DISCUSSION

A. The Soviet Program for the Acquisition of Western Technology

Organization of the Program

1. The basic Soviet motivation behind the acquisition of Western technology [2] is to increase the military power of the USSR, advance the state of the art of its military technology, and modernize key industries. This motivation has been evident since the early 18th century. Today, however, the Soviet program for the acquisition of Western technology is more extensive, better coordinated, and more precisely targeted than ever before. (U)

Coordination and Supervision Organs

2. The Soviet effort is highly centralized and under the overall supervision of the top political leadership (see figure 1). The military orientation of the Soviet technology acquisition program is reflected in the dominant role played by the Military-Industrial Commission (VPK). This organization is responsible both for coordinating the development and production of Soviet weapon systems and for supervising the acquisition and assimilation of military and advanced dual-use Western technology. The VPK coordinates the requirements of 12 major ministries. These are the nine key defense-industrial ministries and the Chemical, Electrical Equipment, and Petroleum Refining and Petrochemical Ministries. These are the principal customers for Western military-related and dual-use technology. The VPK also coordinates the activities of the seven principal collectors who service those requirements. CIA Statute

3. Assisting the VPK in coordination of the Western technology acquisition program is the Technical Center of the All-Union Institute for Inter-Industry Information (VIMI)—an organization subordinated to the State Committee for Science and Technology (GKNT). The Technical Center acts as the central clearing house for technology and information acquired by the collecting agencies and for requirements and reports submitted by the industrial ministries to the VPK. The center is thus involved in almost every important stage of the technology acquisition cycle. CIA Statute

4. The Interagency Commission on Intelligence Information is another organ that may serve a coordinating function. 25X1 but it apparently assists in supervising the assimilation of Western technology. This suggests that it acts as an arm of the VPK. Its membership may include representatives from the Main Armament Directorate of the Ministry of Defense, the Defense Industrial Ministries, and the key Soviet collectors. CIA Statute

Collectors

5. The Soviets regard all acquisition of equipment and science and technology (S&T) information from the West in support of VPK requirements as an intelligence operation, regardless of the collectors or collection mechanisms used. Consequently, the Soviets designate as intelligence collectors the GKNT, the Academy of Sciences, the State Committee for Economic Relations (GKES), and the Ministry of Foreign Trade—in addition to the State Committee for Security (KGB), the Main Intelligence Directorate (GRU) of the Soviet General Staff, and the intelligence services of its East European allies. CIA Statute

6. Directorate T of the KGB is responsible for that organization's S&T collection effort abroad. Directorate T has approximately 1,000 officers in the USSR and in foreign countries. KGB foreign residencies with S&T missions have a component designated as Line-X, which is manned by Directorate T specialists. Line-X officers conduct the majority of the KGB's S&T collection operations. There are some 300 Line-X officers serving in foreign countries. 25X1
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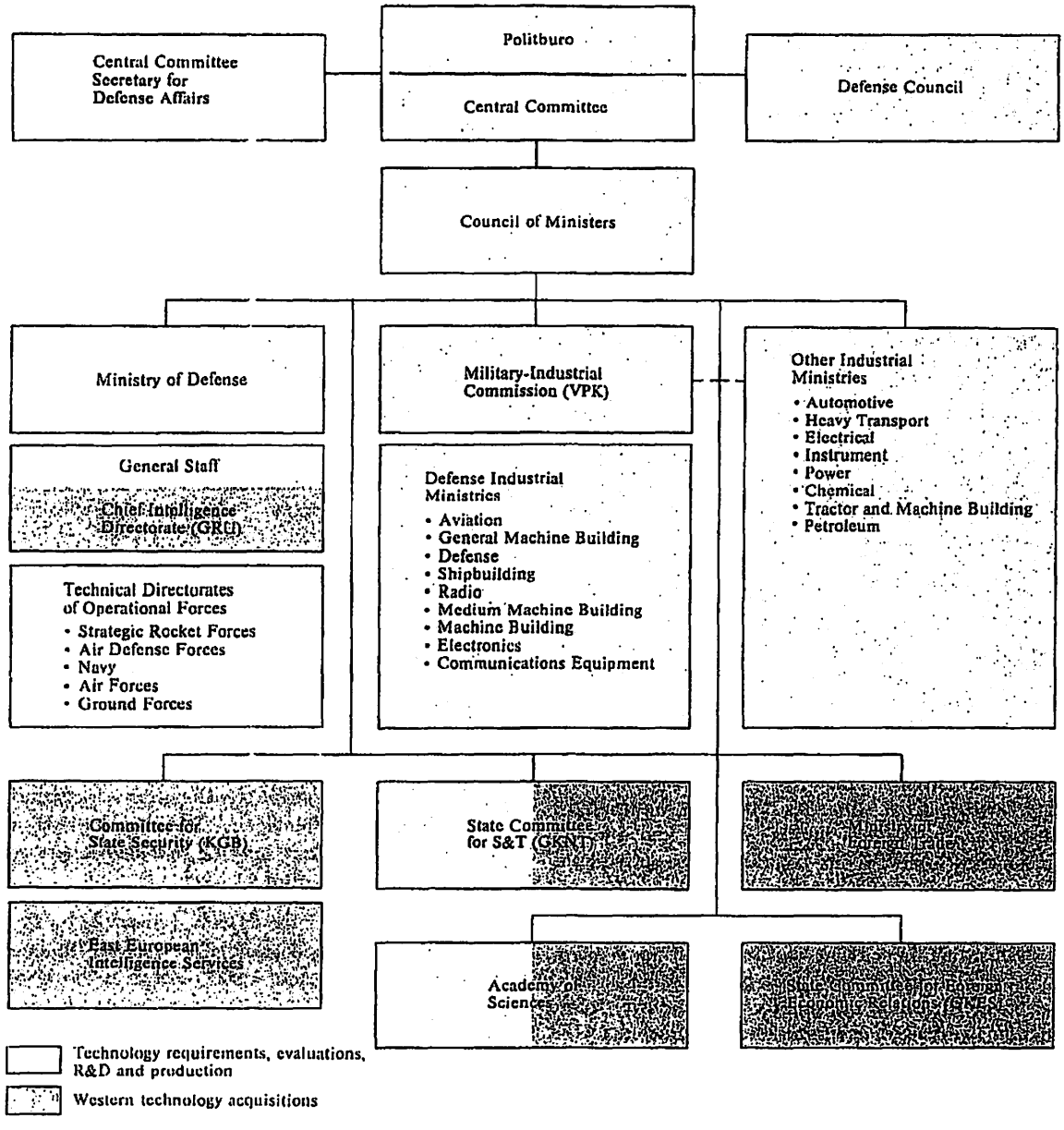
[2] While there are numerous interpretations of technology for weapons, it is defined in this report as the application of scientific knowledge, technical information, know-how, critical materials, keystone manufacturing and test equipment, and end products that are essential to the research and development as well as the series manufacture of modern high-quality weapons and military equipment. Western technology is defined as that technology developed by the Free World. (U)

Figure 1
Key Organizations Contributing to Soviet Military R&D and Production and the Acquisition of Western Technology



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7. In contrast to the KGB, the GRU has no dedicated cadre of career S&T specialists. Instead, all GRU officers (most of whom have technical backgrounds) collect S&T intelligence as part of their overall responsibility. 25X1
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8. Many Soviet requirements for the acquisition of Western technology are closely coordinated among the intelligence services of Moscow's East European surrogates. The Soviets value highly the S&T collection activities of these services and often will provide their East European allies with increased economic or military aid in return for US and other Western technology they have acquired. CIA Statute

