Chapter 1

# Overview

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# OVERVIEW

## Introduction

On May 12, 1989, President George Bush took a page from the history of the 1950s and called for establishment of an Open Skies regime. His proposal echoed and amplified the failed 1955 Open Skies proposal of President Dwight D. Eisenhower, calling for mutual overflights of sovereign territories to provide common assurance as to the benign (or at least inoffensive) intentions and capabilities of the signatory nations. In its current incarnation, the Open Skies Treaty is being negotiated by the countries of the North Atlantic Treaty Organization (NATO) and the members of the now formally dissolved Warsaw Treaty Organization (WTO). Under conditions to be specified in the treaty, freed-wing airplanes equipped with special sensing devices would fly over the territory of each treaty party in turn to provide a clearer picture of the status of the nation overflown.

The revival of Open Skies has also drawn attention to other uses for cooperative aerial surveillance in international agreements. (Open Skies is just one possible manifestation of cooperative aerial surveillance.) The idea of using cooperative overflights as a tool of international policy has not been completely dormant since the 1950s: it has been applied successfully in isolated instances (e.g., the Sinai and Antarctica[2]) and is currently being negotiated into a side agreement of the Conventional Armed Forces in Europe (CFE) Treaty.[3] But the acceptance of Open Skies negotiations, particularly by the Soviets, has led to a renewed willingness of governments to consider mutual overflights as a means of gathering information to promote a variety of goals, from confidence building and weapons counting to pollution monitoring and invasion warning.

The collection of information about other countries has historically been of great importance. In the case of the United States in the post-World War II era, government officials were particularly concerned about the growing Soviet threat and tried to obtain as much information about the Soviet Union as they could. President Eisenhower in 1955 sought to fill some of this informational void through his proposed Open Skies. However, Soviet secretiveness and continued rejections of cooperative measures led the United States to spend billions of dollars developing unilateral capabilities to collect information about the Soviet Union, especially regarding military preparations. These capabilities ranged from an early-and not particularly successful-use of camera-carrying weather balloons snapping pictures at random,[4] through airplanes (e.g., the U-2 of Francis Gary Powers), to those current collection practices (e.g., photoreconnaissance satellites),[5] known in an arms control context as national technical means (NTM) of verification. The superpowers may find in cooperative overflights unique qualities that could—under proper circumstances--supplement their NTM. Less technically advanced treaty partners that have not had the luxury of knowing as much about the world around them as the superpowers may look to cooperative aerial surveillance as a partial remedy.

During the late 1980s the opportunity, and to some extent the need, for cooperative aerial surveillance grew. Primarily, this was a result of "new thinking' and 'glasnost' in the Soviet Union-the necessary prerequisites for what President Bush has heralded as the dawning of a "new world order. "

[1]The principle of a state possessing sovereign airspace over which it, and it alone, has control was established by the 1919 Paris Convention. The Chicago Convention of 1944 superseded the Paris Convention and provides the basis for modem international civil aviation. See Allen V. Banner, Andrew J. Young, and Keith W. Hall, *Aerial Reconnaissance for Verification of Arms Limitation Agreements: An Introduction (New* York, NY: United Nations, 1990), pp. 15,30.

[2]Overflights of Antarctica do not violate sovereign airspace. Ibid., p. 22.

[3]The CFE Treaty itself contains limited provisions for brief helicopter overflights. The side agreement, dubbed ' 'CFE IA," will, if agreed to, permit much more extensive and intrusive aerial observations.

[4]See Merton E. Davis and William R. Harris, *RAND's Role in the Evolution of Balloon and Satellite Observation Systems and Related U.S. Space Technology (Santa* Monica, CA: The RAND Corp., September 1988).

[5]"Photoreconnaissance satellites have become an important stabilizing factor in world affairs in the monitoring of arms control agreements. They make an immense contribution to the security of all nations.'—President Jimmy Carter, in a speech at the Kennedy Space Center, Oct. 1, 1978.

