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Confidence Building in Northeast Asia: Possible First Steps For Cooperation on the Korean Peninsula

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1. 0 Introduction

International relations are often devoted to establishing agreements that define, control, or regulate issues of potential conflict or dispute. These agreements span a full range of national and international issues from human rights to resource allocations and national security. The scope of these agreements can vary from bilateral arrangements to global treaties or control regimes. In many cases, elements of the agreement are monitored to verify compliance or increase confidence among parties that the terms of the agreement are being met.

This article outlines options for cooperation on the Korean peninsula that could build confidence and reduce tension. The role of monitoring technology in helping to implement such agreements is also described.

2.0 Arms Control and Confidence Building in Regional Security

Since the end of the Cold War, the emphasis on regional security has increased significantly. There is a widespread perception that without the stability provided by a system of states dominated by two super-powers, local conflicts over military balance of power, resources, disputed territory and ethnic antagonisms are more likely to escalate into violent conflict. Regional wars can have global consequences, especially when the countries involved possess weapons of mass destruction.

In the last two decades, the United States, Europe and the former Soviet Union have recognized the vital role played by arms control and confidence building measures (CBMs) in enhancing security. Although some states are uneasy with the concept that arms control and increased openness can enhance their security, others acknowledge the need to decrease regional conflict, and are beginning to consider new options. By limiting the numbers and types of military equipment in European countries, the 1990 Conventional Forces in Europe (CFE) Treaty reduces the possibility that one country can surprise another with a conventional military attack. In the Middle East multilateral peace process, the Arms Control and Regional Security working group is discussing potential regional arms control and confidence-building measures. In South Asia, India and Pakistan have implemented a hotline agreement and have negotiated several other military confidence building measures such as the notification of military exercises. South

[1] Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-AC04-94AL85000.

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America has contributed to the regional arms control process with the Treaty of Tlatelolco, which prohibits nuclear weapons in Latin America, and with the quadripartite agreement for monitoring nuclear facilities among Brazil, Argentina, The Brazil-Argentina Agency for Accounting and Control of Nuclear Materials (ABACC) and the International Atomic Energy Agency (IAEA).

These regional discussions involve a broad spectrum of issues, ranging from nuclear arms control to environmental protection. In the initial stages of regional security discussions, it is important to identify issues where progress is possible. Even if the primary regional arms control concern is nuclear weapons, the first series of discussions may need to focus on less volatile issues, such as the environment, conventional weaponry, or disaster response. In regions where tensions are high, limiting armaments or ceasing controversial weapons development programs may only become possible after considerable confidence building in other areas. Table 1 illustrates potential topics for regional arms control and confidence building measures.

Table I. Potential Topics for Regional Arms Control and Confidence Building Measures

Nuclear	Conventional	Delivery Systems
Fissile material production cutoff	Demilitarized zones	Missile non-deployment
Reactor closure	Arms reductions or limitations	Missile destruction
Nuclear weapon-free zone	Pre-notification/observation of military exercises	Missile production limitations
Material disposition and safeguards	Incidents at Sea Agreements	Missile test limitations
Test limitations	Arms transfer registers	Missile ban
Nuclear emergency response	Military exchange programs	Pre-notification of missile launches

2.1 Regional Versus Global Cooperation

Many regional security initiatives occur against a backdrop of multilateral or global arms control. In such cases, the question of the relationship of the regional to the global agreement often arises. Many arms control analysts emphasize the over-riding importance of global agreements, especially those which concern nuclear issues, and stress that regional agreements should be embedded in a global context. However, regional agreements can have advantages over their global counterparts.

First, where political issues impede participation in global treaties, a regional agreement may be the only viable solution in the near term. The series of agreements between Argentina and Brazil regarding the cessation of nuclear weapon programs provides a good example.

Second, regional agreements can be tailored to meet particular concerns of regional parties. For example, a regional verification regime might be needed for a Middle East nuclear weapon free zone to supplement international measures such as those implemented by the IAEA.

Third, regional agreements sometimes can be negotiated more rapidly than global agreements. The 1991 bilateral Open Skies Agreement between Hungary and Romania and the 1989 Wyoming Memorandum of Understanding on the destruction of chemical weapons between the United States and the former Soviet Union demonstrate this point.

Fourth, some issues are purely regional in nature. While a third party may be requested to monitor compliance with agreements in some regions, such as the demilitarization of the Sinai between Egypt and Israel, the Israeli agreement to withdraw from occupied territory is an inherently regional issue.

It is important to keep in mind that participation in regional or bilateral agreements does not preclude participation in global arrangements. Indeed, a regional or bilateral regime may be a stepping stone or a necessary first step. It is possible to imagine a global nuclear weapon dismantlement program for which bilateral agreements between the U.S. and the former Soviet Union, such as START and INF, provide a starting framework.

Long-term effectiveness of regional security agreements ultimately will depend on the commitment and day-to-day involvement of regional parties. Although an external presence may remain important in many regions, it will not obviate the need for a strong indigenous infrastructure for both the development and the implementation of region-specific options for arms control and confidence-building measures. An institutional infrastructure is needed to support the analysis of policy options and the process of negotiating agreements. Implementation of agreements will also require a technical infrastructure that could include the development of monitoring technologies, a communications network for exchanging information, data analysis capabilities and trained inspectors.

2.2 The Role of Cooperative Monitoring

Monitoring often plays a role in implementing security and arms control agreements. Monitoring is cooperative when the information is collected, analyzed and shared by parties to an agreement. Cooperative monitoring provides a method of openly documenting compliance with the terms of an agreement and makes any act of noncompliance difficult to ignore. If technical tools are used to collect relevant information, the technologies must be sharable among all parties, and all parties must receive equal access to information acquired by the system. A cooperative monitoring regime also should include administrative procedures for dealing with anomalous data and false positives. Such procedures are necessary for constructively resolving disputes that may arise.

Many monitoring technologies originally developed for national security purposes in the United States and elsewhere are applicable to a broad spectrum of regional arms control and confidence-building applications. Examples of unclassified and exportable technologies are unattended ground sensor systems, aerial overflight systems, commercial satellite systems, and systems for data security and access control. When combined with data management, analysis and integration capabilities, these technologies provide powerful tools for implementing regional agreements. They enable parties to observe relevant activities, to define and measure agreed parameters, to record and manage information, and to perform inspections.

Because technology plays an important role in implementing agreements, it can be a particularly fruitful area for first steps in cooperation. Although many countries have achieved significant technical sophistication, applying technology to the cooperative monitoring of security agreements is often a new concept. For less technically advanced countries, achieving familiarity with monitoring technologies may require significant investment in education and training. Lack of knowledge about monitoring technology and procedures can undermine commitment to an agreement and impede effective use of monitoring technology. Collaborative projects by regional parties to identify and assess options for technical monitoring can be significant CBMs.

Experimental approaches to develop technology to support cooperation are constructive because they can proceed before formal agreements are in place. A cooperative monitoring experiment is a technical collaboration on collecting and sharing data relevant to a monitoring application. The object is to familiarize participants with monitoring techniques and procedures. Although valuable as a CBM, monitoring experiments can also provide information needed by negotiators during the negotiation process. Experiments provide the opportunity to investigate monitoring options in a neutral environment and adjust procedures and technologies to meet regional needs. Experience from experiments forms a base for a comprehensive agreement when future political conditions permit. Interpersonal relationships resulting from collaboration further support the confidence-building process. The experiments on sharing seismic data internationally, conducted by the Group of Scientific Experts in preparation for the Comprehensive Test Ban Treaty, is a good example of a large-scale cooperative monitoring experiment.

