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REP 1-1-SE

Management and Development of Soviet Military Technology [redacted]

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National Intelligence Estimate
Volume II—Summary

Secret

NIE 11-12-87/II
August 1987
Copy 0349

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THE NATIONAL FOREIGN INTELLIGENCE BOARD CONCURS, EXCEPT AS NOTED IN THE TEXT.

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NIE 11-12-87/II

MANAGEMENT AND DEVELOPMENT OF SOVIET MILITARY TECHNOLOGY (S)

VOLUME II—SUMMARY

Information available as of 1 July 1987 was used in the preparation of this Estimate, which was approved by the National Foreign Intelligence Board on 23 July 1987.

Declassified in Part - Sanitized Copy Approved for Release 2012/04/17 : CIA-RDP89M00699R002201790003-6

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NOTE

This Estimate is issued in three volumes:

— ***Volume I*** contains the Key Judgments.

— ***Volume II*** contains the Summary.

— ***Volume III*** is the Estimate and contains:

Chapter I Soviet Management of Technology and Military Systems Development.

Chapter II Key Soviet Military Technologies.

Chapter III Influence of Technology on Possible Major Soviet Military Systems, 1995-2010.

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OUTLINE OF THE SUMMARY

I. Soviet Management of Technology and Military Systems Development

The Soviets have instituted several management initiatives to increase the pace of technology development over the next 20 years. [redacted] 25X1

To compete more effectively with the West in critical high-technology areas or to advance in technology areas not emphasized in the West, the Soviets have established centrally managed, goal-oriented programs to oversee technology development. [redacted] 25X1

The Soviets make national forecasts of the expected progress of technological developments to support their long-term weapon research planning. [redacted] 25X1

The Soviets will continue for the foreseeable future their low-risk management approach by selecting technology early in the system acquisition process. [redacted] 25X1

To improve technology development, the Soviet leadership has been pushing Academy of Sciences personnel into more applied research work. [redacted] 25X1

Western technology has helped the Soviets considerably. [redacted] 25X1 [redacted] 25X1

Systems Management

The USSR uses a schedule-dominant management approach to conduct the engineering development and test phases of the military system acquisition process. [redacted] 25X1

The Soviet system for management of weapons and space system planning and acquisition has evolved several advantages which allow them to compete at the system rather than the technology level and pose a continuing challenge to US planners. [redacted] 25X1

We see the Soviets taking more concurrent steps in managing military system development, and we believe they have moved to the use of less-than-mature technology (feasible but not yet proven producible) in system planning. When successful, this results in shortening the transition time from technology development to system development. [redacted] 25X1

[redacted] 25X1

Even though the Soviets designate some military system development programs to be a high priority, they do not appear to reduce the time it takes to conduct the program. [redacted] 25X1

The military and space systems the Soviets will deploy between the early 1990s and the early 2000s will be based largely on technology developed indigenously or obtained from the West between 1978 and 1990. [redacted] 25X1

Technology and Systems Management

The number of Soviet military and space development programs and the supporting technology programs is higher than we previously believed. [redacted] 25X1

Data continue to show the Soviets are continuing to increase the resources allocated to support military technology and system development programs in the USSR [redacted] 25X1

The Soviets have two major technology problems, even though their use of innovative design solutions and compensatory technologies allows them to make good systems. [redacted] 25X1

II. Key Soviet Military Technologies

Comparison of the technology levels achieved in the United States and the USSR clearly shows the United States is leading in most technology areas. [redacted] 25X1

Comparison of the United States and the USSR in technology alone is not only inadequate but could be misleading for US military system planning purposes. [redacted] 25X1

The Soviets have successfully built significant numbers of weapon systems competitive with advanced Western systems despite the many technology areas where they lag the West. [redacted] 25X1

In many technology areas, such as directed energy and optical computing, the Soviets are emphasizing development. [redacted] 25X1

The Soviets continue to develop technologies and systems currently not pursued in the West, and this practice is expected to continue [redacted] 25X1
[redacted] 25X1

Technology transfer from the West continues to provide the Soviets with an expanding technology base. It has allowed the Soviets to truncate indigenous research projects earlier than originally planned and the Soviets were able to begin military system development earlier than they would have originally planned if they had relied solely on their indigenous effort. [redacted] 25X1

[redacted] 25X1

The Soviets conduct feasibility tests of new military technology before they decide to use the technology to develop a military weapon system. [redacted] 25X1

Soviet laser technologies will progress and production capabilities will grow throughout the 1990s. [redacted] 25X1

The USSR will continue to pursue technology development in many strategic defense areas. [redacted] 25X1

A design bureau and production infrastructure associated with explosive MHD and explosive MCG power sources probably were established in the early 1980s. [redacted] 25X1

The Soviets have an extensive research effort in hypervelocity kinetic energy impact supported by a very large organizational infrastructure. [redacted] 25X1

The Soviets have made limited applications to military systems, with mixed results, of composite materials—an area where significant gains are being made in the West. [redacted] 25X1

III. Influence of Technology on Possible Major Soviet Military Systems 1995-2010

For systems reaching operational forces in the mid-1990s and later, the Soviets will use the strong and sizable base of military technology advances they have made since the late 1970s. [redacted] 25X1

Soviet industry should, in the mid-1990s, after 20 years of modernization, retooling, and management shifts, be capable of more rapidly assimilating high-technology military products into production. [redacted] 25X1
[redacted] 25X1

Production and deployment rates observed for new high-technology military equipment show a trend towards fewer but better individual systems. [redacted] 25X1

Soviet Technology Surprise [redacted] 25X1

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SUMMARY

I. Soviet Management of Technology and Military Systems Development

The Soviets have instituted several management initiatives to increase the pace of technology development over the next 20 years. The most significant trend for Soviet weapons acquisition for the remainder of the century will be a continuation of the concerted effort the Soviets are making to upgrade their management of technology development; we believe their performance will continue to improve. [redacted] 25X1

To compete more effectively with the West in critical high-technology areas or to advance in technology areas not emphasized in the West, the Soviets have established centrally managed, goal-oriented programs to oversee technology development. The Soviets have had such programs for critical military systems or production technology since at least the early 1960s. Examples of programs in critical areas include: lasers, particle beams, millimeter waves, and computers, as well as important production technologies including robots and industrial lasers. These goal-oriented programs tend to be narrow in focus and may lead to a lack of commitment in basic sciences today, which is essential to innovations that would evolve in the future. [redacted] 25X1

The aim of a technology development program, which the Soviets call Scientific Research Work (NIR), is to bring the technology involved to the level of producibility necessary to support full-scale engineering development, which the Soviets call Experimental Design Work (OKR), of a military system. Extensive feasibility demonstration testing, however, may occur with system-like models during technology development. The technology development phase of a goal-oriented program may last five to 15 years or even longer before technological maturity sufficient to support system development occurs. Another five to 15 years would be required for system development before operational use. Thus, for a program conducted with the goal-oriented management style, up to 30 years may pass from the formation of a management structure to oversee a technology development until the initial weapon system completes state trials and is ready for deployment. [redacted] 25X1