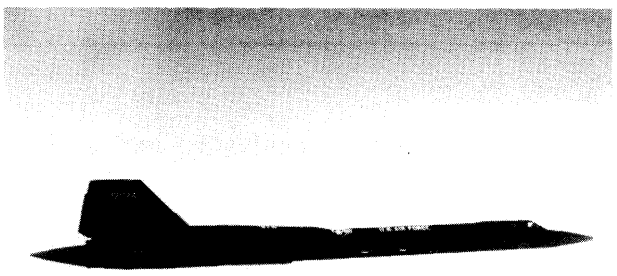

*Photo credit: U.S. Air Force*

**The once-supersecret SR-71A Blackbird reconnaissance jet used high altitude and record-breaking speed to avoid interception as it gathered information for the U.S. defense and intelligence communities. The SR-71 A was taken out of service in 1990.**

During the late 1980s, the Soviet Government, under the direction of President Mikhail Gorbachev and then Foreign Minister Eduard Shevardnadze, developed a new foreign policy that emphasized cooperation over confrontation and realism over dogma. Not only did this policy loosen the Soviet grip on Eastern Europe and lay the groundwork for settlement of regional disputes, it also led to the negotiation of more extensive mutual confidence and security agreements. Cooperative measures, e.g., on-site inspections (OSIs) and cooperative aerial surveillance, which had previously been rejected by the Soviet leadership as overly intrusive, were declared acceptable. However, the optimism that crested in 1990 has ebbed in 1991. While Eastern European countries remain free, concerns have been raised in the international community about slowed withdrawals of Soviet troops, evidence of bad faith regarding the recently signed CFE Treaty,[6] and grumbling among Soviet reactionaries about "who lost Eastern Europe. " Inside the Soviet Union, these same elements seem to be promoting a reassertion of Stalinist norms: iron discipline, restricted speech, militarism, and an antagonistic foreign policy.

In this environment where cooperation and competition coexist, negotiated agreements may:

- reduce tensions and build mutual confidence;
- . limit, restrict, and reduce armaments;
- . stabilize regional trouble spots;
- . settle outstanding disputes; or
- provide for the monitoring of new environmental standards.

Without cooperation, no agreements would be possible, and if there were no concerns, no agreements would be necessary.

Cooperative aerial surveillance, if applied appropriately, could be a useful instrument for implementing some agreements and might add unique capabilities to the tool box that already includes NTM and cooperative measures, such as OSIs.

Americans, in concert with others, may someday be able to fly aircraft through the airspace of the Soviet Union and other countries on a reciprocal basis, taking pictures and collecting other data that will contribute to a more secure future. This report explores the many potential uses of cooperative aerial surveillance in international agreements and provides a basis for evaluating its applicability, effectiveness, and costs.

## Summary of the Report

**The** Open Skies Treaty, which is being negotiated by members of NATO and the now disbanded Warsaw Pact, is intended to be primarily confidence-building measure to reduce international tensions and foster trust and goodwill. Although there has been some talk of Open Skies flights assisting in the monitoring of other agreements, the provisions being negotiated are largely designed for their symbolic effect.[7] In contrast, the possible inclusion of extensive and intrusive aerial surveillance measures in a CFE follow-on agreement (CFE IA) would augment other means of verification in determining compliance with the CFE Treaty limits.

This report examines the application of cooperative aerial surveillance to these and other possible international agreements. Although the report often focuses on agreements that include the United States and the Soviet Union, the discussion is applicable to

[6] See, e.g., "Figures Row Suspends C'FE, " *Jane's Defence Weekly, Mar. 2,* 1991, p. 290. The outstanding CFE issues now appear resolved.

[7] The Open Skies negotiating partners released a joint communique on Feb. 13, 1990 stating that Open Skies overflights "would contribute to the process of arms reduction agreements and existingobservation capabilities." However, the parties have not as yetspecified any agreements that Open Skies will support. (" 'Open Skies' Communique," *Official Text,* U.S. Arms Control and Disarmament Agency, Feb. 13, 1990.)