3.0 Application of Cooperative Monitoring Concepts to the Korean Peninsula

The Korean Peninsula is the site of one of the world's most tense military confrontations. Nearly 2 million North Korean, South Korean, and U.S. troops face each other along the 255-km long military demarcation line. CBMs, particularly military ones, that address the security needs of both countries could decrease the danger of conflict and help create an environment where a peace regime might be negotiated. In spite of the present high level of mutual distrust, steps can still be taken to prepare for future development and implementation of CBMs. The next section defines some simple and specific first steps toward CBMs that might be useful on the Korean Peninsula.

3.1 A Summary of Arms Control on the Korean Peninsula

Inter-Korean relations have been quite volatile since the 1953 armistice. Relations cycle between outright conflict and Ministerial-level agreements for cooperation. Between 1954 and 1985, North Korea made 205 arms control proposals and South Korea made 55.[2] The proposals included CBMs, operational and structural arms control, and disarmament. In some cases, the two countries offered proposals more for political propaganda purposes than for arms control. Because of the political conditions in the two countries, none of these proposals resulted in

[2] Cha, Young-Koo; *Arms Talks on the Korean Peninsula: A Korean Perspective*, Korean Journal of International Studies, XXI, Vol.2 (Summer 1990), pp. 231-248.

concrete actions. The December 1991 "South-North Agreement on Reconciliation, Non-Aggression, Exchanges, and Cooperation" (known as the Basic Agreement) appeared to be a diplomatic breakthrough. The Basic Agreement, which contains provisions for confidence building, military transparency, and operational arms control, soon stalled and is currently frozen.

There is a consistent philosophical difference between South and North Korean proposals for arms control. South Korean, European, and American analysts have examined the history of the Conference on Security and Cooperation in Europe (CSCE) process and promoted the application of CBMs and operational arms control to the Korean Peninsula. In contrast, Chung-In Moon described North Korean perspectives on arms control as being based on Europe's experience during the 1920s with little analysis of the last 20 years in Europe.[3] The South argues that confidence must be built before structural arms control or disarmament can occur. The North argues that arms reduction, primarily in the number of active military personnel, will result in increased confidence.

3.2 Opportunities For Military Confidence Building

Extrapolations of European experience to Korea should be done selectively. A feature of arms control in Europe that may have application in the Korean context is "transparency." The fundamental purpose of transparency measures is to share selected information about activities that previously were shrouded in secrecy. Transparency does not limit military activities or resources and can be part of a formal agreement or be performed on informal basis as a confidence building measure. Techniques to achieve transparency fall into two broad categories: *non-technical* (e.g., declarations, on-site observers) and *technical* (e.g., the use of sensors to monitor activity, analysis of physical samples). A side benefit to implementing transparency measures is that direct contact between adversaries helps to counter the dehumanizing effects of prolonged hostility.

James Goodby assessed the evolving South-North positions in operational and structural arms control.[4] Young-Koo Cha and Kang Choi examined transparency along with other potential CBMs for the Korean Peninsula.[5] Both studies found a number of similarities in the positions of South and North Korea. South and North Korea agree on the basic principle of constraining certain military operations and dispositions. Their differing views of the threat, however, result in very different applications of that principle. In spite of these different perceptions, the two sides agree that:

- The demilitarized zone (DMZ) should be truly demilitarized and made a zone of peace.
- Communication links should be established to avoid inadvertent conflict.
- Military exercises should be declared in advance of performance.

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[3] Moon, Chung-In; *Arms Control On The Korean Peninsula*, Yonsei University Press (Seoul, Korea), 1996, pp. 36-41.

[4] Goodby, James; *Confidence and Security Building in the Korean Peninsula: The Negotiating Agenda*, Project on Arms Control and International Security, proceedings of the American Association For the Advancement of Science (AAAS) annual meeting, Washington, D.C., June 11-14, 1992, pp. 171-194.

[5] Cha, Young-Koo; Choi, Kang; *Land-based Confidence Building Measures in Northeast Asia: A South Korean Perspective*, The Korean Journal of Defense Analysis, Vol. VI, No. 2, winter 1994, pp. 237-260.

- Both governments should mutually declare their intention to avoid the use of force.

Cha and Choi concluded that transparency measures, accompanied by some constraint measures, are the best choice for future initiatives to develop military confidence between South and North Korea. They recommended that transparency measures be introduced first because excessive secrecy about military status can damage relations by fostering even greater suspicions. Measures that provide transparency in pertinent areas of military affairs help reduce suspicions by providing opportunities for communicating non-hostile intentions.[6] Although transparency is an excellent first step to take, it does not solve all security concerns nor does it change military realities. The goal of transparency should be a balance between secrecy and the acknowledgment of legitimate mutual security concerns.

To date, North Korea is resistant to transparency in military matters. On-site inspection of military activities has been rejected as an infringement on sovereignty. Only strong international pressure convinced North Korea to provide the IAEA access to its nuclear facilities. Given the centrally controlled political system in North Korea, transparency measures that are not carefully defined may be perceived by the leadership as presenting a threat to the state. Therefore, proposals to North Korea to implement specific transparency measures should demonstrate pragmatic benefits. Including justification with the transparency proposal would help North Korea recognize the potential benefit of selective openness in military activities.

3.3 Four Conceptual CBMs on the Korean Peninsula

Relations between South and North Korea are poor but have been worse. Bilateral contacts still occur. The multilateral Korean Peninsula Energy Development Organization (KEDO) project to build nuclear reactors is progressing. South Korean companies continue to establish commercial links with the North. Military confrontation, however, remains a serious risk. Given the suspension of direct official talks between South and North, are there steps that either might take that would contribute to the long-term goal of building confidence?

Based on the analysis by Cha, Goodby, et.al. of common themes in South and North Korean arms control proposals, four conceptual transparency measures for military activities are presented here. After the presentation of the conceptual CBM, a first step that South Korea could conceivably take is defined for each option. A second step, that could become cooperative, is then defined for each option.

Communication of these first steps to North Korea is possible in spite of current political tensions. Formal diplomatic interactions are often concerned with setting legalistic precedents. For many years, North Korea rejected direct official interaction with South Korea because of the implication that it recognized South Korea as a sovereign entity. There are alternatives to traditional diplomatic communication. Third parties, including the news media, can function both as communication channels and advocates. An independent review of confidence building proposals by a credible third party may contribute to North Korean acceptance. The Internet

[6] Prvoslav, Daviniv; Opening Statement, Disarmament Topical Paper, No. 13, National Security and Confidence Building in the Asia-pacific Region (New York: UN, 1993), P.6.

offers a new mode of communication that can be performed discretely and unofficially. All the information associated with the second step of the conceptual CBMs presented in this paper can be transferred unilaterally through the Internet. North Korea could then access the information without the obligation to make comment.

The analysis of the following and other options for military transparency may present an opportunity for political confidence building. North Korean academics and technical experts might be invited to participate in a joint study of military confidence building options. Alternatively, North Korean academics could perform such analysis independently but present the conclusions in a multilateral forum.