[redacted] 25X1

[redacted] 25X1

[redacted] 25X1

The Soviets make national forecasts of the expected progress of technological developments to support their long-term weapon research planning. Outlooks for 20 and 30 years are intended to guide current planning to ensure that no long-term, major technology requirements are overlooked. The Soviets believe that formal planning and forecasting will make them more competitive with the West and will leave them less vulnerable to major Western technology advances. [redacted] 25X1

The Soviets apparently assume they can eventually produce any technologies already produced in the West. They will, therefore, include such technologies in their forecasts for system planning even though they have not yet demonstrated the capability to produce the technology. For example, Soviet industrial ministry forecasting of microelectronics development and production for the late 1970s and throughout the 1980s was completed in the mid-1970s. Where Soviet technology lags, planning well in advance is used to focus research, development, production, and, when applicable, technology transfer to keep the lag within manageable bounds. [redacted] 25X1

The Soviets will continue for the foreseeable future their low-risk management approach by selecting technology early in the system acquisition process. The Soviets believe their basic management approach to be effective. Moreover, their long-range technology development plans, supported with focused research commitments and technology transfer, should keep them relatively close to Western developments in areas of technology where they now lag. As long as the Soviets continue to receive early knowledge and specific details of new Western military programs, they will be able to choose the least demanding technical approach necessary to field effective countering systems. [redacted] 25X1

In cases where they are pursuing systems programs not being undertaken by the West, they can pace their technology development according to their own internal scheduling factors. For example, the Soviets are considering a manned mission to Mars shortly after the turn of the century, which would probably employ nuclear propulsion and nuclear power supply subsystems. Projects such as these—many of which are not being pursued in the West—if successful, allow them to portray themselves as innovators despite adherence to a conservative development schedule. [redacted] 25X1

To improve technology development, the Soviet leadership has been pushing Academy of Sciences personnel into more applied research work. The formation of Interbranch S&T complexes (MNTKs) are a national-level effort to better manage the transition from research to production of multiuse technologies under Academy leadership. To move more academy researchers into applied projects, state funding for basic research has been cut, and academy institute members are being selected to head joint academy/ministry technology/product development programs. Soviet sources indicate that about 30 percent of academy research is now conducted under contract funding. Despite the pressure to conduct more applied research, many academicians are resisting the rush into more applied research work. [redacted] 25X1

Western technology has helped the Soviets considerably. The Soviets' well-organized national program for acquiring and assimilating Western technology has been a major factor in many advances they have made since the early 1970s, especially those essential to the development of modern military systems, such as microelectronics and computers. [redacted] 25X1

Technology transfer from the West continues to provide the Soviets with an expanding technology base. There are two ways the Soviets supplement their indigenous technology needed for weapon systems: (a) by free-world market volume acquisition through illegal trade diversion of manufacturing and test equipment for direct use in production lines and (b) by acquisition of one-of-a-kind hardware and blueprints primarily through the espionage program for design through reverse engineering and copying and overcoming technical obstacles that were slowing down their progress by learning from Western design solutions. Characteristics of these programs overlap. [redacted] 25X1

Western technology is used to supplement indigenous technology in both design and production/testing of weapon systems. Analysis of available Soviet technology transfer requirements shows that about 75 percent is for acquisitions of production and test equipment and that about 20 percent is for design and basic technology. To apply Western technology that will affect the performance of a new weapon system would require the Soviets to assimilate the technology before their earliest design phase begins. To apply Western production technology the Soviets plan for acquisitions before decisions to begin engineering development, but acquisitions and installation may occur up to the time of production line startup. [redacted] 25X1

[redacted] 25X1

Technology transfer from the West has allowed the Soviets to shorten technology development programs. Applying Western technology to their military programs yields significant savings in program costs, frees indigenous R&D resources for efforts in other areas, and enables the Soviets to develop and produce more capable military systems at earlier dates than would otherwise be possible. Given the length of full-scale development and test programs, the time required for foreign technology acquisitions that affect military system performance to impact deployed military capability probably ranges from five to 15 years. New systems would be closer to the high end of this range and modernizations of existing systems would typically be toward the low end. [redacted] 25X1

Reliance on the technology transfer from the West has a downside, in that it tends to impede indigenous development. The USSR's practice of reverse engineering may cause the Soviets problems, as US and Japanese integrated circuits, for example, become more complex. [redacted] 25X1

The tightening pinch in Soviet labor, capital, and natural resources and the accelerating advance of leading Western technologies are causing the Soviets continual problems. These larger problems ensure that the Soviets will continue to require substantial amounts of Western technology and equipment. The Soviet drive to acquire and assimilate technology, therefore, almost certainly will intensify through the remainder of the 1980s, as will its efforts to improve the mechanisms involved. [redacted] 25X1

The USSR uses a schedule-dominant management approach to conduct the engineering development and test phases of the military system acquisition process. We have examined the schedules of over 1,000 military and space programs conducted by the Soviets since the 1950s to determine patterns in the development process. The scheduling of Soviet programs, we found, was based on system complexity and the amount of technical innovation required. We found program schedules falling into three general time frames for systems development:

- Five to seven years for minor improved and converted systems.
- Eight to 10 years for major improved or converted systems.
- Twelve to 15 years for new, complex systems with several major technology upgrades.

Figure 1 relates the weapon development schedules to technology maturation dates [redacted] 25X1

Technology selection occurs early in a schedule-dominant management style before the full-scale engineering phase. The approach used by the Soviets for program management and technology selection is