production plant) or they may be elusive (e.g., a mobile missile). They may be available for viewing at known times (e.g., weapon eliminations or the display of SS-25 launchers and sliding-roof garages provided for under the Intermediate-Range Nuclear Forces (INF) Treaty); or they may be spotted on a catch-as-catch-can basis (e.g., underground nuclear tests, which airborne "sniffers" could monitor for radiation leaks banned under the Limited Test Ban Treaty). The object being observed may, in fact, be an entire facility, perhaps closed as the result of an accord. If instituted, aerial monitoring flights are most likely to be included in arms control agreements, but they might also be used to monitor civil agreements (perhaps governing pollution levels). All these flights are intended to observe compliance with the provisions of an agreement, and through this observation deter, detect, and warn of significant violations. Aerial monitoring may also be used to assist other means of monitoring, such as NTM and OSI. Aerial monitoring could take three

any combination of participants and to any region of the globe.[8] Conceivably, overflights might even be conducted by international organizations in much the same way OSIs are executed by the International Atomic Energy Agency. "Cooperative aerial surveillance" describes a collection of concepts for using sensors on airborne platforms as an important element of bilateral and multinational agreements. A party to an agreement providing for aerial surveillance would allow overflights of its territory in exchange for rights to similar flights over the territories of the other parties.[9]

Cooperative aerial surveillance, while generally thought of as involving only airplanes and cameras, could take many forms. Possible choices for aerial platforms include airplanes, helicopters, unmanned aerial vehicles, or lighter-than-air craft such as blimps. Sensor choices include photographic, electro-optical, and radar imaging devices, as well as radio receivers, air samplers, radiation or magnetic anomaly detectors, and acoustic devices. Different sensors' strengths and weaknesses make them suited to different inspection tasks, and the output of these sensors can be synergistically combined to let them see into one another's blind spots.

Cooperative aerial surveillance could be the subject of a stand-alone agreement in which the flights are both the means and the objective (as in Open Skies); it could be one provision among several supporting the ultimate goals of an agreement (as in CFE); or it could be the basis for an agreement that supports the goals of another agreement that does not itself provide for equivalent overflights (as in CFE IA).

Cooperative aerial surveillance has three main uses: mutual confidence building, aerial monitoring of specific targets or activities, and collateral information gathering (see figure l-l). Confidence about another country's intentions and capabilities can be built when two or more states work cooperatively and open themselves to outside scrutiny. The Open Skies Treaty is an example of an agreement whose primary purpose would be to build confidence among the signatories.

"Aerial monitoring," as distinct from confidence building, is the process of observing from the air specific objects or specific activities (defined in terms of changes in or movement of discrete objects). These objects and activities may be found at known (perhaps declared) locations (e.g., a

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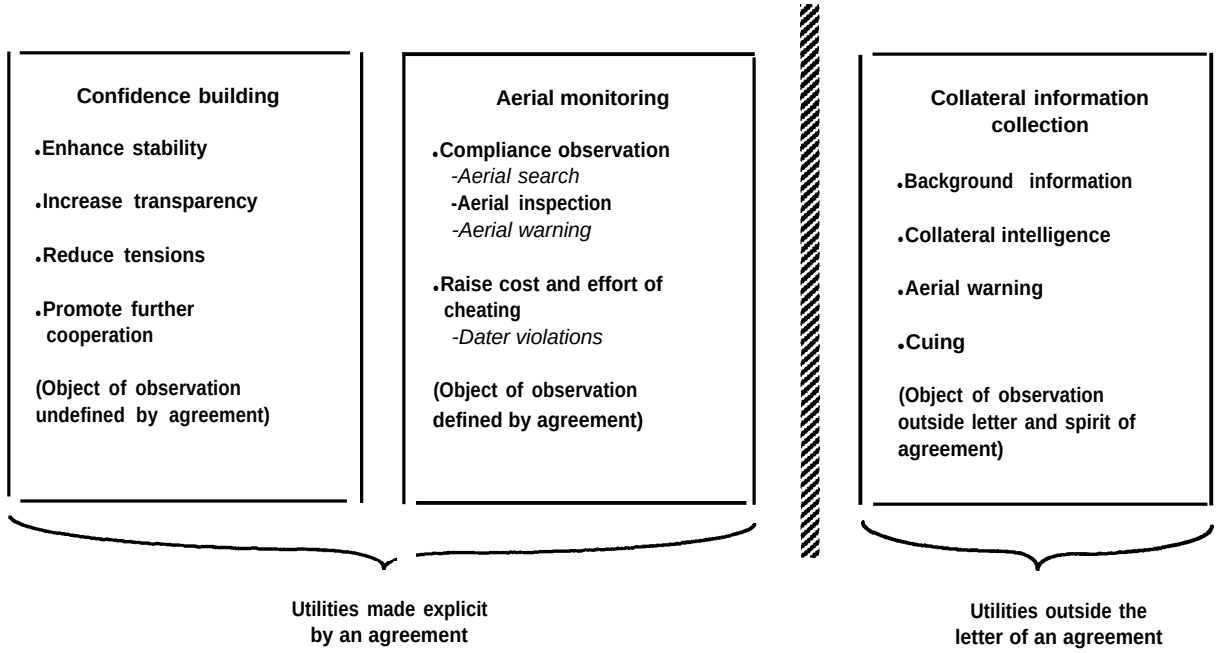
[8]For example, in May 1991 Hungary and Romania signed a bilateral aerial surveillance agreement calling for four overflights a year of each country. *The Arms Control Reporter: A Chronicle of Treaties, Negotiations, Proposals, Weapons, and Policy* (Brookline, MA: Institute for Defense and Disarmament Studies, 1991), p. 409.B.25.