9. Since the Western post-Afghanistan embargo on technology transfers to the the USSR, the Soviets have increased their use of the East European intelligence services to acquire Western technology. 25X1
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10. The Soviet intelligence services and their East European surrogates are the major collectors of Western technology directly related to the Soviet space program. We believe that in the late 1970s the most useful technology acquired by the intelligence services concerned missile, aircraft, and space technology. These acquisitions included classified military items, export-controlled technology and equipment, company proprietary technology, and, especially, S&T information in the public domain. CIA Statute

11. The Soviet intelligence services work closely with the GKNT and the Academy of Sciences in acquiring Western technology. The GKNT is the key player in arranging S&T agreements with Western countries in order to facilitate access to and acquisition of key technology. This organization also oversees the allocation of scarce Soviet hard currency for the legal purchase by various Soviet organizations of selected Western technology for military purposes. CIA Statute

12. If the GKNT is unable to acquire the necessary technology by open or legal means, it tasks Soviet intelligence through the VPK to acquire the technology. High-ranking KGB officers supervise the GKNT's foreign S&T collection program. Control is exercised mainly through the GKNT's Main Administration for Scientific and Industrial Cooperation, which is headed by a KGB general. CIA Statute

13. Most basic research in the Soviet Union is done in the research institutes of the Academy of Sciences. Over the past 20 years the number of the Academy's workers engaged in military research has increased more than fivefold. Recognizing the high prestige and excellent reputations of the Academy's scientists in the Western scientific community, the Soviets are pressing the exploitation of the Academy's exchange programs with Western universities and research centers to acquire sensitive scientific information. 25X1
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14. The State Committee for Foreign Economic Relations (GKES) also works closely with the GKNT and the Academy of Sciences in collecting foreign technology. It is primarily responsible for obtaining literature through such overt channels as technical conferences and subscriptions to technical and trade journals. CIA Statute

15. The Ministry of Foreign Trade (MFT) is responsible for the majority of equipment diverted from the West to the USSR through trade channels. 25X1
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both the KGB and the GRU use the MFT's trade missions in foreign countries as cover for their own S&T collection operations 25X1
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Generation and Exploitation of Requirements

16. The USSR's technology acquisition program begins with the massive, worldwide collection of open-source scientific and industrial literature, supplemented by other data from more covert types of collection such as the intercept of communications (see figure 2). This material is then reviewed by each defense industry research institute and design bureau for new Western technology advances of importance to the Soviet military-industrial complex. This review process results in the generation of collection requirements that are compiled, reviewed, and assigned priorities by the Technical Center of VIMI. Final review and validation of the requirements are done by the VPK. CIA Statute

17. VPK requirements are issued to the collectors in great detail. The requirements generally identify the items sought, their collection priorities, how long each requirement is valid, the Soviet ministry that levied the requirement, the most likely sources of the technology, and the budget for each acquisition. The requirements encompass a broad spectrum of military hardware and related production technology and technical data. They probably are revised and updated annually. CIA Statute

18. The exploitation of acquired foreign technology appears to be handled primarily by the Technical Center on behalf of the VPK. The collectors provide the center with acquired items known as special information provisions. These are first recorded and evaluated and are then distributed to the consumer ministries. CIA Statute

19. The Technical Center also checks to make sure that research and feasibility studies at the institute, design bureau, and plant level incorporate the information and the equipment samples obtained by the collecting agencies. Each research institute and design bureau is required to send the Technical Center a monthly report on the results obtained from foreign technology. The Technical Center, in turn, uses these results to compile an annual report for the VPK. CIA

20. The VPK periodically evaluates the results and benefits of the collection program in terms of ruble and time savings for Soviet programs. CIA Statute

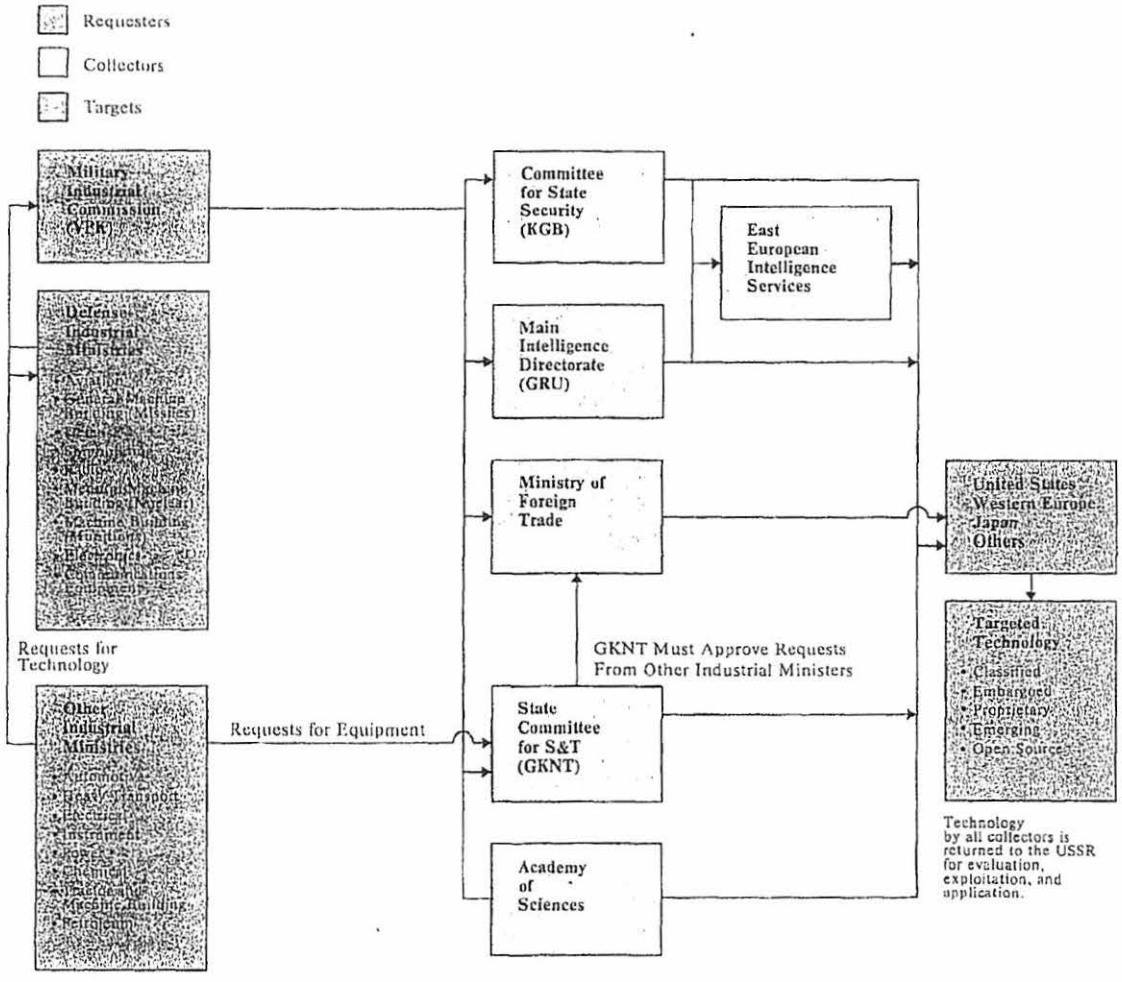
Space Technology

Benefits

21. We believe that the Soviets' military and nonmilitary space programs—for example, their developmental space transportation system (STS)—have clearly benefited from acquired Western technology, including that from Western space programs. Apparently, the principal benefits the Soviets have derived from the data and equipment they have collected have been shortening of program development times and reduction of ruble expenditures for military-related space and other programs, the acceleration of technological development, the removal of technological obstacles, the introduction of new concepts and programs, the cancellation of programs already under way, and the evaluation of their technology relative to that of the West. CIA Statute

22. Acquired controlled and uncontrolled technology has provided an avenue for the Soviets to circum-

Figure 2
Soviet Requirements, Collection, and Acquisition Cycle



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vent institutional inertia and accelerate technical development. We can ascertain several general benefits for the Soviets:

— Documents and published materials that reveal successful demonstrations of feasibility, system specifications, and equipment configurations and layouts have aided in overcoming Soviet bureaucratic obstacles to new ideas at both leadership and design bureau levels.