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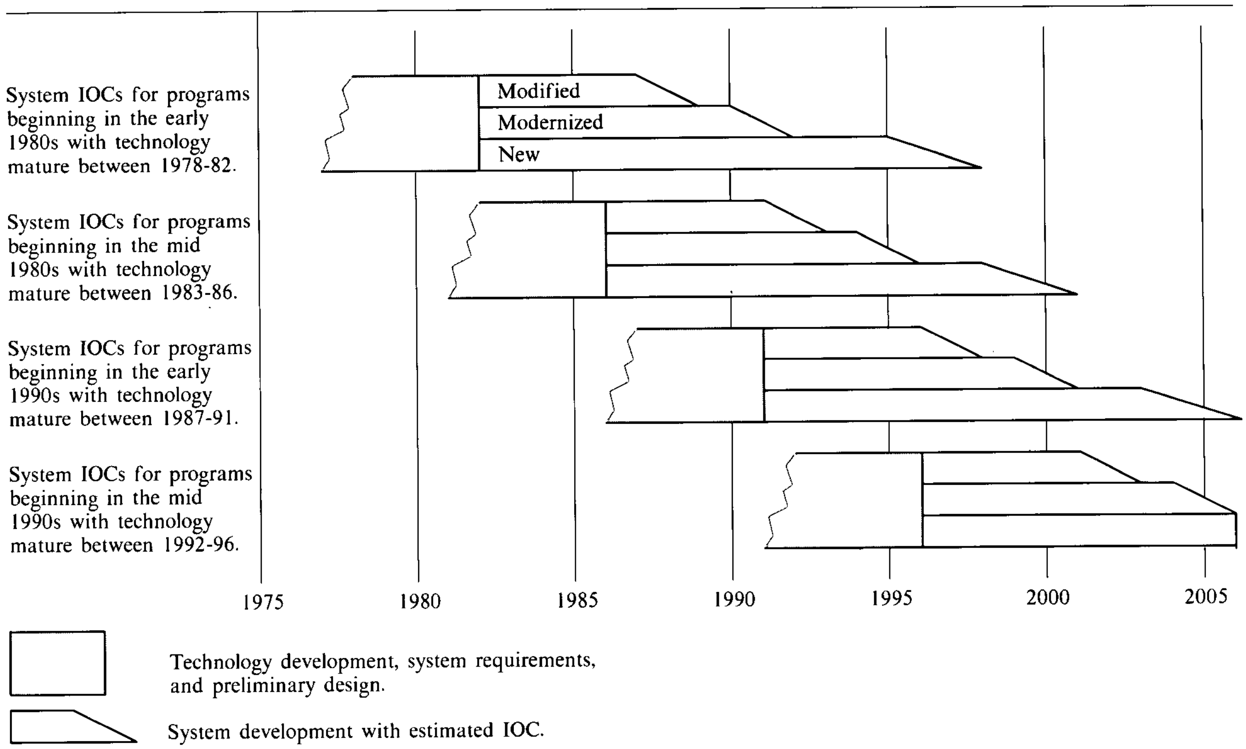
Figure 1
Technology Maturity for Soviet Military Designs



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much like that used in US commercial development programs (for example, IBM computers, AT&T toll switches, and Boeing commercial airliners). The Soviets evidently believe that a stable engineering development phase using technologies proven to be feasible limits the risks in new programs. They routinely plan for product improvement and begin pacing technology development for follow-on versions of the system and its subsystems when they authorize full-scale development of the initial version. 25X1

The Soviet schedule-dominant style of management has resulted in highly successful weapon programs. We believe that more than 90 percent of Soviet weapon programs starting the engineering development phase of acquisition are completed and the systems deployed. For a period under Khrushchev, the Soviets began the engineering development for some programs without proven technology; they had some costly and significant program setbacks—such as the solid-propellant ICBM program, the Tu-144 supersonic transport, T-64 tank, A-class submarine, and their lunar landing program. The Soviets changed to their present management approach in the late 1960s. 25X1

The Soviet system for management of weapons and space system planning and acquisition has evolved several advantages that allow them to compete at the system rather than the technology level and pose a continuing challenge to US military planners:

— By assigning top priority to assimilating the best available technology, indigenous and externally obtained, into their military systems and doing this incrementally with a regular stream of new and improved weapons, the Soviets are able to reduce the qualitative gap with many US weapon systems.

— By exploiting the open discussion of many of our weapon programs, they are able to postpone their own weapon development decisions until the United States has committed to engineering development. [redacted] 25X1

We believe the chances are better than even for Soviet military and space systems to improve technically—relative to Western systems—over the next 20 years. The Soviets have successfully built significant numbers of weapon systems competitive with advanced Western systems despite the many technology areas where they lag the West. Military advantage is not achieved through technology advances alone. Others include: material equipment (its numbers, technology, design, and purpose); organizational structure, doctrine; tactics; understanding its optimum utilization in combat and the training and morale of the troops. [redacted] 25X1

The USSR appears to be following a number of research strategies to bring to maturity technologies needed for new system starts. They do not attempt to compete with the West at the technology level except in a few areas. Overall, they have not pursued a "first-to-market" strategy across the board, as has the United States. Rather, the Soviets have opted for using "follower" or "copycat" research strategies in many areas. These research strategies utilize technologies developed by others and generally result in lower overall costs. The "follower" strategy in research sometimes stifles the development of indigenous technical capabilities in areas where they are weak. [redacted] 25X1

In those areas where the Soviets believe their technology base is good, they attempt to compete with the West in a first-to-market research strategy. They are then often quite innovative in their systems designs and have produced some weapons superior to those of the West, especially armor/antiarmor systems for their ground forces. [redacted] 25X1

The Soviets have been able to use their development infrastructures to accommodate new requirements. Changes in design team product specialties have occurred, and weapons design teams have

[redacted] 25X1

managed technology development projects. They have authorized new organizational infrastructures for emerging technologies when shifting organizational specialties was not adequate. But, when a new need required a wholly new technology, development, and production infrastructure, it has taken them a long time to achieve production rates and qualities competitive with similar Western military systems. Leadership commitment has not often wavered once a goal is set, and resource allocations are increased to meet the pace of accomplishment. The growth rate in the directed energy area, for example, has been steadily upward since work began in the 1960s. [redacted] 25X1

We see the Soviets taking more concurrent steps in managing military system development, and we believe they have moved to the use of less-than-mature technology (feasible but not yet proven producible) in system planning. When successful, this results in shortening the transition time from technology development to system development. For many years, we have seen production activities (production preparation, capital investment, and trial production) taking place at the same time system design and development are occurring. Production line models are tested during latter phases of military system qualification. Recently, we have found the Soviets planning system requirements and preliminary design based on forecasts of production capabilities and successful feasibility demonstration of technology. This was allowed by a change in state standards for system planning in the late 1960s. The Soviets are now allowed to begin system development programs about two to three years earlier than they could in the 1960s. The Soviets in the 1950s began preliminary system designs only when the technology had been proven producible—the so-called off-the-shelf approach. [redacted] 25X1

While the Soviets appear to be taking more risks during the early design phase, they still adhere to their conservative style for the system full-scale engineering phase of development. They apparently will not enter system development, however, without the successful demonstration of component pilot production. Moreover, the Soviets will often try to use proven components already in production when system preliminary designs begin to keep costs as low as possible. The use of goal-oriented programing also has allowed the Soviets to speed up technology development. [redacted] 25X1

Even though the Soviets designate some military system development programs to be a high priority, they do not appear to reduce the time it takes to conduct the program. Analysis of 1,050 Soviet system programs conducted over the last 25 years shows Soviet adher-