[9]Military and intelligence flights over or parallel to the borders of a noncooperative nation are not included in this discussion.

**Figure I-l—Utilities of Cooperative Aerial Surveillance**




SOURCE: Office of Technology Assessment, 1991.

forms: aerial search (looking for restricted objects or activities over a broad area); aerial inspection (observing objects or activities at designated inspection sites, as well as developing an overall assessment of the site); and aerial warning (alerting observers to threatening developments).

Aerial searches are intended to survey wide areas in order to provide information that will assist policy makers in making a determination of compliance with an agreement. These searches have two aspects: one is to locate and document legal objects and activities; the other is to detect objects or activities that violate an agreement. Even if aerial searches are unable to provide concrete evidence of violations, they might collect useful information that could be used to plan ground inspections or NTM observations.

Aerial inspection flights might resemble aerial searches over small designated sites or they might be used to:

- establish baseline counts and documentation of **treaty-limited** items (TLIs);
- conduct preparatory work for OSIs by developing site maps and pinpointing the most promising search strategy;[10]
- document the elimination of large TLIs and monitor their status; [11]
- monitor the status of closed-out facilities and bases; or
- monitor the perimeter around a facility before an OSI team can arrive.

Besides monitoring the number or existence of certain objects and activities, aerial monitoring might provide warning of potentially hostile acts. This warning might result from discovering too many objects, too much activity, or the presence of objects and activity at restricted sites. Conversely, the absence of legitimate objects or activities at designated areas might constitute warning that they are somewhere more threatening. Functionally similar to aerial searches or aerial inspections, aerial warning flights could observe compliance with military exclusion zones, border restrictions, or

[10] Amy Smithson and Michael Krepon, "Streng~e@ the Chemical Weapons Convention Through_ Monitoring, " Occasional Paper No. 4, The Henry L. Stimson Center, Washington, DC, April 1991, pp. 15, 18-25.

[11] IFo~e-pie, under the SALT II Treaty, retired bombers were cut up and placed out in the open so that NTM satellites could verify their elimination.