— Detailed design manuals and experimental test reports have saved time and resources in Soviet development programs. Lengthy indigenous testing need not be conducted, and alternative design approaches need not be explored.

— The transfer of production technologies and processes and materials techniques has provided one of the most important means of advancing Soviet state of the art. Without advances in technology, Soviet design advances often cannot be executed into hardware. CIA Statute

23. There are many general benefits related particularly to weapon systems which include the following:

— The Soviets have been able to facilitate weapon system development and reduce R&D costs by direct use of Western production technologies, manufacturing machinery, and test equipment.

— Acquired technology allows the Soviets to develop and incorporate countermeasures against Western weapons early in the weapons development process, and to avoid the cost of incorporating unneeded performance capabilities.

— The Soviets have achieved greater weapons performance at less cost along with incremental system improvements than by relying solely on Soviet technology.

— The acquired technology allows modernization of critical sectors of the Soviet defense industry. CIA Statute

24. There are several instances where certain Soviet spacecraft systems and subsystems are so similar to US spacecraft systems or subsystems that we can confidently assess that the Soviets have at least benefited greatly from, if not actually copied, Western technology or systems. These Soviet systems and subsystems are the computer on the developmental spaceplane, the synthetic aperture radar tested on the Progress-17 and -22 resupply vehicle, the Global Navigation Satellite System (GLONASS), and the Satellite Data Relay System (SDRS). Annex A presents a discussion of the Soviet systems and subsystems and their similarities to US systems, and subsystems. There are other Soviet systems, such as the developmental STS, discussed later in this report where there is clear evidence the Soviets intended to copy the US system. CIA Statute

Acquisition Mechanisms and Acquisitions

25. The Soviet Union and its East European allies use many legal and illegal methods to acquire Western technology. These mechanisms are used in all of the Western countries. Legal acquisitions include purchases through normal trade channels of machinery, equipment and manufacturing know-how, scientific and technological exchanges, open-source publications, and international organizations and conferences. Illegal acquisitions encompass military and industrial espionage, diversions through trade channels that evade Western export controls, and in-place diversions from a civilian end-user to a military production or research facility. The inset provides an overview of some of the many technology transfer mechanisms that must be monitored to detect illegal transfers, and it identifies some of the control mechanisms that help stem the leakage of Western technology to the Soviet Union and Eastern Europe. CIA Statute

26. Espionage. Soviet covert collection operations against Western space technology focus on classified and company proprietary information that will move the USSR into a strong military position in space. US industry, which is responsible for most of the research, development, and production of space technologies and systems required by the USSR, is the main target. Many US companies have been targeted. Among the most important are Boeing, General Electric, Honeywell, Lockheed, Martin Marietta, RCA, and Rockwell International (Rocketdyne Division). Other prime targets include NASA and three of the associated research centers: Marshall Scientific Research Center, the Johnson Space Center, and the Langley Research Center. CIA Statute

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Selected Technology Transfer Mechanisms and Controls

Mechanisms: [a]

— Recruited agents and industrial espionage.
— Hostile intelligence service acquisition.
— Direct investment.
— Complete (turnkey) plant sales.
— Patents and licenses with extensive teaching effort.
— Joint ventures and joint production development.
— Technical exchanges with ongoing contact.
— Know-how—training, consulting in high-technology areas.
— Processing equipment (with know-how).
— Technical data and engineering documents.
— Proposals, presale negotiations, and sales presentations.
— Commercial visits.
— Governmental and industrial equipment sales.
— Sales of products.
— S&T and student exchanges.
— Open literature (journals, magazines, technical articles, for example).
— S&T conferences, trade shows, and exhibits.
— Illegal arms trade.
— Illegal trade.
— End-user diversions.
— Third-country diversions.
— Foreign SIGINT.
— Capture in war.

Controls:

— Export controls (national and international).
— Government security and regulations.
— Industrial security.
— Company management.
— Visitor control (governmental and industrial).
— Prerelease reviews of open literature.

[a] All transfer mechanisms can be employed with or without the participation of hostile intelligence service personnel. The involvement of such personnel can range from the overt, legal collection of unclassified, unembargoed technology to the clandestine acquisition of classified, military technology by agents working pursuant to the direction of hostile intelligence service personnel. Furthermore, most of the transfer mechanisms can be legally or illegally employed. Some of the mechanisms, such as capture in war, make the concern of legality moot.

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29. Although the very nature of espionage makes it difficult to gauge its effectiveness as an S&T collection mechanism, two general conclusions can be drawn. The first conclusion is that space technology obtained through espionage probably has had a more direct and significant impact on Soviet military programs than acquisitions made through other mechanisms when compared on an item-by-item basis. We estimate, however, that the Soviets have succeeded in acquiring through espionage only a modest amount of classified and company proprietary technology. The second conclusion, therefore, is that other mechanisms have contributed more to the overall Soviet space effort through the sheer volume of information and equipment collected. CIA Statute

30. Indeed, the combination of ready access to a large amount of sensitive technology and information, numerous legal and illegal acquisition mechanisms available to the Soviet Bloc, and the open societies of the West, confront the United States and its allies with many serious technology transfer problems in addition

to the traditional problem of espionage. The most serious of these are trade diversions, communications intercepts, legal trade, scientific exchanges, open-source collection, and the exploitation of Western data bases. CIA Statute

31. **Trade Diversions.** This mechanism is perhaps the most serious long-term problem confronting the United States and its allies in the transfer of technology to the Warsaw Pact countries. We have identified some 300 companies operating from 30 countries that have been involved in illegal high-technology trade with the Soviet Bloc, and there are probably many more such companies that are unidentified. 25X1

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32. The Soviets have been the dominant force behind trade diversions. 25X1

25X1 They have concentrated the use of this mechanism on the acquisition of COCOM-controlled dual-use equipment. CIA Statute

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35. Abetting the illegal trade activities of the Soviet Bloc and their Western accomplices are the many in-transit zones (foreign-trade zones) in Western Europe. Customs inspection of in-transit goods is minimal because such goods are not officially imported into the country. Controlled merchandise exported from the United States and licensed for a COCOM country often proceeds through that country in transit

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to a neutral destination, such as Austria, Sweden, or Switzerland, and then to the USSR or Eastern Europe. CIA Statute

36. Companies owned jointly with Western entrepreneurs provide the USSR and its East European allies with another important entree to Western technology—their incorporation in Western countries gives them legal access to sensitive technology that would otherwise be denied. Several of these firms are engaged in clandestine networks of post office box companies that serve as conduits for bypassing Western export controls and customs inspection. Several of these joint companies act as cover organizations for Soviet intelligence officers and, in some cases, cooperate with the KGB and the GRU in joint collection operations. CIA Statute

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25X1 The Soviet space program, however, needs and almost certainly has obtained, through this mechanism, a sizable amount of high-quality microelectronics coating equipment, computer-aided design and manufacturing systems, lubricants, composite technology, advanced instrumentation (particularly Western mass spectrometers), and production technology for rocket engine casings, reactants for rocket fuels, and fiber-optic systems. CIA Statute

38. **Communications Intercepts.** Compounding the diversion problem is Moscow's use of communications intercepts. The Soviets regularly monitor the

communications of US defense contractors. 25X1
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39. The Soviets use at least four different types of collection sites to intercept US and other Western communications: sites in the USSR; auxiliary general intelligence vessels at sea; the Lourdes Central Signals Intelligence Complex at Torrens, Cuba; 25X1
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[redacted]
25X1 The KGB currently has at least 10 intercept facilities in the USSR for monitoring foreign communications satellites. These facilities are probably used to monitor commercial traffic, which would include scientific and technical data transmitted over the INTELSAT network. The GRU and independent SIGINT units of Soviet military districts also monitor the INTELSAT network. CIA Statute