1) ***Reduce Dangerous Military Activities In The DMZ***

ISSUE: Military incidents within the DMZ are a frequent source of tension.
CONCEPTUAL CBM: Restrict troops to observation posts in the DMZ and declare travel to those posts.
COOPERATIVE MONITORING OPTION: Use ground sensors to perform the function performed by military security patrols.
POSSIBLE FIRST STEP: Establish an experiment to assess performance and reliability of a variety of intrusion detection sensors in a realistic Korean environment.

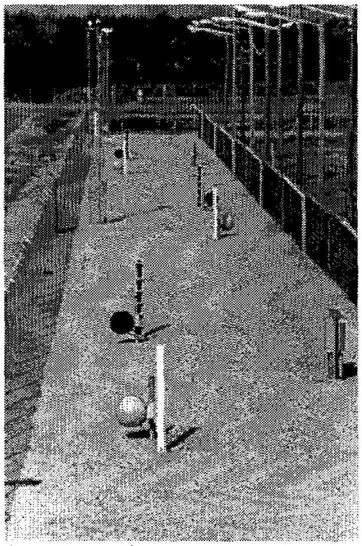

Figure 1: Example of Facility For Evaluating Ground Sensors

BACKGROUND COMMENTS:
Security patrols operate routinely in the DMZ. Military intrusions occur that violate the terms of the 1953 Armistice Agreement. Such incidents are relatively common and adversely affect bilateral relations. An accidental violation of the Armistice may be interpreted as having greater political significance than the reality. If security troops in the DMZ were restricted to observation posts, there would be far less potential for conflict between rival patrols. The security troops would continue to function as observers at the post and also form a rapid-reaction force to respond to potential violations.

An experiment in monitoring with sensors would contribute to the development of options for transparency. There are several direct benefits associated with monitoring experiments:

- Preparation of options for a time when future political conditions are more favorable
- Development of indigenous technical capability
- An opportunity to assess operational issues in monitoring
- Increased confidence with monitoring technology and procedures

The experiment should operate for an extended period (6 months to a year) to evaluate the effect of climate and aging on the monitoring hardware. The experiment should also test alternative modes of communication to transmit data to a monitoring center for evaluation.

POSSIBLE COOPERATIVE STEP: Establish communication links with interested parties and share data from the experimental system.

This step would serve to acquaint the North Koreans with cooperative monitoring and transparency. An impartial review of the experimental system and test results by a credible party should make the transparency option seem more realistic to North Korea. The independent review might encourage North Korea to participate in future experiments.

2) ***Transparency in the Storage of Heavy Weapons***

ISSUE: Uncertainty about the location and status of heavy weapons raises concern about aggressive intent.
CONCEPTUAL CBM: Declare heavy weapons in storage sites and announce when weapons leave or enter.
COOPERATIVE MONITORING OPTION: Monitor the perimeter around a storage site to detect and report the movement of heavy weapons leaving or entering.
POSSIBLE FIRST STEP: Establish an experimental system at a realistic site to assess sensor system performance and reliability.

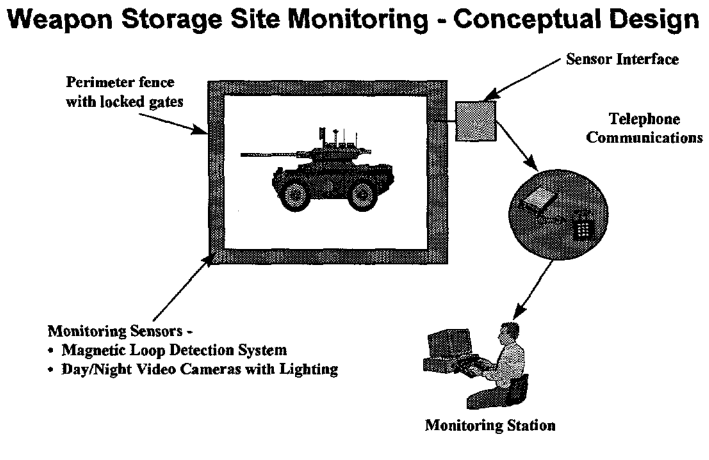

Figure 2 Diagram of System For Monitoring Weapon Storage

BACKGROUND COMMENTS:
The status and location of heavy weapons (e.g., tanks, artillery, rocket launchers) are a security concern. The uncertainty is that an exercise or routine military movement may transform into an attack. A declaration of pending movement is a declaratory CBM. This cooperative monitoring option supports the declaration by providing transparency into the location and status of heavy weapons. The number, capability, or ability to use these weapons are unaffected. Canada pioneered monitoring concepts for stored weapons as a NATO-Warsaw Pact CBM in Europe.

The strategy for this experiment is similar to the previous one for intrusion detection. The type of monitoring sensors will be different but the experimental system should operate for an extended period to evaluate performance and reliability. Credibility in distinguishing significant events from unimportant background activity and reporting that information to a monitoring center is important.

POSSIBLE COOPERATIVE STEP: Establish communication links and share data from the experimental system with interested parties.

The strategy is the same as with the previous option for dangerous military activities. Third parties could again perform the role of neutral reviewer of the experimental system.

3) ***Transparency in Military Movements***

ISSUE: Military movements raise concerns about preparations for attack.
CONCEPTUAL CBM: Permit regularly scheduled or challenge aerial overflights to monitor ground activities.
COOPERATIVE MONITORING OPTION: Install commercially available sensors on an unarmed aircraft.
POSSIBLE FIRST STEP: Perform analysis of sample imagery to determine what capability is necessary to monitor activities of concern.

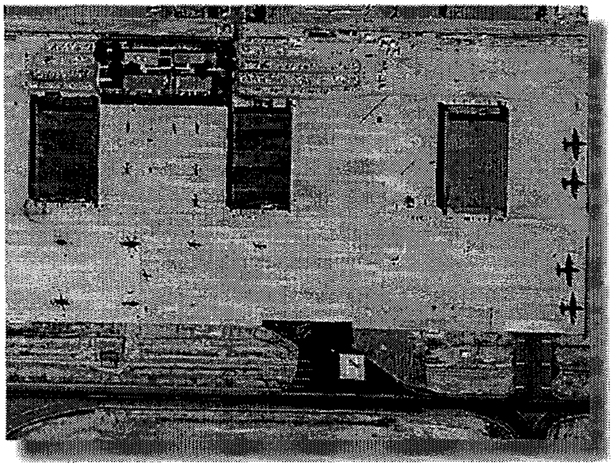

Figure 3 Example of Aerial Photographic Image With Resolution of the Open Skies Treaty

BACKGROUND COMMENTS:
Large military training maneuvers and movements are destabilizing when there is a low level of trust between countries. Permitted aerial overflight provides a means to implement transparency without restricting capability. Aerial monitoring is less intrusive and creates fewer political implications than ground-based sensors or observers. The *Open Skies Treaty* between members of NATO and the former Warsaw Pact and the 1991 bilateral agreement between Hungary and Romania are useful precedents. Several papers have investigated the concept of cooperative aerial monitoring in Korea.[7, 8]

A country contemplating the use of aerial monitoring needs to understand what technical capability is necessary to make a substantive contribution to transparency. A useful first step would be to assess various methods of aerial sensing to decide which ones should be used. While optical image resolution is a function of the capabilities of the optics and the altitude of the aircraft, the Open Skies regime permits no better than 30-cm resolution. Although the Open Skies Treaty is frequently cited as an example, the monitoring techniques used were negotiated specifically for that treaty. The Open Skies Treaty should not be viewed as either the only technical approach or as an upper limit of sensor capability. Airborne monitoring equipment is available commercially today that has greater capability than that agreed during Open Skies negotiation. Higher resolution synthetic aperture radar is particularly pertinent to the Korean environment because rain, snow, fog, and haze are frequently present.