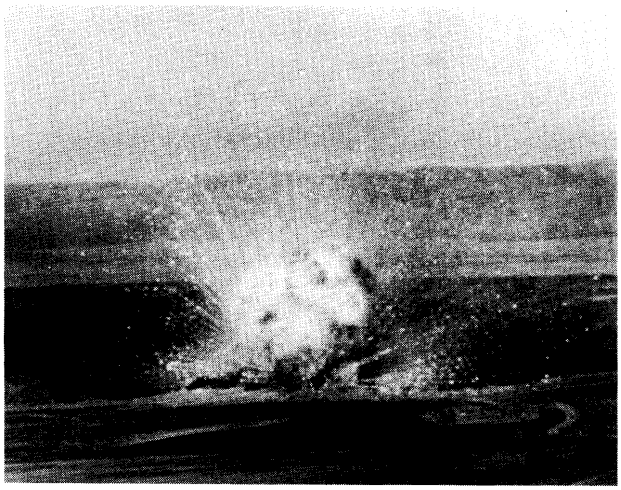


*Photo credit: U.S. Department of Defense, On-Site Inspection Agency*

**In a spectacular display, a Soviet SS-12 missile is eliminated by explosion in accordance with the INF Treaty.**

military exercise limitations (and in fact aerial surveillance already has been used this way, for example, in the Sinai).

Overflights could also be used to gather information beyond the letter and spirit of an agreement. Indeed, the gathering of some such information would be hard to avoid. The use of this collateral information could support the stated goals of the agreement, or it could serve other intelligence purposes, e.g., strategic assessment, targeting, and general warning. Because of fears of spying, negotiators may seek to limit the gathering of collateral information to an absolute minimum by placing restrictions on overflights and the equipment carried aboard. Controlling the costs associated with the loss of collateral information to a military, political, or even economic adversary may be more important to a country than the financial costs of an overflight regime.

The advisability of agreeing to aerial surveillance would depend on the goals of the agreement in question, the capability of overflights to accomplish the missions set for them, a comparative analysis of different combinations of information-gathering options (e.g., NTM and OSI), and the costs and benefits of the overflights. Potential aerial surveillance regimes can range from the purely symbolic to complete openness with correspondingly high intrusiveness.

An understanding of cooperative aerial surveillance issues can be useful to Congress because:

- Two agreements that may include cooperative aerial surveillance (Open Skies and CFE IA) are under negotiation, though talks are currently stalled. The Senate may be asked for its advice and consent on one or both of these, and the Congress as a whole will be asked to fund any implementation.
- Cooperative aerial surveillance is a relatively new form of information gathering that maybe useful as a supplement to NTM or other cooperative measures (e.g., OSI). As such, it could be incorporated into a wide variety of current or future international accords governing anything from arms control monitoring and border patrols to radiation and pollution measurements.
- A study of aerial search, in particular, illuminates some of the complexities inherent in all types of searches. This knowledge, therefore, provides a basis for evaluating search by NTM.
- Witnesses testifying before Congress on the topic of arms control treaty verification are often pressed to quantify what they mean by such statements as 'If the Russians cheated, we would be 90 percent sure of catching them, given enough time." Though most such estimates are impressionistic, and best taken as figures of speech, some have a possible empirical basis. In the context of aerial search, this report illustrates how such estimates could be generated and interpreted.

This report addresses both the diplomatic and the technical aspects of cooperative aerial surveillance as a tool of international cooperation, and it builds a foundation for evaluating the costs, benefits, and effectiveness of aerial surveillance regimes. In particular, it examines the possible provisions currently being negotiated for overflights in the Open Skies and CFE IA treaties,[12] which may have much in common procedurally and technically when the actual provisions are agreed upon.

Unlike arrangements that might focus on building confidence alone, an aerial *monitoring* regime lends itself to rigorous analysis. The selection of aerial platforms and sensor suites and the monitoring

[12]Neither treaty was completed at the time of this writing, and drafts of each remain internal executive branch working documents, unavailable to legislative branch staff (and thus OTA) until signed by the President.

procedures can all be optimized for the targets in question.

Important points in the negotiation of an agreement to permit aerial monitoring would include limitations on the number, frequency, and territorial scope of overflights. Negotiators might also agree to restrictions on the capabilities of sensors and data storage. They would need to create an inspection protocol that recognized and limited the potential for camouflage, concealment, and deception before a flight can arrive.

The chances that aerial monitoring will function as hoped are lessened by the difficulties presented by the task of discriminating illegal targets (e.g., covert missile launchers) from legitimate ones (e.g., flatbed trucks), the potential mobility of the targets, and the desire to detect cheating before it becomes significant. Under some plausible restrictions, aerial monitoring could be so perfunctory as to be of symbolic value only—perhaps providing a false sense of confidence. At the other extreme, flights that provide much useful information might be too intrusive to tolerate.