40. 25X1 Soviet satellite communications intercept site outside the USSR is the Lourdes facility. This site probably can monitor the full range of US satellite-based communications: domestic, military, and commercial transatlantic traffic. 25X1
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41. Acquisitions by intercept of technical information transmitted over commercial communications by aerospace contractors and other high-technology firms are expected to grow as Western firms make increasing use of telecommunications to transmit data. CIA

42. **Legal Trade.** Legal sales have played a major role in the development of the Soviet industrial base. Since 1970 the USSR alone has purchased an estimated $50 billion worth of Western machinery, equipment, and other technology. Because of the priority accorded to the military over the civilian sector of the Soviet economy, Western dual-use technology required by the military almost always finds its way into defense R&D or production facilities. Legal trade has affected the Soviet space program primarily through the acquisition of key production technologies such as powder metallurgy and numerically controlled machine tools. The Soviets have managed to circumvent export controls on some of these items by legally purchasing such items from neutral European countries. CIA Statute

43. **Scientific Exchanges.** Technology transfer resulting from Soviet and East European exploitation of S&T exchanges poses a continuing problem. Soviet and East European students and technical delegations visiting Western countries are generally of high quality, and we suspect that many of them perform classified work in their home country—all are collectors. Private visits and other arrangements that permit direct Soviet access to Western companies is one of the most serious aspects of this problem because there is no mechanism in many Western countries for effectively monitoring the activities of Soviet Bloc personnel involved in privately sponsored visits. CIA Statute

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44. Soviet scientific cooperation with Western countries since the mid-1960s has been one of the more significant mechanisms for the acquisition of space technology. Technology transfer occurs through extended contact between Soviet and Western personnel during joint projects and at associated scientific meetings, or colloquiums as well as through direct Soviet access to hardware and facilities. Some technology of military significance has been acquired through such joint projects that dealt with space-related subjects. CIA Statute

45. France has had the longest and most extensive contact with the USSR in the space field. Franco-Soviet space cooperation has spanned two decades and 25X1 25X1 In February 1983 the cooperative program was extended through 1993. 25X1 25X1 25X1 CIA Statute

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49. **Open-Source Collection.** Open-source publications (particularly US Government and contractor documents) in which state-of-the-art technology with military potential is made available prematurely are the Soviets' largest and most important source of US space technology. We have determined that thousands of openly acquired technical materials have been used directly in Soviet space-related R&D projects, ranging from the developmental STS to space medicine. CIA CIA Statute

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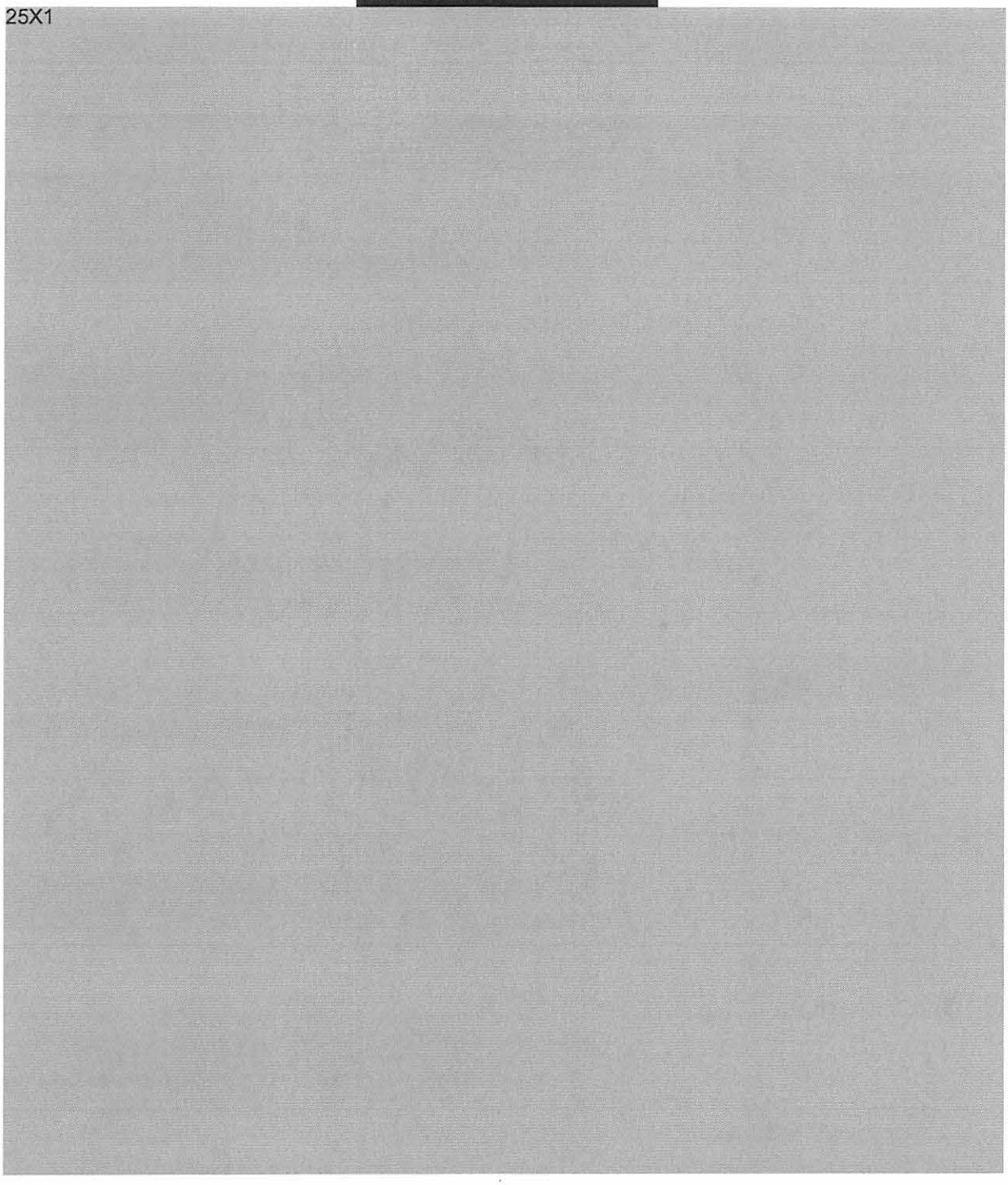

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50. We believe that NASA documents and NASA-funded contractor studies have provided the Soviets with their single most important source of unclassified material in the aerospace area. The Soviet and East European intelligence services are the principal collectors of such unclassified space-related material. In fact, we estimate that well over half of the Soviet intelligence service's acquisitions in the aviation and space category have been unclassified. CIA Statute

51. The largest category of unclassified NASA reports collected by the Soviets concerned the STS—particularly the design and construction of the STS shuttle orbiter. 25X1 the Soviets by 1971 had obtained extensive amounts of data dealing with the US STS, but the Ministry of Aviation Industry's Central Institute of Aviation Engine Building (TsIAM) evinced little interest. 25X1 25X1 TsIAM was translating hundreds of English-language documents relating to the US shuttle orbiter—indicating a rising interest in it. 25X1 much of the shuttle orbiter material was in-depth technical data containing many charts. 25X1 25X1 25X1 we believe that in 1978-74 the Soviets made the decision to copy, with some modifications, the US shuttle orbiter (the Soviet shuttle orbiter is 25X1 25X1 discussed in annex C). CIA Statute

52. Additionally, several Soviet emigres and scientists attending international meetings have expressed interest in the US shuttle orbiter's thermal protection system, specifically the tiles, and have stated that the Soviets worked on such a system for their developmental shuttle orbiter. 25X1 25X1 25X1 CIA Statute