[redacted] 25X1

ence to a consistent set of military program schedules. These program schedules are established by the system complexity and the technical level required of new components. High priority allows early access to materials, the best personnel, first call on facility construction crews, and speedup of materials shipments in the transportation system. Thus, priority allows the Soviets to achieve results within these standard program schedules rather than to suffer slippages and delays that would be encountered without this priority. [redacted] 25X1

Our data base for indigenous Soviet research for technology development is not as extensive as that for system programs, but we have found difficult technical developments taking long periods to complete despite high priority. Examples of pacing technologies and subsequent system developments, which will take the Soviets about 30 years to complete, include wing-in-ground-effect vehicles, space nuclear power reactors using thermionic power conversion, liquid fluorine rocket engines, and modern solid-state lasers. [redacted] 25X1

The military and space systems the Soviets will deploy between the early 1990s and the early 2000s will be based largely on technology developed to maturity between 1978 and 1990 (see figure 1 [redacted] 25X1

The number of Soviet military and space development programs and the supporting technology development programs is higher than we previously believed. The Soviets have made a commitment to maintain a large military research, development, and industrial base and to support a large number of simultaneous weapon programs. As a result, the United States will continue to be confronted by a steady stream of new and improved military equipment emerging from Soviet industry for the foreseeable future. [redacted] 25X1

The Soviets' weapons procurement process can be divided into three general categories: technology development, system planning, and weapon development. At present, we believe the Soviets have under way: about 5,000 research projects (3,500 to 4,000 for technology development and 500 to 1,000 for system planning, see table 1) each year for military-sponsored technology development and about 350 to 375 development programs (200 new or major improved or converted system development programs and about 150 program for minor modifications or conversions of existing operational systems) per decade. About 50 Soviet design bureaus are involved with program management for complete weapon systems. The number of full-scale engineering programs has been maintained by the Soviets for over 25 years. The level of research projects for military-related technology development was

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Table 1
Categories of Soviet Military Technology Projects and Weapon Development Programs

Category	Number of Programs	Activities
Technology development	3,500 to 4,000 per year	Technology to improve mission performance. Technology to improve production.
System planning	500 to 1,000 per year	Technology for evaluation/selection of projected systems. Preliminary designs. Planning and production technology for specific systems.
Weapon development	350 to 375 per decade	Systems design, engineering, pilot production, and testing.

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attained in the early 1980s; it was somewhat lower in the 1970s. The large effort in weapons development has not been affected by changes in Soviet leadership, arms agreements with the United States, rises and cutbacks in Western military budgets, major technical failures, program cancellations, and industrial reorganizations. 25X1

We believe that the large number of improved systems that the Soviets are developing will cause more US military concern than any single weapon that might result from a major technology breakthrough. The Soviets reassign design teams to new programs when one program is complete rather than dissolve the team. This practice, in combination with an improving technology base, has a cumulative effect that will be hard for the United States to overcome in areas where the Soviets are already superior or close to the United States. The Soviet approach to systems development has been characterized by gradual, but continuous, improvements to weapon systems and has compensated somewhat for Soviet production weaknesses as well as for the lag in the Soviet technology base relative to that of the West. The Soviets have had in excess of 300 different production programs for military systems under way in any given year since the mid-1970s. To support this effort, the Soviets have about 150 assembly plants for series production of military equipment. 25X1

The number of system development programs we have identified in the 1980s indicates that the Soviets are continuing at the same high level they reached in the 1960s. The expansion of facilities at design bureaus in the early-to-mid-1980s indicates the Soviets will continue to support a high level of system developments for the foreseeable future. To sustain a constant, large number of programs, as the Soviets have been doing, has required an increasing commitment of funds and resources as systems become more complex. 25X1

[redacted] 25X1

Table 2
Soviet Military Systems: Development Programs Per Decade, 1961-1990 [a]

Program Type	Total Since 1960	1961-70	1971-80	1981-90 [b]	Average Expected [c] Programs Per Decade
Strategic Offense Systems	106	33	44	29	35±
Strategic Defense Systems	104	31	36	37	35±
General Purpose Ground Systems	156	50	49	57	50±
General Purpose Land-Based Air Forces and Air Mobility Systems	220	88	74	58	80±
General Purpose Naval Combat and Support Systems	334	136	115	83	110±
National Command, Control, Communications, Intelligence and Electronic Warfare	5	NA	NA	5 [d]	Unknown
Space Support Systems	125	43	29 [e]	53	50±
Totals	**1,050**	**381**	**347**	**322+**	**350 to 375**

[a] Includes those programs that completed state trials or were canceled during the decade.
[b] We expect evidence of as many as 50 additional programs completing state trials—and some currently operational but as yet unidentified systems—to be identified later in the decade.
[c] The expected numbers are not a mathematical average of previous decades but reflect recent trends and reallocations of defense industry design resources. (See Soviet Design and Development Reallocations Section of Chapter I, Volume III.)
[redacted] 25X1
[e] Several spacecraft programs were canceled during the 1970s as a result of booster program failures, [redacted] 25X1

[redacted] 25X1

Any increase in projects in the 1980s, we believe, would be in the technology development category. About 1,100 Soviet organizations have been identified as conducting technology, component, or subsystem development. [redacted] 25X1

Table 2 shows the overall program level-of-effort by decade. Programs are included in the decade in which they were completed. Programs canceled before they were completed are included in the decade in which they were terminated. The slightly lower numbers in the 1970s, we believe, would be higher if we knew all the spacecraft programs the Soviets canceled as a result of their failures in development of the large SL-X-15 space booster, liquid hydrogen upper stages for the SL-12, and in their manned lunar program. [redacted] 25X1

Examination of evidence related to the 50-or-so major design bureaus that are responsible for system development in the USSR shows no reduction of effort through the mid-1980s. We, thus, expect the Soviets to again complete about 350 programs by 1990, and this will continue through the 1990s. [redacted] 25X1

[redacted] 25X1

[redacted] 25X1

Data continue to show the Soviets are continuing to increase the resources allocated to support military technology and system development programs in the USSR. We believe that in 1984, the Soviets spent between 18 and 27 billion (constant 1982) rubles on military RDT&E—about 50 percent of all Soviet RDT&E outlays. Overall, we believe military RDT&E outlays in 1984 as measured in rubles were about 20 percent of Soviet defense expenditures. [redacted] 25X1

Soviet military-related institutes, design bureaus, and test facilities have continued [redacted] 25X1 1986. Moreover, we have associated about 1,100 Soviet organizations with military developments. We now believe about 3 million people work in military research or development projects. The number of institutes and people associated with military developments has increased since our last Estimate in 1983 due mostly to our identification of additional organizations associated with military research. [redacted] 25X1

New analysis has changed our insights into the dollar value of Soviet military-related research, for technology development, and system development, test, and evaluation (RDT&E). A new methodology, stressing inputs, has been developed and shows greater uncertainty bounds in our estimates of the dollar value of Soviet RDT&E activities. Our best estimate is about a third higher, on average, than comparable expenditures of the United States, although they are lower than we previously estimated (see figure 2). The uncertainties in these estimates, however, are such that the lower bound is not significantly greater than US military RDT&E expenditures but the upper bound is half again as much [redacted] 25X1