POSSIBLE COOPERATIVE STEP: Publish and distribute analysis of sample imagery.

The concept of permitted and reciprocal aerial overflight for monitoring is not beyond the realm of possibility since North Korea opened three commercial air routes over its territory in 1996. Even if motivated solely by financial remuneration, this action is unprecedented in North Korea's history.

South Korean publication of the sensor study and imagery analysis would contribute to North Korea's understanding of this option for transparency. The document could be directly or indirectly distributed to North Korea for review. Third parties can again play a useful role as independent reviewers of the analyses.

The United States performed a similar project for the Open Skies Treaty. The Defense Special Weapons Agency (DSWA) produced a book containing actual imagery along with a description of the monitoring equipment and procedures used to collect the images.[9] The United States

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[7] Koo, Bon-Hak; *Open Skies in the Korean Context*, proceedings of the Arms Control in the North Pacific Workshop, Royal Roads Military College, Victoria, B.C., Canada, Feb. 19-21, 1993, pp. 128-141.
[8] Smithson, Amy; Cheon, Seong; *"Open Skies" Over the Korean Peninsula: Breaking the Impasse*, Korea and World Affairs, Spring 1993, pp. 57-77.
[9] Defense Special Weapons Agency (formerly the Defense Nuclear Agency), Arms Control & Test Limitation Division, 6801 Telegraph Road, Alexandria, Virginia, USA, *Open Skies Imagery Portfolio*, published November 1994.

distributed the book to interested parties to increase understanding of the Treaty and provide a reference tool.

4) ***Transparency in Missile Production***

Transparency measures are potentially applicable to topics as controversial as the production of long-range missiles. Both South and North Korea have an interest in ballistic missile production. The U.S. has held bilateral talks with North Korea on missile development, production, and sales with the goal of persuading it to accept the guidelines of the Missile Technology Control Regime (MTCR).[10] The 1980 ROK-U.S. missile development agreement restricts South Korean missiles to a maximum range of 180 km. South Korea has cited the need to modernize its aging ballistic missile force for defensive purposes. This program would involve indigenous development and production. After meetings with ROK representatives in 1996, the U.S. has indicated that it would relax the restrictions of the 1980 agreement and support South Korea's entry into the MTCR.

ISSUE: Production of long-range missiles raises regional concern about aggressive intent.
CONCEPTUAL CBM: The MTCR does not limit domestic deployment of long-range missiles or reduce regional concerns about their use. A significant CBM would be for both South and North Korea to renounce the possession and production of long-range missiles. Long-range missiles could be defined by the MTCR guideline of 300 km. Under this assumption, production of the North Korean SCUD-B missile and the proposed replacement for the South Korean NHK-2 missile could conceivably be permitted. North Korean Production of SCUD-C, No Dong, and Taepo Dong missiles would be banned.
COOPERATIVE MONITORING OPTION: Install sensors at production facility gates to distinguish between short and long-range (i.e., over 300 km) missiles.
POSSIBLE FIRST STEP: Conduct a study to define the physical characteristics of missile systems that comply with the range restriction and assess how these characteristics can be detected and measured by sensors.

BACKGROUND COMMENTS:
Monitoring technology, given appropriate intrusiveness, can successfully monitor missile production. The 1987 Intermediate Range Nuclear Forces (INF) Treaty between the U.S. and the Soviet Union provides a useful precedent for the selective monitoring and inspections of missile production facilities. Intrusiveness is the key factor in any missile production monitoring system. A study to identify and define the physical characteristics of missiles consistent with the 300 km range limitation would permit production monitoring options to be identified and proposed.

POSSIBLE COOPERATIVE STEP: Publicly demonstrate options for monitoring missile production identified in the study with a functional model.

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[10] The MTCR was created in 1987 to define common export guidelines for missiles and related technologies. The original threshold for control was ballistic missiles and unmanned aerial vehicles capable of delivering a 500 kg payload to a range of 300 km. In early 1993, this threshold was lowered to include any missile believed to be intended to deliver a nuclear, chemical, or biological warhead.

A "laboratory-scale" experimental model to demonstrate the procedures and technologies of a conceptual missile production monitoring system is a way to correct misconceptions. It will also demonstrate how much intrusiveness would be present and how much transparency can be achieved. The U.S. built a detailed and functioning table-top model of a proposed system to monitor missile production as an orientation tool. The model was shown to the Soviets during the negotiation of the INF Treaty (see Figures 4 and 5). National leaders benefit from an intuitive understanding of the role of monitoring and the INF model was demonstrated to President Reagan in 1987.

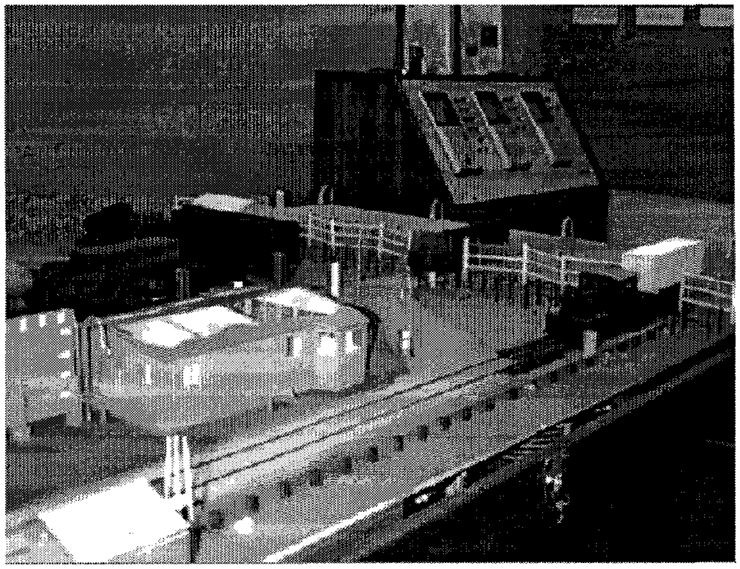

Figure 4: A Functioning Table-Top Demonstration Monitoring System For Missile Production

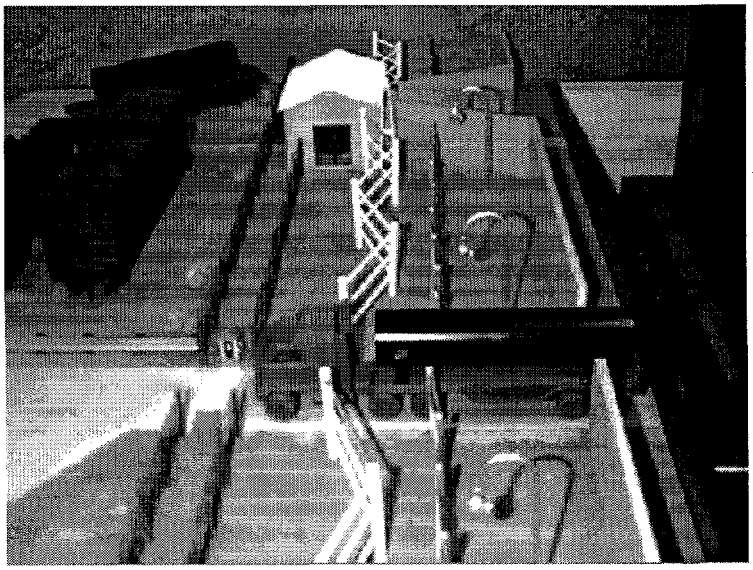

Figure 5: A Close-up Of Monitoring At A Production Facility Gate

4.0 Conclusions

Cooperation among countries in Asia will be needed to reduce tensions and to solve security problems. Arms control and confidence building measures, both international and regional, could play a role in reducing threats of nuclear proliferation and conventional military conflict. Developing an infrastructure to support cooperation will be a complex technical and political challenge because there is little tradition of openness about national security activities. In addition, countries in the region have relatively little experience with technologies for implementing cooperative agreements. This is changing as many will be participants in international agreements that require verification, such as the Chemical Weapons Convention and the Comprehensive Test Ban Treaty.