53. We believe the Soviets acquired considerable information on the US shuttle orbiter's thermal protection system from the surface heating data obtained from the second and third shuttle flights. These data were released to the public in June 1982. NASA estimates that the data could save the Soviets the equivalent of $750 million in R&D cost and considerably reduce development time. CIA Statute

54. **Exploitation of Western Data Bases.** The collection of technical documents and scientific papers recently has been greatly facilitated by Soviet access to Western S&T data bases. This access has been through commercially available online services 25X1 25X1 Over the past several years the Soviets have improved their exploitation of these data bases. This exploitation should accelerate the assimilation of Western technology into military R&D programs. CIA Statute

55. The US Department of Commerce's National Technical Information Service (NTIS) data base is a high-priority target for the Soviets. It is a highly efficient service whose principal function is to expedite the quantity and timeliness of data flow to users including foreign countries. There are more than 30,000 space-related documents in this data base. Approximately 13 percent are NASA or NASA-sponsored documents. NASA itself has an effective program, the Technology Utilization Program, to assure that significant advances in technology receive exposure through NTIS and other channels. Although we cannot cite specific examples, it must be assumed that Moscow's ready access to NTIS has enabled the Soviets to obtain as much of this information as they need. 25X1 25X1 25X1 CIA Statute

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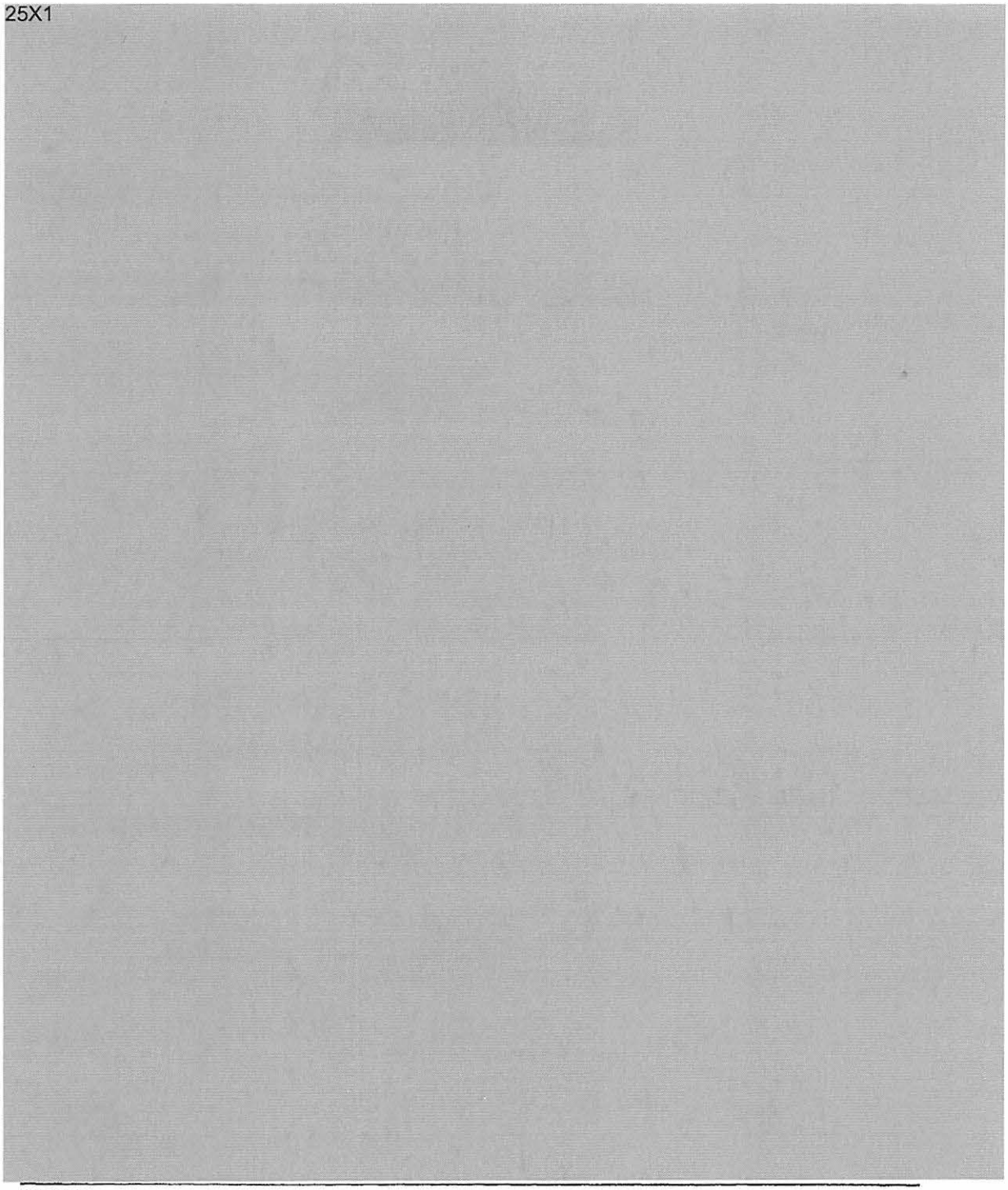

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B. Perceived Soviet Space Technology Problems and Needs

56. This section addresses Soviet problems and needs as developed through assessment of their military system and military-related space system and subsystem capabilities and the missions the Soviets are attempting to perform. CIA Statute

The Soviet Approach to System Development

57. The Soviets perform design trade-offs early in the development process. At this critical stage they prefer to rely on proven technology and use proven materials, components, and subsystems specified in their standard design handbooks. This allows the design task to be a technology-packaging, rather than a technology-development, exercise. While development costs cannot be forecast accurately at this stage, specific costing of components or system features is not an overriding consideration in a development decision—the Soviets are more concerned about the integrated military requirements for weapon systems and the capability of the economy to successfully carry them out. CIA Statute

58. Soviet weapon programing practices result in a technology freeze (actually a decision to design the system at a proven technology level) once a decision to proceed with the development phase of a weapon program has been made. The Soviet leadership compensates for this early technology freeze by early commitment to follow-on improvement programs, an approach that is responsible in part for the cyclical appearance of new and modernized weapon systems. These follow-on programs incorporate new approaches and technologies that have become available during the initial program and cumulatively can prevent technical stagnation. As a result, major weapons design bureaus are continually working on new and modernized weapon systems in different stages of development. This process also reduces any tendencies of designers to incorporate newly available technologies in an ongoing program—the odds are that there will be a follow-on program that can more easily incorporate the new technologies. CIA Statute

59. Some technologies are more important than others to the Soviet military-related space program. For some of the space systems which may be desired by the Soviets to fulfill estimated national space objectives, the required technologies may be well in hand and available to their system designers (these are called "key" technologies in tables 2 through 5 on pages 38-45). Other technologies may not yet be suitable for the satisfaction of system requirements, but Soviet designers can expect the technological capability to be available through indigenous development or acquisition when it is needed during the system development process (these are called "major" technologies in tables 2 through 5). Other possible options for space systems may make such severe demands upon Soviet technological capability that a system development program cannot be started until further technology advances are made—assuming that current Soviet development practices are continued (these are called "pacing" technologies in tables 2 through 5). The date at which a "pacing" technology becomes available, or can be confidently predicted as becoming available, for system application is the earliest date at which the formal system development can be initiated. Overall, these are referred to as "critical" technologies. CIA Statute