Our view of how much the Soviets spend on military technology and system developments as a share of all defense spending has changed. Estimates based on the new methodology show the Soviets' share is about 20 percent of total defense spending as opposed to about 12 percent for the United States. In the previous Estimate we judged that the Soviets were devoting about 25 percent of total military spending to military technology and system development. [redacted] 25X1

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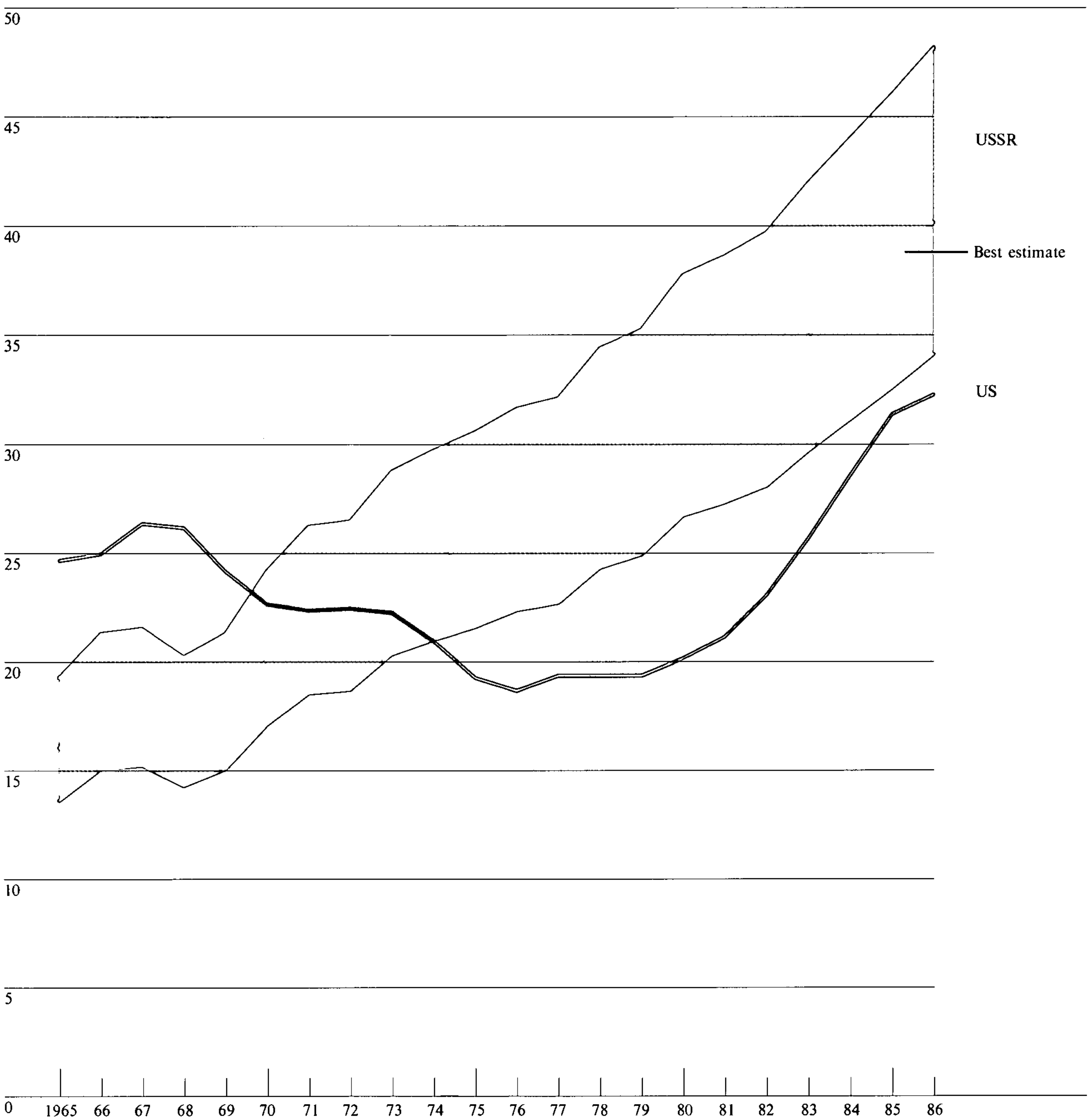
Figure 2
US and Estimated Soviet Military RDT&E Expenditures, 1965-86

Billion 1985 dollars



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[redacted] 25X1

Some portion of the difference between US and Soviet military RDT&E expenditures can be attributed, we believe, to differences in productivity and defense program management approaches. In the United States, RDT&E has been characterized by the extensive use of computers, development of better test equipment, and more efficient pilot production of prototypes. In the USSR, greater numbers of people and facilities must be devoted to RDT&E because of the slower Soviet transition to functions now automated in the United States; for example, preparation of blueprints and design approaches by hand in the USSR versus by using CAD/CAM in the United States. [redacted] 25X1

Since 1975 the Soviets have significantly expanded their large and very costly space program. Considerable portions of that effort are now in the full-scale engineering phase—the most expensive preproduction phase—of the acquisition cycle. [redacted] their engineering 25X1 development costs are about 60 percent of all RDT&E costs. [redacted] 25X1

The Soviets have two major technology problems even though their use of innovative design solutions and compensatory technologies allows them to make good systems. First, they generally lag the West in technology development. A major reason for this lag is their weakness in technological innovation and in transferring technologies developed in one sector of the economy to another. Second, their production base (particularly in microelectronics, computers and telecommunications, composite materials, and high-performance guidance and navigation subsystems) limits their ability to produce higher technology products and quickly move new designs into full production. They hope that their investments for developing technology at a faster pace and for an improved production base will pay off in major economic and military dividends by the year 2000. [redacted] 25X1

For the near term, many high-technology components and materials will be used only in the highest priority military programs. Production problems often prevent more extensive utilization of new technology in other system designs. This problem is most apparent in microelectronics and electro-optics. [redacted] 25X1

[redacted] 25X1

II. Key Soviet Military Technologies

Comparison of the technology levels in the United States and the USSR clearly shows the United States is leading in most technology areas. Overall, however, our research over the past three years has shown the Soviets to be much more capable than we believed in some vital areas. Moreover, they have not fallen further behind the United States in as many areas as we estimated. The number of technology areas where the Soviets lead or are equal to the United States has increased since our last estimate, but much of this is due to the increased numbers of technologies covered this year. [redacted] 25X1