Cooperative monitoring offers an opportunity for countries to engage in meaningful collection and exchange of information that can increase transparency and reduce tensions. Without credible information about relevant activities in other countries, arrangements will not reduce tensions or alleviate concerns. On the contrary, they could form the basis for countries to accuse each other of violations and thereby actually increase the potential for conflict.

A number of regional security analysts see opportunities for constructive measures to decrease military tensions on the Korean Peninsula. To date, political conditions have not permitted the successful negotiation and implementation of any significant measures. This chapter presented four conceptual options for CBMs with first steps that could evolve into South-North cooperation. These concepts for military CBMs are intended to stimulate discussion and require further study.

Parties can experiment with cooperative monitoring concepts to achieve transparency before entering into either a formal or informal relationship. Experiments familiarize participants with both the procedures and technology for monitoring and can be a form of confidence building themselves. Collaborations can provide neutral ground for interaction among technical communities and produce results that will aid national leaders in the implementation of potential future agreements. Collegial relationships that develop among participants can also contribute to confidence.

Progress in building confidence is more likely to occur when all parties understand they will not necessarily be worse off as a result of implementing military transparency. Explanation of key concepts and assumptions should be included with proposals. Alternative means to formal diplomatic exchanges, such as the use of the Internet, now exist and may permit a quiet, yet effective, process of information exchange and consensus building.

Appendix A - Principles and Technology of Cooperative Monitoring

Cooperative monitoring is the process of obtaining and sharing of agreed information among the parties to an agreement.[11] It makes use of technologies that are shareable among all of the parties to the agreement. This means that the technologies that collect, display, or analyze the data are not classified and are exportable to interested countries. The data collected as part of a cooperative monitoring agreement are equally accessible to all of the parties to the agreement. In addition, procedures should exist for addressing anomalies in the monitoring information. In that way, questions can be resolved to avoid escalation of concern that could lead to armed conflict.

There are many examples of cooperative monitoring systems, including formal treaty verification systems as well as less rigorous confidence-building measures. The systems may consist of inspections or sophisticated sensor and data processing equipment accessed remotely. These systems are not limited to arms control or military applications, but also may monitor a wide range of other regional concerns including natural resources, commerce and trade, the environment, or emergency response issues.

In each case, establishment of a cooperative monitoring regime is a process. There is no single monitoring solution. To evaluate monitoring options it is first necessary to establish a framework. The diagram and discussion which follow present a model for evaluating the role of monitoring systems in addressing a variety of applications.

Framework for Cooperative Monitoring

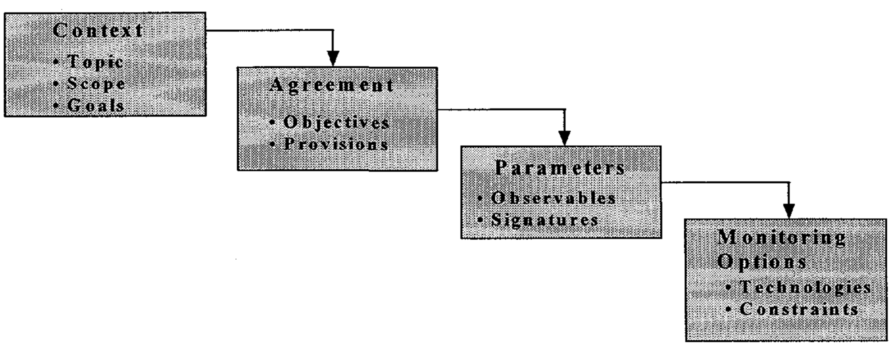

Figure 6

Context

The framework begins with a context for undertaking security or confidence-building measures (CBMs). The context has several elements that include:

[11]Biringer, Kent. L.; *Cooperative Monitoring: A Framework for Issues Analysis and the Role of Technology*, Sandia National Laboratories, VST-75, May 1996.

Topic–This is the subject of interest.

Scope–The scope of the agreement addresses the region, the number of parties involved, the time frame, and the extent to which the agreement will apply.

Goals–These are the high-level purposes for which an agreement is being considered. These high level goals will become more specific when incorporated in the agreements that are to be implemented.

Agreement

A desire for improved relations will eventually lead to specific agreements. The agreements, whether formal treaties or less formal CBMs, have certain objectives and provisions intended to achieve the goals established in the context. In addition to specifying the contextual elements described above, the agreements contain:

Objectives–All agreements, treaties, and CBMs have a stated purpose or objective. These objectives may:

- set limits or restrictions on objects or activities.
- provide mechanisms for transfer of information, thereby reducing uncertainties or perceived threats.
- promote or enhance relationships among the parties to the agreement.

Provisions–The objectives of the agreement are expanded in the detailed provisions. The provisions describe, for example:

- the types of control proposed,
- the objects controlled by the agreement, and
- the phase in the life cycle of the objects at which they become subject to the agreement.

Agreements may specify provisions for format and frequency of communications. Other provisions may include quantity, performance characteristics, physical dimensions, location, or operational doctrine.

Parameters

The next step in defining a monitoring system identifies specific parameters of the agreement that are measurable.

Observables–Observables are those items in the agreement that lend themselves to being monitored and observed. These may include objects, activities, processes, or movements.

Signatures–Signatures are the specific physical characteristics of the item, object, or process being observed. They may include optical and thermal characteristics, chemical composition, acoustic patterns, nuclear isotopic composition, or other measurable parameters associated with the observation. These signatures allow sensor systems to detect and classify differences between the items observed.

Monitoring Options

Once the objectives and provisions of an agreement have been determined and the monitoring parameters defined, a wide range of monitoring system options are possible using different types of monitoring technology. Other factors such as cost, manpower, redundancy, timeliness, data and hardware security, power requirements, sensor function and display, environmental conditions and vulnerability need to be assessed. In addition, the level of access or intrusiveness permitted under the terms of the agreement will affect the possible monitoring systems.

Although the chart shows the cooperative monitoring framework as a single flow path, there may be feedback loops as well. Understanding monitoring options and limitations may result in a need to modify the original agreement to establish provisions that can be monitored.

Generally, increasing the level of monitoring will lead to increased confidence that the agreement is being followed. All systems are subject to some level of uncertainty. However, by including redundancy in key components, utilizing different sensor detection phenomenologies, performing vulnerability analyses, and having extensive coverage, high levels of confidence can be achieved. Confidence is as much a political issue as a technical one. The political tone set by national leaders, along with their willingness to provide needed openness, is critical to the success of cooperative technical monitoring systems and procedures.

Cooperative monitoring systems supplement rather than replace other national means of data collection, including intelligence means. Ultimately, each nation will use the entire set of shared and private data to determine treaty compliance.