As noted above, aerial monitoring of treaty compliance could perform search, inspection, or warning functions. Chapter 6 and its associated appendices A, B, and C apply quantitative analysis to one of those functions: aerial search.[13] Focusing on this one mission permits OTA to illustrate:

- how quantitative methods can be applied to the larger problem of estimating confidence levels in our ability to find treaty violations if they exist;
- how comparisons could be made among various monitoring options to produce more cost-effective monitoring regimes; and
- the importance of applying multiple, complementary instruments to monitoring tasks.

In the case of a wide-area search, any single flight--even a relatively intrusive one-would be unlikely to catch a treaty violation, for several reasons. First, the overflown party might not be cheating (perhaps as a result of the prospect of overflights). Second, if the overflown party is cheating, the illicit objects or activities would probably be restricted to a region that is relatively small when compared to the nation as a whole: because of the limitations of the airborne platform, any one flight could probably cover only a small percentage of the territory subject to overflights. Without knowing where to look, the probability of finding the violation would be relatively small. Third, given sufficient prior notice and information about how a flight is to be conducted, the cheater could take steps to minimize the chances of being observed through camouflage, concealment, or deception, so that violations would be missed even if they were inside the region inspected by a flight.

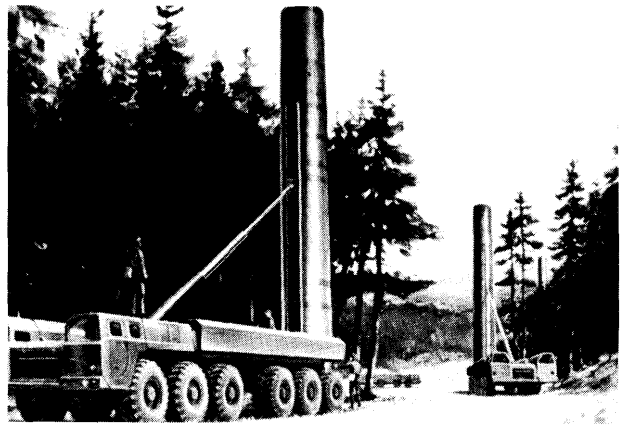


*Photo crefit: U.S. Department of Defense*

**The existence of small, off-road-capable, mobile missile launchers, like this Soviet SS-20, has made the task of monitoring covert deployments more difficult. SS-20s have been eliminated as part of the INF Treaty.**

To be reliable, a program of aerial search would need a series of flights to compensate for the relative unlikelihood that any one flight would catch a violation if it existed. Prior information about the characteristics of the target could narrow the region to be searched and thus lessen the reliance on chance alone. Several kinds of prior information can be helpful: the results of previous aerial searches; the outputs of other information sources, e.g., NTM, OSI, and other types of aerial monitoring; the natural constraints provided by topography and weather, as well as the additional constraints imposed by infrastructure; and a sense of the overflown side's operational practices and doctrine. The full use of such prior information is one of the skills of the *photointerpreter,* an artisan whose craft remains largely unautomated.

[13]Note that aerial warning is closely related to aerial search and that many of the same principles apply.

The most difficult part of using information gathered by aerial search (or, indeed, any other means) in treaty verification is deciding what to make of a continuing stream of reports that no cheating has been found. *Bayesian statistics,* a recently revived[14] body of early statistical thought, allows the incorporation of such negative evidence into a continuously updated view of the situation. Bayesian calculations make possible the form of expert testimony that decisionmakers want most: "Based on the fact that we haven't seen any cheating, on the probability that we would have seen it if it were going on, and on our original estimate of how likely it was that they would cheat, we assess that there is an x percent chance that they are violating the treaty. '

Although the prospective Open Skies Treaty is primarily intended to build mutual confidence among its signatories, it is also presented by some of the participants (and indeed, the aforementioned joint communique) as helpful for monitoring provisions of other, particularly arms control, agreements. As an illustration, OTA applied the publicly released Open Skies overflight provisions to the task of monitoring Soviet mobile missiles of the types covered by the Strategic Arms Reductions Talks (START). OTA's analysis, while preliminary, suggests that the number of flights would be far too few to make an exhaustive search of the Soviet Union. However, their measurable chance of uncovering a sizable violation—should it exist—in a matter of months would loom large in the minds of Soviet planners. The chances that flights would find a violation—should it exist-would be raised if the use of prior information obviated the need for exhaustive search of the entire Soviet Union. Flights could cue NTM as well as be cued by them.