Since the late 1960s, the Soviets have moved to make technological progress a linchpin of their economic and military strategy. Soviet political leaders recognize that technology plays a major role in developing military capabilities that would be competitive with the West. They apparently believe incorporation of new technologies into military systems and an improved military industrial base are the keys to accelerating the growth of military capabilities. The Soviets are working hard to improve the pace of technology development and to modernize their industrial base for the production of new technological products—especially those for the military. Because the quality and depth of engineering and, particularly, industrial capability change slowly, the Soviet areas of weakness will probably persist over the next 10 to 15 years. Furthermore, the accelerating pace of Western advances in such areas as microelectronics and computing will probably frustrate their efforts to achieve self-reliance. [redacted] 25X1

Key technology areas where the USSR continues to lag the United States are microelectronics, signal processing, communications, ASW, electro-optics, infrared sensors, manufacturing, and genetic engineering technologies. We see the Soviets falling further behind in digital computers, computer software and in some integrated circuit research—for example, gallium arsenide—in spite of the high priority and often large resource commitments given to these areas. See table 3 for a comparison of US and Soviet technologies [redacted] 25X1
25X1

Some areas where the USSR currently leads the United States include optical processing, liquid fluorine and nuclear rocket propulsion, chemical warfare, explosives, high-power-density liquid metal reactors for nuclear submarines and for possible space applications, titanium metallurgy and welding, some high-energy lasers, some areas

[redacted] 25X1

Table 3
Technologies Mature for Application to Military Systems: A Comparison of Selected Areas

Topic	Leader	Topic	Leader
IR/EO/UV	United States	Turbine engine propulsion	United States
Radar	United States/equal [b]	Naval propulsion	Equal
ASW	United States	Ground propulsion	United States/equal [b]
Signature reduction	United States	Lasers	Equal
Microelectronics	United States	Radiofrequency power generation	USSR
Computing hardware	United States	Charged particle beams	United States/USSR [a]
Computing software	United States	Neutral particle beams	United States/USSR [a]
Signal processing	United States	Nuclear	United States/USSR [a]
Communications	United States	Conventional explosives	USSR
Guidance and navigation	United States	Chemical/biological warfare	USSR
Power	United States/USSR [a]	Kinetic energy—armor/antiarmor	USSR
Materials—metallic	United States/USSR [b]	Kinetic energy—hypervelocity	USSR
Materials—nonmetallic	United States	Life sciences	United States
Rocket propulsion—liquid	USSR	Ocean sciences	United States
Rocket propulsion—solid	United States	Production	United States

[a] There are important areas where the United States is ahead and important areas where the USSR is ahead.

[redacted] 25X1

[redacted] 25X1

of charged and neutral particle beam-related theory and technology, millimeter wave (radiofrequency) power sources, and possibly vacuum integrated circuits. [redacted] 25X1

The Soviets have made substantial progress in explosive and some prime power technologies. Until recently, we considered the United States to be equal or superior to the Soviets in deployed armor/anti-armor technology, but we now find that the US R&D technology applications are only about equal to technology the Soviets have already incorporated in deployed systems. In the explosives technologies, the Soviets have synthesized many new compounds and they have a large program on these technologies. They have developed enhanced blast munitions technologies that use a powered aluminum wrap (reactive surround) around a high-blast explosive, have continued to advance fuel-air explosives technology and have begun a research program for new advanced types of explosives. [redacted] 25X1 25X1 25X1 They surpassed the United States by the 1970s and have continued to maintain a clear lead in hypervelocity impact research—an area of importance to nonnuclear kinetic energy weapons. They could be on a par with the United States in various nonnuclear kill

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[redacted] 25X1

devices, including light gas guns and electromagnetic rail guns. They are ahead in magnetohydrodynamic (MHD) and magnetocumulative generator (MCG) power sources; such power sources that have potential applications in directed energy systems. [redacted] 25X1

In a number of areas where the Soviets are lagging in the development of technology, they are attempting to use an alternate technology to make up for the shortfalls. In some of these alternate technology areas, the Soviets have established technical leadership. Some examples include: development of storable liquid propulsion vice solid propellants for ballistic missiles; optical processing to help make up for an overall lag in signal processing; and development of stellar sensors and hydrostatic gyroscopes to make up for their lag in other guidance and navigation technology areas. [redacted] 25X1

In 1983 the Soviets began a research program intended to produce by the early 1990s a supercomputer based on optical processing technology. We do not know its current status. This computer project may be an attempt by the Soviets to close some of the gap with Western computers that are based on digital electronic processing. We do not expect the Soviets to overcome the US lead in computers, but they will make major strides forward as new generation digital devices continue to be produced. [redacted] 25X1

Since the last Estimate we have become aware of Soviet work in several areas that have a major impact on their military systems applications. Analysis of Soviet research in polymers for drag reduction shows advanced work applicable to burst speed capability for torpedoes and submarines. The Soviets began to research and test blue-green lasers in the 1970s for application to aircraft- and space-to-submarine laser communications systems. Support appears to have continued in the early 1980s and may be related to spacecraft applications. They have also begun titanium-doped sapphire laser research, which may also support spacecraft-to-submarine communication system development.
[redacted] 25X1

[redacted] we have noted several efforts that could be indicative of significant emerging Soviet technical capabilities. For example, the Soviets have made a multibillion-dollar investment in research facilities for hypersonic aerodynamics, developed a high-purity beryllium metal processing technique, and have conducted extensive research in laser radar technology. [redacted] 25X1

We have also found some technologies where the Soviet work was sufficiently advanced for the United States to begin research or make significant strides in existing work as the result of using Soviet published theoretical work. Most notable was the US use of Soviet theory in particle beams, hypervelocity accelerators, and X-ray lasers. [redacted] 25X1

[redacted] 25X1

[redacted] 25X1

Comparison of the United States and the USSR in technology alone is not only inadequate but could be misleading for US military system planning purposes. There are three key features to support the above conclusion. First, the Soviets supplement their indigenous technology base by free world market acquisitions and by inputs from their large technology espionage program. Once an acquired technology has been reverse engineered and proven producible, it can be selected for a program. They will continue to pursue external technology in areas where they lag in order to achieve system performance goals. [redacted] 25X1

Second, the frequency of Soviet system modernization and early knowledge of Western system characteristics allow the Soviets to undertake competitive system designs on schedules responsive to the United States. To fill these operational requirements, Soviet designs do not always require the same level of technology as the United States to be competitive and often larger Soviet force levels to some extent compensate for technological disparities. A gradual growth in technology advances allows Soviet designers to increase technology levels incrementally during their frequent system upgrades. [redacted] 25X1

Third, the achievement of a specific performance level in a technology does not automatically mean that the technology is available for Soviet military systems development. Laboratory test results are not considered demonstrations of military system performance levels. Moreover, not all technologies producible in highly capable institutes or lead plants are easily translated into the Soviet production base. The Soviet production base has difficulty in beginning to produce new high-technology products and often, even after they do so, product quality is not up to Western standards. [redacted] 25X1