A wide range of monitoring options can be incorporated into the terms of an agreement, ranging from no monitoring provisions to extensive technical monitoring options. Human inspectors are a key element of many agreements. Baseline inspections may be included as a formal part of an agreement to establish and confirm initial agreement declarations. Agreements may also require regularly scheduled inspections or less frequent challenge inspections. Other inspections, known as elimination inspections, may be required to ensure that items to be eliminated under the terms of the agreement have been destroyed or otherwise eliminated.

Finally, permanently manned or unmanned monitoring may be possible under terms of an agreement. This monitoring may take place within a facility or outside from the ground, air, or space. These different monitoring options represent different levels of intrusiveness.

In addition to intrusiveness, other constraints, shown in the following table, influence the design of the monitoring regime.

Considerations in Monitoring System Design	
Cost and Personnel Constraints	Installation and training
Confidence Level	Redundancy
	Different sensor phenomenologies
	Timeliness
	Security and data authentication
Intrusiveness	Inspections (challenge or scheduled)
	On-site sensors
	Remote Sensing
Sensors	Functions: detection, screening, assessment
	Operational parameters: alarms, reliability, maintenance, exportability, environmental conditions, power requirements
System Integration	Communications
	Hardware and software compatibility

Table 2

Monitoring system costs include not only the financial costs of hardware associated with design, deployment, and operation, but also the manpower requirements or limits associated with the system. The level of confidence required for the system will depend on the specific concerns addressed by the agreement. The more critical the information, the higher the requirement for redundancy in numbers of sensors and use of multiple sensor phenomenologies. Timeliness and security of the data are other variables affecting the system design.

Similarly, the functions expected of the technical monitoring system will affect the level of system complexity and choice of sensors. Sometimes it is sufficient for sensors to detect activity and to sound an alarm. People can then respond to the detection alarms. In other cases, it may be desirable for the monitoring system to screen detections to only report significant events. For example, sensors could distinguish between military vehicles and animals that pass a point and report only the vehicles detected. Screening not only detects the presence of an object but measures other parameters such as weight or magnetic characteristics. The final level of system sophistication is item identification. In this case, a camera or other sensor system specifically identifies the detected item.

Many other parameters affect sensor operations and performance. These include the false alarm rates of the sensors and systems as well as the probabilities of not detecting a relevant event. Reliability measures, maintenance efforts and expense, and environmental operating conditions also help establish criteria for appropriate monitoring system design and choice of components.

Individual components need to be integrated into an operational system including an assessment of system vulnerabilities. This introduces an additional set of design and cost considerations, including the need to communicate between sensors, to transmit data to a central control point on-site or away from the site, and to provide power for the system. Software to manage the sensors and data collection system is another important element in system integration. Data security can be addressed in several ways. Data authentication provides a means for ensuring that data have not been altered. Data encryption provides codes that scramble the information and require decoding to read the data.

Monitoring Technologies

Many technologies can be used in different cooperative monitoring agreements. This section describes some of the categories of technology for consideration in cooperative monitoring.

A. Physical Security

Physical security sensor systems are designed to control, monitor, and record movements of vehicles, people, or objects. These systems may be designed for exterior or interior application and are used extensively in the monitoring and protection of both government and private facilities. Fig.7 shows some examples of physical security sensors. These include fences to control entrance or exit from a protected facility, camera systems to record images periodically or when triggered by other sensors, and ground sensors to measure seismic, magnetic, infrared, or other signatures of the presence or movement of objects or people. Agreements requiring assessment of activities or materials in a facility might make use of such systems in a monitoring regime.

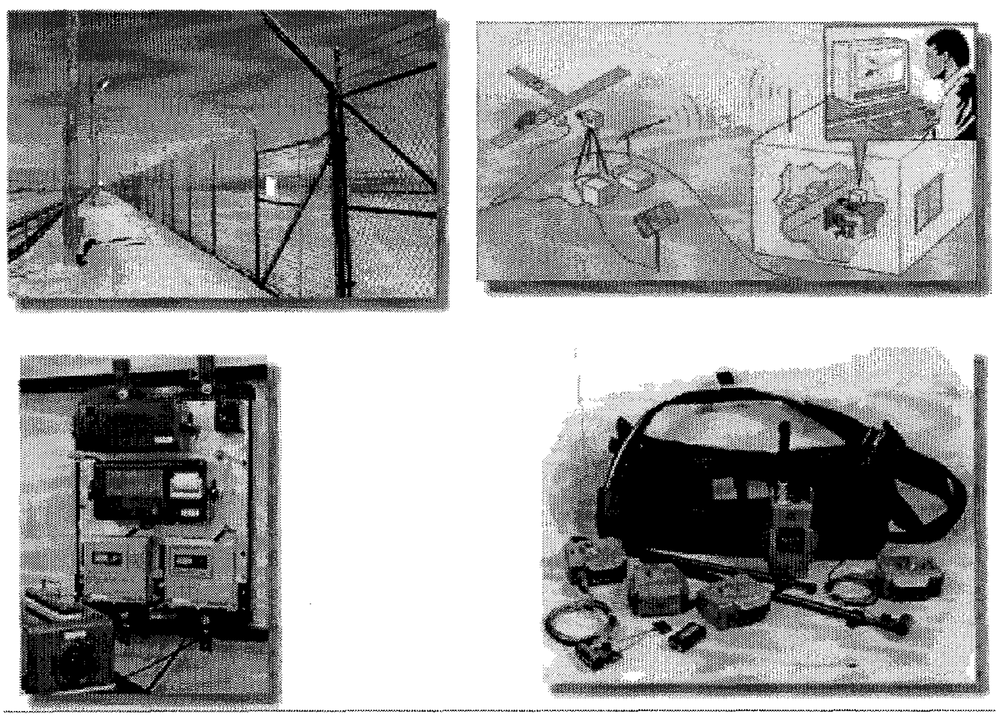

Fig. 7 Physical Security Sensors

B. Access Control and Delay

Access control and delay technologies limit timely access into secure or controlled facilities. In its simplest form, access control can be simply a locked door to an off-limits area. With increasing levels of sophistication, access control can include more complicated locking mechanisms that require codes, cards, or unique signatures associated with those permitted access. One example of such a system is the hand geometry reader shown in Fig. 8. Both an access code typed on a key pad and a measurement of hand dimensions are required to enter. Other systems known as "man traps" are small booths with locking doors that can isolate someone wishing to enter a secured location. An individual entering the booth provides some form of identification to an operator electronically connected to the booth, and then someone else opens the next door to allow the individual to proceed into the controlled area.

Delay technologies impede the progress of an unauthorized person seeking entry or doing something in a controlled area. Fig. 8 shows two examples of such systems. Pyrotechnic smoke obscurant can quickly fill an area with smoke, making visibility and breathing difficult for a would-be intruder. Large concrete barriers, requiring special equipment to move, can limit access to a facility if placed in front of access doors.