The mobile missiles limited by START are not the only possible items of interest to arms control treaty verifiers. Some other topics, e.g., the location and status of declared sites, the absence of undeclared freed facilities, and the location or movement of large-scale military formations, could be readily investigated by a program of aerial monitoring. Nor is the utility of overflights limited to search-for example, flights could aid in the monitoring of START or START-like provisions by loitering over the site of a challenge inspection while an OSI ground team was on the way, or provide clues as to the best locations to conduct such inspections.

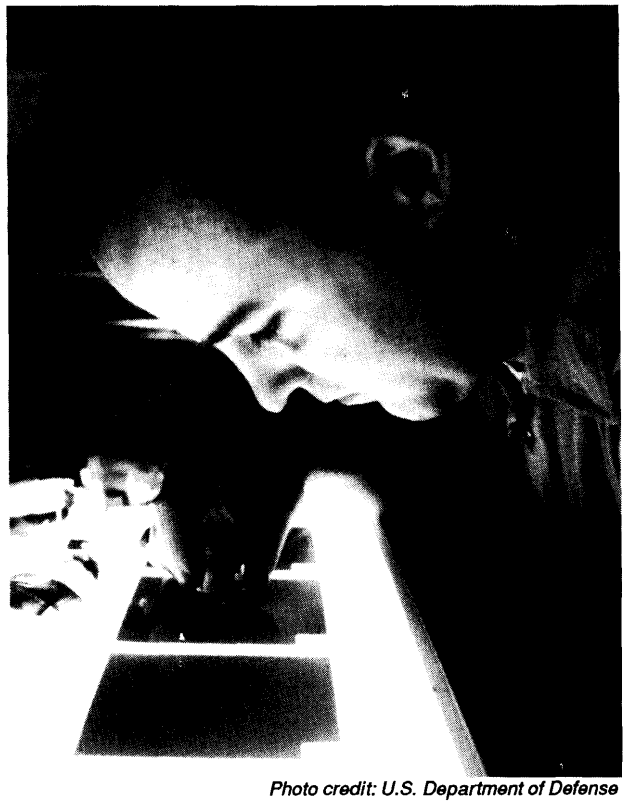


*Photo credit: U.S. Department of Defense*

**After data has been gathered by an aerial surveillance flight, the arduous task of sifting, sorting, and analyzing the data commences. In the case of imagery, highly skilled photointerpreters must carefully examine each frame for valuable information.**

## Organization of the Report

Chapter 2 of this report presents an overview of the utilities of cooperative aerial surveillance-both good and bad—and discusses the interaction of cooperative aerial surveillance with other means of information gathering, most notably NTM and OSI. Chapter 3 surveys the types of airborne platforms and sensors that might be applied to a prospective overflight regime and raises some of the issues associated with their use. In chapter 4, Open Skies is discussed as both the source of renewed interest in using overflights as an instrument of international relations and as a prime example of the use of cooperative aerial surveillance as a means of build-

[14] M.G. Bulmer, *Principles of Statistics* (New York, NY: Dover, 1979), pp. 169-176, especially p. 176. See also Steven M. Stigler, *The History of Statistics: The Measurement of Uncertainty Before 1990* (Cambridge, MA: Belknap Press, 1986).

ing international confidence. Chapter 5 looks at other possible applications of cooperative flights in agreements designed, inter alia, to build confidence, monitor arms and environmental restrictions, and safeguard borders. Through a discussion of the capabilities and limitations of broad area search, chapter 6 builds an analytical framework for evaluating overflight monitoring regimes using quantitative methods and Bayesian statistics. The first three appendices to this report continue the quantitative discussion. The final appendix records NATO's initial Open Skies proposal.