The Soviets have successfully built significant numbers of weapon systems competitive with advanced Western systems despite the many technology areas where they lag the West. The Soviets are able to begin development of military systems shortly after the required technologies mature. For example, in 1977 the Soviets conducted a feasibility demonstration of a rib-truss space antenna (the KRT-10) and by 1980/81 had authorized a space system using this antenna technology. Also, they completed research for gallium arsenide space solar cells in the mid-1970s and used them on the MIR space station that entered development in the mid-1970s. They also reportedly conducted feasibility tests with an analog fly-by-wire aircraft avionics subsystem in 1973 and authorized its use in the AN-124 transport in 1977 when it was qualified for design application. [redacted] 25X1

When a country other than the United States is the world leader in a technology, the USSR attempts to procure technology there as well as in the United States. For example, the Soviets are now obtaining some communications technologies from both Japan and the United States. In such cases, the USSR might apply a technology development to a weapon system design at the same time or before the United States, even if they lagged the United States in that technology. [redacted] 25X1

In many technology areas, such as directed energy and optical computing, the Soviets are emphasizing development. Areas of priority Soviet technology development are manifested in several ways: increased program authorizations, growing research infrastructures, increased capital investment, and application of goal-oriented management. [redacted] 25X1

The Soviets continue to develop technologies and systems not currently pursued in the West, and this practice is expected to continue. Some technologies once actively pursued in the United States are major research areas in the USSR. The Soviets undoubtedly saw merit in the use of such technologies for their requirements, while the United States made other program and requirement choices. The Soviets have been developing nuclear rocket propulsion technology for spacecraft applications since the early 1960s with a hiatus in the late 1960s to early 1970s, while the United States abandoned it about 15 years ago. Both the United States and the USSR researched automatic loaders for tank guns in the 1950s. The United States dropped its effort in the late 1950s, but all Soviet tanks entering development beginning with the T-64 in 1958 have used such loaders. [redacted] 25X1

The Soviets are also developing liquid fluorine rocket engines for space missions. Moreover, they continued to develop nuclear power reactors for space applications while the United States discontinued its efforts between 1973 and 1985.[1] The USSR continued an active chemical warfare program after the United States cut back. The United States was an early developer of fuel-air explosives and conducted research in enhanced blast munitions. Today these are areas where the Soviets are very active and the United States is not rapidly pursuing development. [redacted] 25X1

[1] The FY-1986 DOE/NASA/DARPA budget included a technology development program start of the SP-100 nuclear space power supply. [redacted] 25X1

[redacted] 25X1

The Soviets have pursued development of mobile strategic missiles since the late 1950s. While many early programs were canceled, most programs begun since the 1970s are being completed—the SS-20 IRBM; the SS-25 ICBM; and the SS-X-24 ICBM programs, for example. The United States has several times investigated mobile strategic missiles but has only deployed the Pershing II. [redacted] 25X1

Although the Soviets have reduced the number of liquid-propellant missiles in development, they continue to pursue development of storable liquid propellants—significantly reduced by the United States when the Titan II program ended. Throughout the 1970s, they continued research to develop gel propellant technology for missiles (gels were dropped by the United States in the late 1960s). [redacted] 25X1

The Soviets continue to develop technologies and system programs for strategic defense. The ABM program in the USSR continues, and the Soviet air defense system is being upgraded. [redacted] 25X1

We also see areas where the Soviets are reducing system developments—liquid-propellant ICBMs and SLBMs, for example. While continuing to modernize their ballistic missile forces they have reduced the number of new liquid-propellant missile types per generation since the early 1970s and shifted some design assets into space and cruise missile programs. The technology is nearly available and they seemed on the verge of a new generation of boosters—using gel propellants [redacted] 25X1 25X1

Technology transfer from the West continues to provide the Soviets with an expanding technology base. It has allowed the Soviets to truncate indigenous research projects earlier than originally planned and the Soviets were able to begin military system development earlier than they would have originally planned if they had relied solely on their indigenous effort. System development would then follow a normal schedule. The system involved reaches the field with performance that could not have been achieved with indigenous Soviet technology at that time. [redacted] 25X1

The Soviets have continued to reverse engineer or buy Western products where they lag the West. For example, the Soviets have reverse engineered and placed into limited production many Western memory chips and microprocessors, and have begun to acquire fiber optics and switching technology for designing new communications systems. Specifically in the area of microelectronics there is sharp disagreement in the Intelligence Community over whether the Soviets

[redacted] 25X1

have successfully reverse engineered recent generation chips—256k DRAMs, for example.[2] Moreover, they are supplementing their weak production base with purchases both legally and illegally of high-technology production equipment from the West. Examples of this production equipment include advanced automated assembly lines, robotics, and autoclaves for producing composite structural materials. [redacted] 25X1

The USSR's practice of reverse engineering, however, may soon run into problems. As US and Japanese integrated circuits, for example, become more complex, reverse engineering will require: (a) tracking hundreds of thousands of connections, (b) understanding how they all fit together, and (c) mastering the complex process steps used in production. Thus, copying such circuits will require not only much more sophisticated Western equipment but also much more effort to duplicate each circuit. We do not know if this will cause the microelectronics gap with the West to widen. [redacted] 25X1

Our analysis of actual Soviet projects that benefited from foreign technology acquisitions in 1979 and 1980 indicates that only about 20 percent were projects related to the design or development of specific weapon systems. Of these, the largest single group of projects were related to the generation of technological concepts and the evaluation of their feasibility and producibility. Another smaller group of projects for developing components, devices, and production equipment were for specific system programs. It appears that the largest portion of the acquisitions is applied in the Soviet equivalent of the US "advanced technology development" (the 6.3A stage of the acquisition process), which precedes full-scale development. On the basis of our analysis of these inputs and the Soviet military research and weapon development process for major systems, we believe that it takes the Soviets about one to five years to incorporate foreign acquisitions into their own full-scale development programs. Given the length of full-scale development and test programs, the time required for technology to impact deployed military capability probably ranges from five to about 15 years. New systems would be closer to the high end of this range and modernizations of existing systems would typically be toward the low end [redacted] 25X1 25X1

The Soviets have reacted to improved Western control of technology by trying new tactics to acquire data or equipment. Recently, they declared they had completed building an operational supercomputer, hoping the West would drop controls when, in fact, the program was

[redacted] 25X1

[redacted] 25X1

still in trouble. Also, another ploy has been to invite Western scientists to participate in science projects on space missions. The science projects solicited would require use of embargoed instrumentation or technology. [redacted] 25X1

