer of advanced weapons and associated technologies, the clarification of the ABM Treaty, ASAT limitations and agreements to reprocess and control materials from eliminated warheads. It is assumed that the maintenance of stable nuclear deterrence will remain the cornerstone of the security policy of the major powers, requiring verified controls over strategic defensive as well as offensive forces.

Verification regimes in the near future will be recognized as mechanisms for providing more than just "effective verification"; they will provide early warning and enhanced predictability, and they will offer indirect benefits in the fields of peacekeeping support, environmental monitoring and detection of drug smuggling. Future verification regimes will require new technologies for the sensors associated with NTM/MTM/ITM, seals and tags, and CW/BW sniffers, sensors and detectors. The OSI technologies, however, will have to be practical, reliable, durable, robust, stable and user friendly.

These evolving verification trends suggest several profitable areas for further research. They include:

- the identification and evaluation of possible complementary roles for verification regimes (combining, for instance, arms control, resource and environmental monitoring);
- the evaluation and formulation of potential forums (including multilateral bodies) for implementing multilateral arms control agreements and fulfilling their verification requirements;
- the assessment and enhancement of the relationship between verification regimes and the confidence-building process;
- the evaluation of the synergistic effects among NTM/MTM/ITM, co-operative measures, OSI, and CBMs within and among arms control agreements; and
- the identification of the unique verification requirements associated with
  - maritime arms control,
  - limits on space weapons (including ASATs),
  - the development of defensive doctrines and deployments,
  - nuclear materials cut-off and destruction, and
  - the transfer of advanced weapons and their associated technologies.

Effective verification will be the key to acceptance of future arms control agreements, a means of maintaining peace, a method of surveillance of less co-operative nations and a means to extend control over natural as well as man-made threats. In circumstances where international relations are friendly and co-operative, verification should proceed with a minimum of friction. If relations deteriorate, however, it is possible for an uncooperative state to use the provisions of verification as a pretext for a series of accusations that would make relations worse. Because the arms control process is both an essential part of international relations and a reflection of those relations, verification to the year 2000 will provide both significant opportunities and major challenges.

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XIV Authors' Résumés

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Chief Scientist and Deputy Director of the National Center for Security Negotiations of Science Applications International Corporation (SAIC), has had a career in U.S. governmental service spanning twenty-nine years. Between 1976 and 1979, he was Director of the Office of Strategic Research of the Central Intelligence Agency (CIA). He also served in the CIA between 1950 and 1964, starting as a guided missile intelligence analyst and becoming chief of the Guided Missile and Space Division. During 12 years in the Arms Control and Disarmament Agency, he served as Alternate Executive Officer of the U.S. SALT Delegation through SALT I, was appointed a delegate to SALT II, and then served as the first U.S. Commissioner of the Standing Consultative Commission, the body responsible for implementing the SALT I agreements. He has received the President's Award for Distinguished Federal Civilian Service. At SAIC, he manages and contributes to analysis related to national security issues involving arms control, intelligence, security and long-range resource planning. He is Chairman of the Committee on Science and International Security of the American Association for the Advancement of Science. His undergraduate and graduate degrees are from the University of Maryland.

George R. Lindsey

A Senior Research Fellow of the Canadian Institute of Strategic Studies, George Lindsey has been pursuing research on aerospace surveillance for the Canadian Institute for International Peace and Security, on strategic stability in the Arctic for the International Institute for Strategic Studies and on the recent history and future prospects for Canadian-American defence relations.

After service in the Royal Canadian Artillery in the Second World War, working on problems of the use of radar, Dr. Lindsey spent 37 years practising operational research in the Canadian Department of National Defence. During this time he worked on problems of air defence, ballistic missile defence, antisubmarine warfare, nuclear strategy and arms control. He was head of the Canadian delegation to the High Level Group of the NATO Nuclear Planning Group, and Executive Chairman of the Undersea Systems Panel of the Technical Co-operation Program involving five countries. For 20 years he was Chief of the Operational Research and Analysis Establishment.

Dr. Lindsey is a graduate of the University of Toronto, Queen's, Cambridge (obtaining a PhD in nuclear physics) and the Canadian National Defence College. He is an Officer of the Order of Canada.

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Senior Research Associate at the York University Centre for International and Strategic Studies in Toronto, James Macintosh works on issues associated with verification, the theory and practice of confidence building and the relationship between arms control and new military technologies.

Mr. Macintosh was a lecturer at York University before joining the Centre for International and Strategic Studies in 1982. He was named Senior Research Associate in charge of European Security Studies in 1985. He has enjoyed a lengthy research relationship with External Affairs and International Trade Canada's Verification Research Unit, for whom he has examined a number of verification and confidence-building research subjects. Mr. Macintosh is a graduate of York University and holds a BA and MA in Political Science.

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Arts and Sciences, University of Pennsylvania; and Academic Associate Vice-Chancellor and Associate Professor, University of Illinois. She has served as a member of the research staff of Columbia University School of Engineering and Applied Sciences and Columbia Medical School. She is a Fellow of the New York Academy of Science and a member of the American Association for the Advancement of Science Committee on Science and International Security. She is a director of CoreStates Financial Corporation, Philadelphia National Bank and First Pennsylvania Bank. She has received decorations by order of the heads of state of six countries. At SAIC she works on national security policy, treaty verification and bilateral treaty compliance issues. Her degrees and post-graduate training were taken at Michigan State (B.A.), Northwestern (M.A. and Ph.D.), Illinois and Columbia Universities.

The graphic on the back cover is based on an ancient Egyptian hieroglyph representing the all-seeing eye of the powerful sky god, Horus. Segments of this "eye in the sky" became hieroglyphic signs for measuring fractions in ancient Egypt. Intriguingly, however, the sum of the physical segments adds up to only 63/64 and, thus, never reaches the equivalent of the whole or perfection. Similarly, verification is unlikely to be perfect.

Today, a core element in the multilateral arms control verification process is likely to be the unintrusive "eye in the sky," or space-based remote sensing system. These space-based techniques will have to be supplemented by a package of other methods of verification such as airborne and ground-based sensors as well as some form of on-site inspection and observations. All these physical techniques add together, just as the fractions of the eye of Horus do, to form the "eye" of verification. Physical verification, however, will not necessarily be conclusive and there is likely to remain a degree of uncertainty in the process. Adequate and effective verification, therefore, will still require the additional, non-physical element of judgement, represented by the unseen fraction of the eye of Horus.

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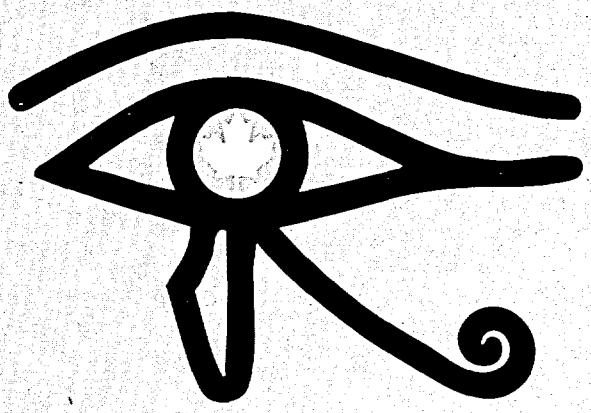

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