60. It is clear from data on the Soviet technology acquisition program that Soviet long-range weapons planning includes the acquisition of specific technologies from the West with primary emphasis on future rather than ongoing weapons programs. Since the critical technologies to be used are frozen when the Soviets make a decision to proceed with a weapons program, it is unlikely that they would go ahead with a development program if its success should depend on the expected acquistion of a Western technology. Less-than-critical Western technology has been incorporated into some on-going development programs. These are usually those programs that have not reached the prototype production stage and that do not require a fundamental redesign of the system or its major elements. The Soviet leadership offsets the tendency of program sponsors to want to include new technology in ongoing programs by authorizing sequential improvement programs that can be structured initially to incorporate the new technology. As a result, the time between the acquisition of a critical technology and its appearance in a weapon system is probably routinely on the order of five to 10 years. We have recent examples, however, of technology being incorporated in a fielded weapon system within approximately two to three years of its acquisition. CIA Statute

The Status of Critical Soviet Space Technologies

61. Current intelligence assessments of Soviet technological capability identify 13 technology areas that are critical to possible Soviet space programs. We do not assert that the technology the Soviets desire and would benefit from will be incorporated in a US space station or in the other numerous space programs in

planning, development, or operations. These 13 "space technology" areas affect approximately 75 space systems or system concepts for which we believe there are Soviet military needs and corresponding intelligence collection requirements. For example, the sensor, computing, and signal-processing technologies will affect the performance capabilities of a large number of systems that are under development or are likely to begin development in the 1990s. Also, major advances in directed-energy-related technology are required before system development can be initiated on a number of important space system options which may be of the highest strategic significance. The following is a discussion of the technologies and Soviet capabilities. CIA Statute

Sensor Technology

62. The United States leads in electro-optic sensor technology, but that lead is being reduced. The Soviet lag is due in part to inferior microelectronics technology necessary for mass production of high-quality, multielement detector arrays. Electro-optic sensor technology affects the Soviet capability to develop real-time space-based reconnaissance systems and the precision pointing and tracking required for effective space-based high-energy laser (HEL) weapons. The current Soviet technology base in electro-optic-sensor-related areas such as optics, signal processing, recording, and display of data is, however, sufficient for the Soviets to use such technology in a variety of space-based systems. Although we believe the capability of Soviet infrared detector arrays is inferior to those of the United States, it is indeed adequate for all but the most demanding strategic applications. CIA Statute

63. The Soviets are assessed as being essentially equal to the United States in overall radar technology. Within the broad area of radar technology, the United States leads the Soviets in digital radar techniques while it trails the USSR in the development of millimeter wave component technology. Advances in Soviet radar technology will pace the development of several space-based reconnaissance systems. Soviet efforts to acquire Western technology to overcome specific deficiencies in radar technology are expected to concentrate on microprocessors and integrated circuits in order to upgrade the processing of radar data—rather than on the acquisition of components of radar systems. CIA Statute

Microelectronics Technology

64. The USSR has demonstrated a theoretical understanding of electronics technologies that is comparable to that of the West, although the Soviet Union clearly lags the West in nearly all industrial applications and is weakest in its electronics production capability. The United States is assessed as having a lead in microelectronics technologies that are available for use by system designers. The West has a two- to 10-year lead in solid-state, microelectronic production. This lead is not so noticeable, however, in military applications where the USSR is approximately on a par with the West. 25X1
25X1 A likely application for improved microelectronics would be in signal processing for space-based surveillance systems. CIA Statute

65. The Soviets are also pressing the development of VLSI and VHSIC technology although it is not clear that they perceive such a capability as necessary to their near-term military needs. In order to achieve an improved VLSI production capability, they are implementing certain competitive procedures, developing an infrastructure to become less dependent on foreign materials, and building more high-precision production equipment. At a recent international symposium, the Soviets announced that they are attempting to produce X-ray lithography systems. 25X1
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66. The greatest weakness in Soviet microelectronics technology continues to be at the manufacturing plant level. The Soviets remain weak in every aspect of production technology. They have a shortage of advanced, high-throughput fabrication machinery. They also use poorly developed computer-aided design and manufacturing techniques and equipment, and their indigenous supplies of semiconductor materials and processing chemicals are inadequate. Their integrated circuit (IC) production is typically labor intensive and efficiency is very low. In order to meet military production requirements, they apparently must use an excessive amount of material at the initial processing stage because of yield problems throughout production. Yields for major Soviet military producers have frequently been estimated at 5 to 10 percent, depending upon the type of IC device produced. CIA Statute

Computer Technology

67. The USSR is estimated to be three to 10 years behind the United States across the spectrum of

computer technology. This lag in Soviet computer technology does not seem to have seriously delayed the development to date of Soviet military systems generally or, in particular, of Soviet space systems. The trend for the remainder of the 1980s will be for the US lead in computer technology to increase—although for high-priority military systems, the Soviets may be able to reduce the impact of this computing gap through innovative system engineering and design CIA Statute

68. While the Soviets have successfully copied the architecture of US micro-, mini-, and mainframe computers, they have demonstrated indigenous design capabilities in each of these areas. The Soviets have yet to develop a supercomputer in a class with US machines such as the Cray-1 or the CDC Cyber 205 or even the now decommissioned Illiac IV. The Soviets are expected to enter the supercomputing arena with the Elbrus-2 in the mid-1980s, but right now they seem to be encountering reliability and production problems in the Elbrus-1 project CIA Statute

69. The greatest potential for rapid Soviet technological advance in computing is in software development. With an ever increasing indigenous repertoire of Western compatible computers, the Soviets could realize significant and immediate advances in particular applications through the acquisition of Western commercial software products. Transaction-sensitive software routines, much like banking and airline reservation systems in the US and Europe, can be adapted to large-scale command and control applications by the Soviets. CIA Statute

Signal-Processing Technology

70. Signal-processing technology affects almost all advanced Soviet military-related space systems and is a key factor in improving the performance of current systems. Our current assessment of Soviet signal-processing technology is that the United States is increasing its lead in the digital processing area. Our assessment is, however, limited to a small number of Soviet examples 25X1

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25X1 The key supporting technology for advances in digital processing is microelectronics, particularly LSI and VLSI circuitry. The Soviets also have an active research program in optical processing which could be applied to wideband systems where analog, hybrid, or digital techniques would be limited. CIA Statute

Command and Control Technology

71. 25X1

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72. 25X1

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Guidance and Navigation Technology

73. Soviet capability in guidance and navigation (G&N) technology has advanced to the point where it could support their overall requirements for space systems through the 1990s. On balance, the United States leads the USSR in G&N technology, but that lead is diminishing. The application of their G&N technological capability to systems being designed or under development will require a degree of precision and quality control that the Soviets have not consistently demonstrated. Soviet capability to utilize their G&N technology would benefit by the acquisition of Western manufacturing equipment and precision test devices CIA Statute

Power Source Technology

74. The Soviets have been strong in the development of power source technology for many years and have effective, well-funded programs. They lead the US in a number of advanced power source areas including nuclear heat sources for use in space, therm-

ionic energy conversion, magnetohydrodynamics, magnetocumulative generators, and inductive storage devices. The US leads the USSR in the fabrication of capacitors used in directed energy devices. These capacitors are critical to the operation of switches that tailor the electrical output of power sources of specific directed energy devices. CIA Statute

75. One area where Soviet power source technology for use in space may advance rapidly is in solar arrays. The Soviets have experienced quality control problems in the large-scale manufacture of reliable and efficient solar cells. The Soviets may now be developing solar arrays that will achieve efficiencies of over 15 percent, possibly approaching 20 percent of the theoretical limit, with reduced weight and increased power output. For comparison, US solar cell arrays have an efficiency of 30 to 40 percent of the theoretical limit. This could affect the design of future large Soviet space structures for collecting solar energy for relay down to remote areas of the USSR. CIA Statute

76. Although the Soviets have several options for providing space power systems to satisfy anticipated military requirements, their current demonstrated technology is expected to limit or pace, in the near term, several space system options in directed energy, sensors for reconnaissance, 25X1
25X1 Nuclear reactors with output levels into the tens of kilowatts will become available for manned spacecraft and perhaps some low-power directed-energy systems before the end of the 1980s. Beginning in the 1990s the Soviets are expected to have available the necessary power technology to support a wide range of space-related missions. CIA Statute