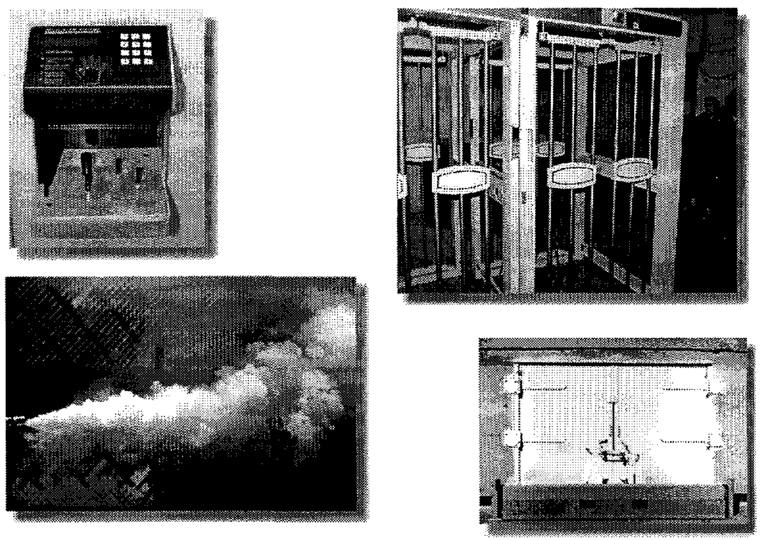

Fig. 8 Access Control and Delay Technologies

C. Tags and Seals

Tags and seals are useful in arms control as well as many commercial applications. These technologies can uniquely identify items controlled by an agreement. A tag is affixed to the object of interest to identify the item. A seal is used to authenticate whether an item previously closed has been opened or altered. In either case, the objective is to provide a unique identifier for the item that cannot be easily modified or replaced and can be useful in identifying and controlling objects. Both passive and active tags and seals are available. Passive tags have a unique identifier that is inspected periodically to confirm compliance with an agreement and helps to ensure that items inspected or monitored are the same items that were previously inspected. Active tags and seals transmit data about the condition of the seal to allow continuous status checks of the item being monitored.

Fig. 9 shows several examples of passive seals. These include a special plastic wrap that has a unique pattern that can be placed around objects and shrunk in place by application of heat. The uneven shrinking of the *heat shrink seal* creates a pattern on the plastic film that can be recorded for comparison with future seal inspection reports. The *reflective particle tag* uses small reflective particles embedded in an epoxy compound that is applied to the surface of the monitored object using a special template. By shining light on the tag at various angles, unique reflection patterns are obtained that "fingerprint" the specific item tagged. Seals that use fiber-optic technology, such as the *Cobra seal*, can be used to secure containers, doors, or other objects to permit detection of any opening or tampering with the items so sealed. The seal uses a fiber-optic cable. When the seal is placed, fiber strands within the cable are intentionally cut and a random pattern of light transmission in the different fibers is created. This pattern is extremely difficult to duplicate. A change in the light pattern reveals a broken or tampered seal. These seals are used by the International Atomic Energy Agency (IAEA) in tagging nuclear storage containers. Finally, the *sample vial secure container* makes use of a unique pattern in the thermoplastic vial to identify uniquely the fluid samples containing nuclear material placed within the vial.

Not shown are active seals that transmit the status of the seal electronically. Such seals may also use fiber-optic cables in which changes in the transmitted light through the fibers will result in an alarm indicating possible seal tampering or damage.

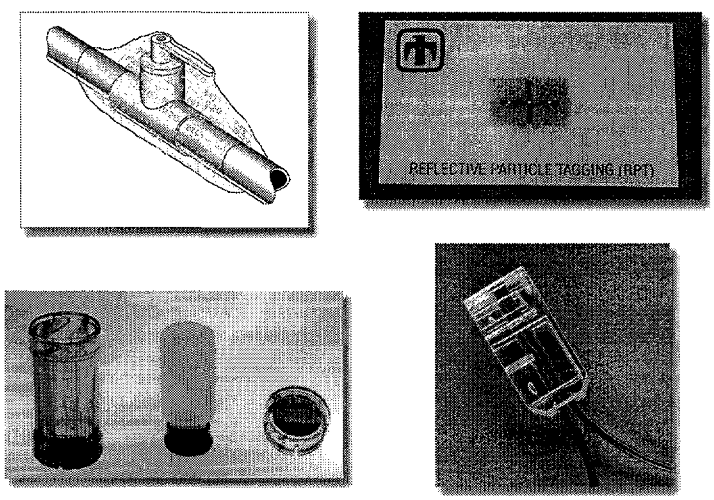

Fig. 9 Tags and Seals

D. Satellite Imagery

Satellite imagery is a way to perform wide-area monitoring. While satellites have long been available to only a few countries, extensive opportunities for the use of commercial satellite imagery now exist. There is a delay in obtaining the data from commercial satellites. Although useful for cooperative monitoring, commercial satellite images are not timely and could not be used to track quickly changing events. In addition, satellites are limited in their revisit times, that is, the time it takes to fly over the same area at the same time of day for consistency in imagery.

Fig. 10 shows three examples of satellite images of the Albuquerque area. Both the resolution and the spectral detection characteristics of satellite imagery are important.

The U.S. Landsat image has a resolution of 30 meters. Discernible objects in this image have a dimension of about 30 meters. The image records seven different spectral bands. These different bands permit viewing of the image in various combinations that reveal information not visible to the human eye. These images are frequently used to assess agriculture and mineral resources and can detect new industrial facilities.

The second image, from the French SPOT satellite, has a higher 10-meter resolution but lacks the spectral detail available from Landsat. This higher resolution permits a finer level of assessment of activities and facilities being monitored.

The bottom image is from the Russian KVR-1000 satellite, which produces black and white images with 2-meter resolution.

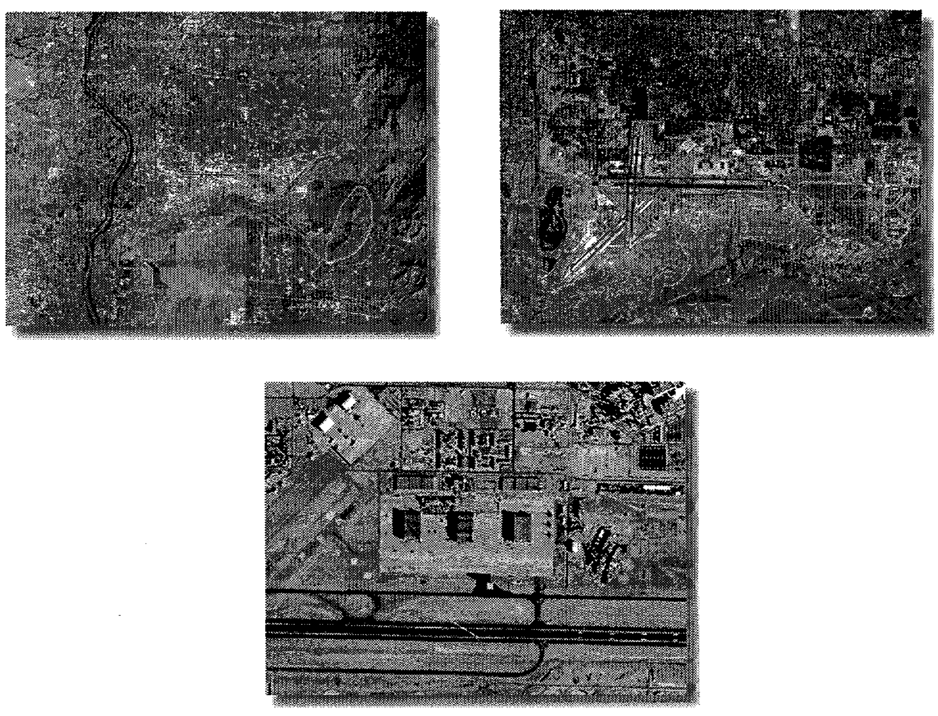

Fig. 10 Commercial Satellite Imagery Of Albuquerque, New Mexico, USA

E. Aerial Imagery/Open Skies

Imagery from aircraft can be used in the monitoring of agreements. The 1992 Open Skies Treaty is based on cooperative aerial monitoring. Sensors based on aircraft can be quickly dispatched to monitor terms of an agreement and can achieve much higher resolution than is available from space-based platforms. However, they must have permission to fly over or near the objects of interest. The Opens Skies Treaty has provisions for optical and video cameras (30 cm resolution), synthetic aperture radar

(SAR, 3 m resolution), and infrared scanners (50 cm resolution). SAR will image objects using electromagnetic signals that permit night and bad weather capabilities not possible with visual imaging systems.