Propulsion Technology

77. Two areas of propulsion technology of particular interest to the Soviets for space applications are cryogenic rocket engines for launching heavy payloads and electric propulsion engines for attitude control, orbit stationkeeping, and orbit adjustment. The Soviets are considered to be world leaders in storable-propellant liquid rocket propulsion technology. They have both ICBM and space launch systems powered by very efficient closed-loop cycle (staged combustion) engines that use readily available liquid propellants. The development of Soviet high-energy liquid-oxygen/liquid-hydrogen engine technology has, however, lagged. Developmental problems with cryogenic fuel and fuel handling have probably now been overcome. The first operational use of such engines may be in the Soviet developmental STS program and would demonstrate Soviet progress in reducing the US lead in this area. Such engines could provide the USSR with increased payload weight for both near-Earth and geosynchronous spacecraft. CIA Statute

78. The Soviets have a significant lead over the United States in electromagnetic (plasma) engine technology. They have chosen to develop the plasma type of engine because of its relative simplicity, higher thrust, and greater power density when compared to the electrostatic type of engine which is under development in the United States. 25X1
25X1
25X1 The Soviets lead the US in electromagnetic engine technology by at least five years, and their electrostatic engine technology program is rapidly reducing a US lead. In the electric propulsion area, the Soviets' goal is to increase the useful lifetime of their systems beyond the current maximum of 25X1 We expect they will therefore have a high degree of interest in Western research on electrode materials and coatings. CIA Statute

Directed-Energy Technology

79. Directed-energy technology as used here encompasses the technology of high-energy laser (HEL), radiofrequency (RF), and particle beam (PB) weapons. The Soviets have made a substantial commitment to HEL weapon development. Several subtechnologies that are important to HEL weapons are laser sources, power sources for electric lasers, mirrors and other optics, pointing and tracking, and wavefront correction. 25X1
25X the Soviets have built higher power laser sources than the United States—although beam quality and other characteristics may not be better. They are reported also to have established an RF weapons study project in the mid-1970s and they have the world's best capability to develop microwave sources. The Soviets are also world leaders in PB weapon technology, having developed ion sources that produce beams that are a factor of 2 greater in beam intensity and beam brightness than those of the US. CIA Statute

Life Support Technology

80. The USSR and the United States are estimated to have approximately equal capability in the area of life support systems. One reason for this is that all NASA R&D in this area is unclassified, and the Soviets have had unrestricted access to the information. Soviet life support technology has shown rapid advancement since the early days of manned spaceflight, and their extensive operational experience in space has created a

large data base which could support continued improvements. In particular, the Soviets have a continuing R&D program in regenerable and bioregenerable life support systems which offer the potential for greatly reducing the expendables required to support man in space. CIA Statute

Large Structure Technology

81. Techniques for the fabrication, joining, and repair of components in space are critical to the construction of large space structures. The Soviets have experience in the automatic assembly and deployment of large spacecraft and have conducted tests which are directly applicable to the development of a large manned space station. Techniques applicable to the assembly of large space structures include the use of mechanical fasteners, welding, soldering, and brazing. These techniques have all been studied by the Soviets, and we estimate that continued technology improvement will make these techniques available for use when they are needed. CIA Statute

Materials Technology

82. The Soviets generally lag the United States in technology in the development of materials for use in space system structures, but they are closing the gap. The Soviets do not, however, appear to have any major deficiencies in structural materials technology that will hinder the production of space systems that would be operational in the 1990s. Any specific deficiencies in materials technology will be compensated for through trade-offs with other materials or systems components during design and development of future space systems. CIA Statute

Attitude Control Technology

83. Spacecraft attitude control systems include attitude determination sensors, attitude control logic and sensors, propulsion devices or momentum storage and transfer devices, and other devices that can produce the requisite moments (controlling forces) about the several axes of a spacecraft. The US typically uses gyroinertial subsystems in spacecraft attitude control systems. These gyroinertial subsystems derive from US military ballistic missile weapon systems developed in the late 1950s and early 1960s and have resulted in a marked increase in the capabilities of US spacecraft attitude control systems. Soviet advances in ballistic missile guidance and control systems are such that they are approaching the capability of the United States in the construction of precision gyroscopes and accelerometers. The Soviets have, however, not yet fully incorporated ballistic-missile-related guidance and control technology into their military-related spacecraft. The gyroinertial components of concern include angle- and angular-rate-sensing gyroscopes, accelerometers, control moment gyroscopes, and reaction wheels. Also of importance is the capability to measure and transmit data to and from these instruments through digital sensors. We believe that the Soviets can match US capabilities in these areas and approach US capability in spacecraft attitude control systems in the 1990s. CIA Statute

84. Future Soviet developments in space and other advanced military systems will also benefit from access to Western developments related to reliability, quality control, and manufacturing of complex equipment and supporting management procedures. CIA Statute

Technology Needs of Key Prospective Soviet Space Systems

85. The following discusses key Soviet space systems we believe to be currently in the planning, study, or development phase, with emphasis on the critical technologies required to perform the required missions. By "key system" (as opposed to key technology) is meant those prospective military-related space systems that are of particular importance to the Soviet Union because they perform either offensive or defensive functions, significant military support, or intelligence missions. CIA Statute

86. In order to separate those technologies in hand versus those not yet available to the Soviets, future systems are divided into three categories:

— The first category includes those systems currently being tested or in development which we believe will be flight-tested by the end of the 1980s. In general, the Soviets must now possess the required technology for systems that are to be flight-tested by about 1989. Once the decision is made to proceed with development of a new, technically complex space system, an estimated seven to 12 years is required to complete the design, engineering, and manufacturing phases before flight-testing of a prototype. Roughly five to seven of these years represents the time between the freezing of the technical design, at which time the technologies to be used must be available, and the initiation of flight-testing. Exceptions occur for those systems for which there are developmental or testing problems. In those cases, subsystem modifications may occur after the initial technical design freeze. This can possibly result in the use of newer or improved technology. CIA Statute

— The second category includes those identified systems not as far along in development as the first category or for which we believe there is a need for development of the required technology. CIA Statute

— The third category includes those systems for which the technical requirements are so stringent that we do not believe adequate Soviet technology will be available through the rest of the 1980s. CIA Statute

87. Table 2 (on pages 38-41) lists these systems; our estimate of the likelihood they will be flight-tested or (for one-of-a-kind missions) put in orbit; an estimated first flight test or mission date; and a list of the technologies critical to the development of the system in terms of pacing, major, or key technologies for the second and third categories (that is, systems currently being tested or in development for flight by the end of the 1980s). 25X1
25X1 Table 3 (on page 42) shows these space systems arranged according to the perceived critical technologies they require. 25X1
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25X1 CIA Statute

Potential Benefits of Space Technology to Nonspace Soviet Military Systems

88. The acquisition of space technology can potentially aid in the development of nonspace military systems. For example:

— The infrared homing sensor needed for a nonnuclear interceptor missile has to operate under conditions similar to that of the developmental ASAT. 25X1
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— Directed-energy and related pointing and tracking technologies needed for several projected space systems could also be used for the development or improvement of projected Soviet air and ship defense HEL weapon systems.