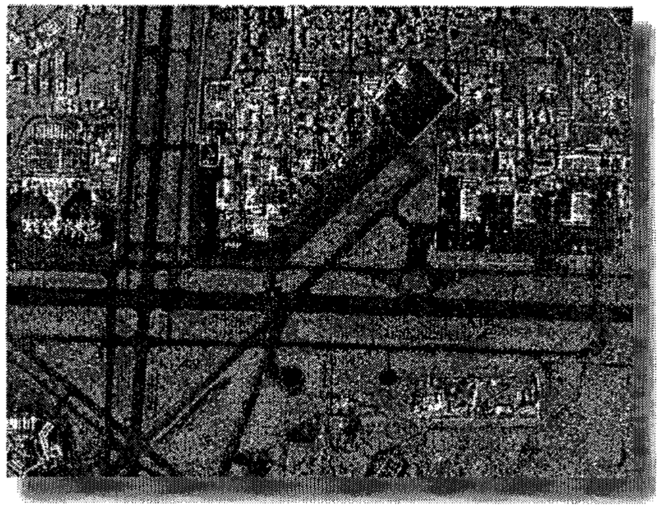

Fig. 11 Example of SAR Image With Open Skies Treaty Resolution

F. Seismic Monitoring

Seismic monitoring is an important arms control technology. Large-scale seismic systems have been used for decades to measure underground nuclear testing and earthquakes. Seismic sensors, placed in the ground record, the patterns of earth motion created by explosions or earthquakes. A sample seismic profile, a map of seismic events, and examples of seismometer hardware and monitoring stations are shown in Fig.12. On a smaller scale, seismic sensors can also be used to measure localized ground motion caused by vehicles on roads or people walking along paths. These smaller scale systems are useful as part of the physical security technology described earlier.

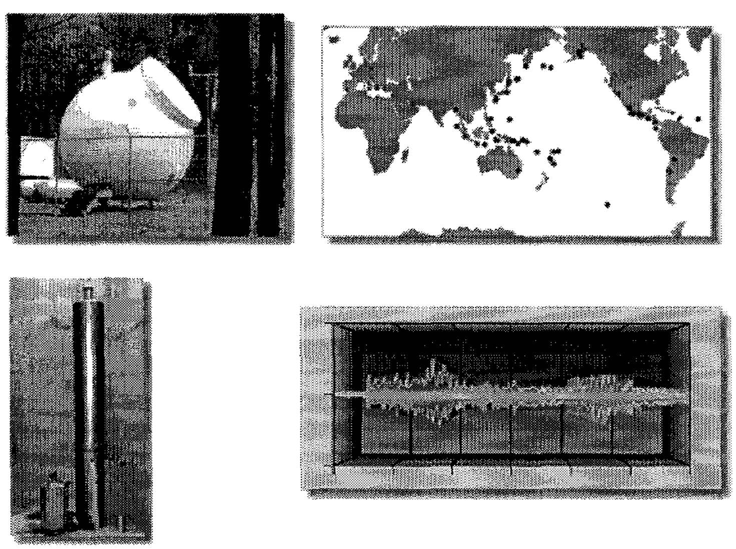

Fig. 12   Seismic Monitoring Technology

G. Other Arms Control Technologies

Many other technologies are useful for arms control. Fig.13 shows a geographical information system tool that can be used to evaluate facilities subject to on-site inspections. The tool can be used to characterize the facility and then to plan and track inspections carried out at the facility.

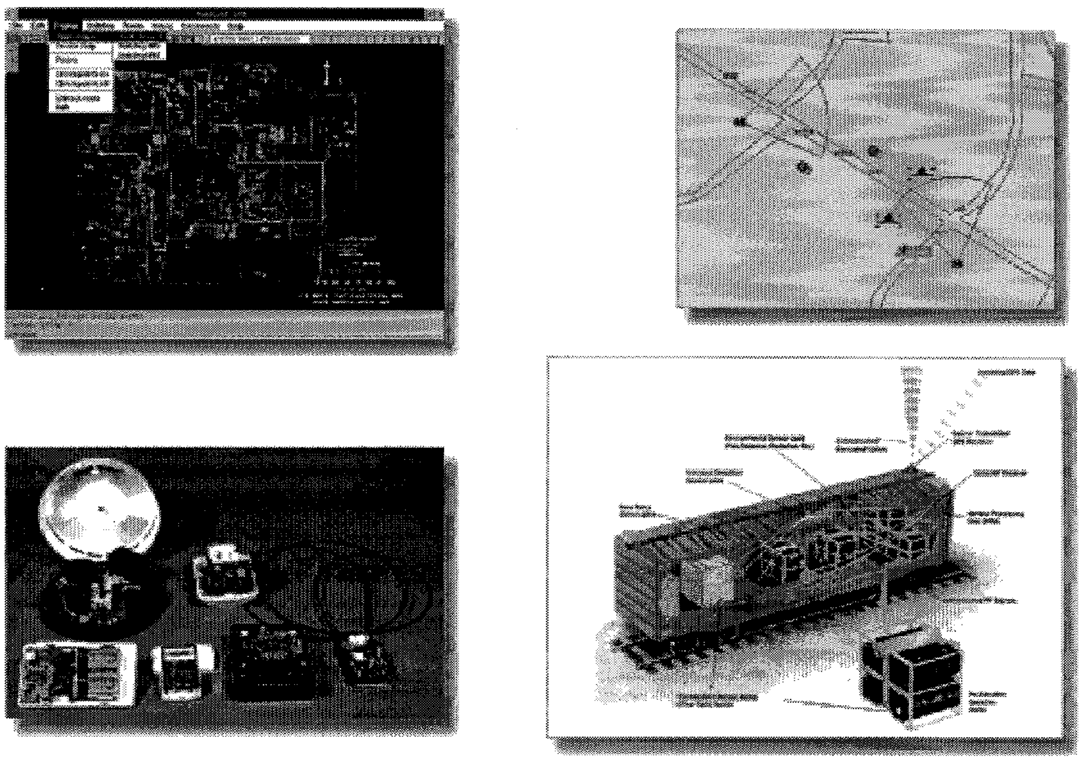

Fig. 13 Other Monitoring Tools and Systems

Other computer tools can be used to design the layout of monitoring sensor systems while others provide authenticated sensor reporting to a control center. By adding a location capability, such as can now be achieved with the global positioning system receivers, it is possible to track shipments of equipment or materials in near real time, anywhere in the world. These examples do not exhaust the monitoring possibilities. Technologies ranging from nuclear and chemical detection sensors to flow and pressure measuring technologies can also support specific applications.