— Maneuverable reentry vehicles being developed by the Soviets may benefit from positional updates from GLONASS or other future space-based navigation systems. CIA Statute

89. Shown in table 4 (on pages 43-44) are Soviet nonspace military systems projected for the 1990s for which development or improvement depends upon some of the same critical technologies needed for key projected space systems. Table 5 (on page 45) shows these nonspace military systems arranged according to the perceived critical technologies they require. CIA Statute

C. Outlook on the Transfer of Space Technology

Overall Collection Program Competence and Vulnerability

90. The increasing sophistication of Soviet military and military-related space systems and other military equipment—much of which incorporates technology acquired from the West—indicates that the Soviet collection program has been performing competently in meeting the requirements of the military-industrial complex. The program's greatest strength is in identifying Western technologies required by the Soviet military-industrial complex and the sources of that technology. The considerably more difficult task of actually obtaining the technology has been less successful but still impressive. We estimate that, during the period 1975-80, the Soviets acquired 25X1
technical documents 25X1
We believe that much of this technology was in the aerospace field with about 10 percent being specifically in the space area. 25X1
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91. The collection program, however, appears to be laboring under the increasing weight of the demands made on it. Moreover, Western security procedures and export controls have been partially effective in countering the Soviet collection program. Consequently, we estimate that—even though the total quantity of technology obtained annually has increased steadily—the collectors have been unable to fulfill the majority of the requirements in force each year. CIA Statute

92. The Soviets' success rate may well decline should the requirement list continue to grow (as we expect) and should the Western countries and Japan persist in their efforts to reduce illegal technology transfer. Faced with the intensification of the military-technological competition and the growing importance of the space arena, however, the Soviets will increase their efforts to overcome Western controls covering space-related technology CIA Statute

Joint Programs

Prospects for Losses

93. The USSR has begun to diversify its joint space programs for political reasons and for greater flexibili-

ty in acquiring Western technology. The termination, for example, of the US-USSR planetary data exchange program has caused the Soviets to seek closer cooperation with the ESA, and Moscow is encouraging US scientists to maintain their contacts with their Soviet counterparts through West European intermediaries. The USSR will be an attractive partner to West European scientists since Moscow probably will proceed with programs that are of interest to them (such as lunar orbiters, a Mars chemical analysis orbiter, and missions to the outer planets) in order to reap the propaganda benefits and cultivate the good will of the European scientific community CIA Statute

94. We believe that joint programs between the United States and its allies on the one hand and between these allies and the USSR on the other will, under current conditions, serve as conduits for the increased leakage of US technology to the Soviets. 25X

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95. Our major concern with the joint US-allied space station project is that it will involve a transfer of US design know-how to our allies. Based on past performance, Moscow probably will succeed in opening a channel into the space station project through the allies and gain valuable insight into US design concepts. CIA Statute

Potential Measures To Decrease Technology Loss

96. **Intelligence Service Acquisitions.** The expansion of Western export controls to cover sensitive but currently uncontrolled items will compel the Soviets to rely more heavily on industrial espionage. US industry and government organizations will continue to be a primary target and their main source of information. Moscow will, however, continue to step up operations against West European targets—this is where they have had increasing success since the late 1970s, particularly to acquire information available through joint projects. Counterintelligence efforts by the West over the past two years, however, have hurt Moscow's clandestine S&T collection operations. In fact, the West has in this area probably taken its most effective actions against the Soviet acquisition program CIA

97. Measures that we believe may allow the West to cope with the growing number of Soviet and East European intelligence officers dedicated to S&T collection are:

- Increase the exposure and expulsion of Soviet Bloc officials suspected of S&T espionage.
- Refuse to permit the Soviet Bloc to replace expelled officials.
- Adopt as a uniform policy the position that expelled officials may not be reassigned to other Western countries.
- Increase cooperation among its intelligence services. CIA Statute

98. **Illegal Trade Operations.** As with espionage, the Soviets almost certainly will intensify and expand their illegal trade operations. Greater efforts will be made to identify and co-opt financially troubled firms for diversion operations, and the Soviets will have to rely even more heavily on the major diversion networks operating out of Europe and the Far East. Stricter licensing review and enforcement of export controls would help to counter this activity. Indeed, most key space-related hardware is already controlled, and efforts currently under way in the COCOM [4] member countries to reduce diversions will enhance COCOM effectiveness even if they are only partially successful. This is particularly true for improved information and intelligence collection regarding diversions, enhanced investigative activities, better documentation verification and more uniform national licensing procedures. CIA Statute

99. In addition, tipoffs to enforcement authorities concerning possible violations of licensing regulations could have a substantial effect on diversion operations. Such a promotional effort would include the education of businessmen and research administrators, particularly those in the aerospace sector, in Soviet acquisition techniques. More systematic procedures among the Western countries for postlicense checks would also serve to reduce diversion operations, as would greater customs supervision of in-transit shipping areas. CIA Statute

100. Finally, a sustained and coordinated effort by Western intelligence and law enforcement agencies would also be necessary against the major diverters and their networks of trading companies. The key

[4] The Coordinating Committee (COCOM) was established in 1949 to serve as the forum to develop a system of export controls. It is comprised of the United States, the United Kingdom, Turkey, Portugal, Norway, the Netherlands, Luxembourg, Japan, Italy, Greece, France, the Federal Republic of Germany, Denmark, Canada, and Belgium. (U)

individuals who organize most of the major diversions probably do not exceed a dozen, and a crackdown against their activities would substantially reduce the flow of strategic dual-use technology to the Soviet Union and Eastern Europe—particularly computer and microelectronics production technology. To be effective, such an effort would have to include far stiffer penalties than currently are imposed for illegal trading since today, with few exceptions, the fines and prison terms for illegal trading do not serve as an effective deterrent. CIA Statute

101. **Open-Source Data.** Dissemination of US aerospace technical data through open literature probably will remain the USSR's single most important source of space technology. We expect the USSR to increase substantially its acquisition of openly published material using current collection techniques and also by making greater use of Freedom of Information Act (FOIA) requests to gain access to much data not readily available in the public domain. It is impossible to prevent the Soviets from acquiring information once it is publicly disseminated. This includes information released through joint programs or to open data bases such as the NTIS. Countering this mechanism, therefore, hinges on the denial of information through the use of stricter classification guidelines or through the delay of dissemination by the withholding of selected material from foreign nationals or firms for periods exceeding one year. Such a procedure would, however, complicate the performance of joint programs. CIA Statute

102. Technology transfer involving knowledge carried by persons and technical documents rather than technology embodied in equipment or instruments is the most difficult to control. Western governments have met with stiff opposition from their scientific communities in attempting to restrict the exchange of information with Soviet scientists. The academic and scientific communities in the West generally underestimate or ignore the intelligence functions of visiting Soviet students, scientists, and engineers. These visitors are, consequently, a difficult problem for Western counterintelligence services. As indicated above, there probably is no effective way of controlling information sharing between scientists without improved visitor screening and some form of security classification of a project and its related technical documentation. CIA

103. Even if most of the potential improvements in technology control are implemented, it is still likely that a large amount of disembodied technology will eventually pass to the Soviets, especially that information involved in joint US programs with the allies. CIA
CIA Statute

104. We believe that in many cases Soviet military engineering R&D teams can count on receiving requested information to meet their schedules without diverting resources to develop alternative data. US engineering data is believed by the design teams to be of such superior quality to indigenous data that engineering resources are not usually expended on verification of the data. CIA Statute

105. The timely fulfillment of collection requirements is of central importance because Soviet military and space R&D programs, for the most part, include only those Western technologies that are obtainable within the time constraints of their development plans.

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106. 25X1

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The Effect of Competition

107. As France, Japan, other allied countries, and ESA emerge as major competitors of both the United States and the USSR for commercial launch services, commercial competition may provide a powerful new incentive for the allies to protect sensitive technology. CIA Statute

108. It is more likely, however, that growth in the space capabilities of Western Europe, Japan, and perhaps Canada—coupled with intensifying competition for commercial space services—will simplify Warsaw Pact efforts to acquire advanced Western technology. Many technologies involved in the commercial space area are directly applicable to military systems. The commercial space sector is also a major stimulator of many new technologies important to the Soviet military space program such as materials, microelectronics, and sensors. Growing emphasis on commercial space services by our allies will probably result in growing capabilities in these areas and more inviting targets for Soviet S&T collectors. CIA Statute