There is no indication that foreign technology acquisitions have reduced the time required for Soviet weapon development programs. But it is extensively used in program planning, especially for technology selection; in justification of design approaches; and in threat determination. We do not believe the Soviets plan to use foreign parts extensively in weapons. We believe technology transfer cannot change the level of feasible technology in an ongoing authorized military system program in full-scale engineering development. [redacted] 25X1

Technology transfer for multiuse components, such as microelectronics, is incorporated in ongoing research work or is used as the rationale for new research projects. The Soviets will still bring such components devices to pilot maturity before making them available for use in the preliminary design phase of military system development programs. [redacted] 25X1

The Soviets conduct feasibility tests of new military technology before they decide to use the technology to develop a military weapon system. The range of technology feasibility testing we have noted includes items from the size of components, such as a silicon-on-sapphire microcircuits, to subsystems such as liquid-propellant rocket engines for spacecraft, to those to test the feasibility of complete system configurations—such as the FAITHLESS V/STOL aircraft, which proved technology for the FORGER fighter aircraft. [redacted] 25X1

25X1

Feasibility test devices are built to applications standards, not production and military operational standards. If such devices are successfully tested, it does not mean the Soviets have achieved a military capability. [redacted] 25X1

25X1

[redacted]

[redacted] 25X1

[redacted] 25X1

The Soviet laser technologies will progress and production capabilities will grow throughout the 1990s. The large tactical laser effort now involves major portions of at least three directorates of the Ministry of Defense Industry (MOP). They will be producing increased numbers of solid-state lasers for the ground and air forces with applications for range finding, detection, target designation, and defense suppression. New tunable solid-state laser technologies are expected to be available for applications to systems in the late 1980s or early 1990s [redacted] 25X1

[redacted] 25X1

measure. The integration of technologies available for use with lasers for radar applications will continue to improve. [redacted] 25X1

For strategic applications, initial use of lasers probably will include air defense and ABM radars, identification of space targets or ballistic missile reentry vehicles, and for use in aircraft and satellite-to-subma-

[redacted] 25X1

The availability of improved lasers for industrial purposes will allow their uses to expand and to satisfy more requirements for a variety of new generation materials and components. The newly formed MNTK goal-oriented program structure under the Academy of Sciences at Shatura should be a driving force in applying lasers to industry. [redacted] 25X1

Soviet technology, we believe, is available to begin development of high-energy laser damage systems in the 1980s: 100+ kW class laser technology became available in the early 1980s and low (1 to 2) megawatt class laser technology by the mid-1980s. There is another view that believes that the Soviets attained maturity for 10 to 100 kW CO and CO_2 EDL lasers in 1973-78 period and for 0.1 to 1.0 MW CO_2 EDL during 1977-80.[3] Additionally, they believe military capability

[3] *This view is held by the Director, Defense Intelligence Agency, the Central Intelligence Agency, and the Director of Naval Intelligence, Department of the Navy.* [redacted] 25X1

that a ground-based ASAT device provides should not be overlooked, even if it has not reached its full potential. [redacted] 25X1

By 1980 the Soviets had technology development under way on Free Electron Lasers (FELs). FEL technology for application to system designs is not expected to mature in the 10 to 100 kW class until the early-to-mid 1990s and in the 100 kW to 1 MW class until the late [redacted] 25X1

The USSR will continue to pursue technology development in many strategic defense areas. We expect they will closely monitor US technical developments to acquire additional insights into our progress and conduct their own research to offset US lines of research. It is unlikely they will forge into any weapon system development program not previously planned for their own military needs, until the United States begins engineering development. They already have instituted research projects to gain insight into ways to counter US technical paths. [redacted] 25X1

The USSR began major research programs in the mid-1960s to provide the technology base eventually to build high-power directed energy weapon systems. Most work through the present has been research and testing for feasibility demonstration of technologies applicable to weapons. Allocation of resources for development of research, test, and a pilot production industrial infrastructure has been steady, though costly, since then. [redacted] 25X1

A key problem, as the Soviet laser program has expanded, has been to determine when the Soviet technology matured for them to begin weapon system designs. Some believe there is direct evidence to support system development under way in the Soviet Union and some do not believe we yet have direct evidence of a system development program. We believe many of the test devices [redacted] and in laboratory physics experiments are feasibility demonstrators. There is another view that believes that not all devices [redacted] are feasibility demonstrators, but some could be system prototypes. Additionally, the holders of this view believe the military capability that a ground based ASAT feasibility demonstration device provides should not be overlooked, even if it has not reached its full potential.[4] We have not found direct evidence of a Soviet high-power directed energy laser weapon system in full-scale engineering development. But we believe the Soviets could have initiated system development in the 100 kW class

25X1 25X1

[4] *This view is held by the Director, Defense Intelligence Agency; the Central Intelligence Agency; the Director of Naval Intelligence, Department of the Navy; and the Deputy Chief of Staff for Intelligence, Department of the Army.* [redacted] 25X1

in the early 1980s and low megawatt class lasers in the mid-1980s. Development beginning in the early-to-mid-1980s probably would not reach IOC for 12 to 15 years after a decision to develop was made—and then if no test problems are encountered. Additional system specific technology development may yet be necessary before development can begin in some weapons-related areas. There is another view which believes that the Soviets launched full-scale development of some high-energy laser weapons programs as early as the mid-to-late 1970s.[5] [redacted] 25X1

A design bureau and production infrastructure associated with explosive MHD and explosive MCG power sources probably were established in the early 1980s. Explosive MHD and MCG technology is available for use as early power source subsystems for directed energy and hypervelocity kinetic energy systems. The work may be directed by the Institute of Hydrodynamics in Novosibirsk. Nonexplosive power sources for MHD devices are widely available and will continue to be used for a variety of both military and civil applications. [redacted] 25X1

The Soviets have an extensive research effort in hypervelocity kinetic energy impact supported by a very large organizational infrastructure. Extensive work has been under way on light gas guns, rail guns, macroparticle streams, and magnetohydrodynamic hypervelocity electrocannons since the 1960s. After 1983 Soviet hypervelocity impact work became centrally managed. [redacted] 25X1

The Soviets have made limited applications to military systems, with mixed results, of composite materials—an area where significant gains are being made in the West. The USSR has lagged the United States significantly in the use of composites. The reason for the Soviet lag may be related as much to policy choices as it is to technical factors. The USSR has a very strong, long established, metallurgical technology and production base. They also have extensive raw material resources in many metallic materials not available in quantity in the West. A major Soviet national commitment was made in the early 1970s to establish a polymer composite materials industrial base and, while the development of technology has progressed, manufacturing has been a problem. Thus, the Soviets have tended to continue to select metallic materials for many design solutions. Moreover, they have bought significant amounts of composite materials production machinery from the West instead of creating a design base for their own equipment. As polymeric composites demonstrate the capability to provide significant strength-to-weight gains over metallic counterparts, the traditional bias toward selecting metallic design solutions may change. However, a major aircraft accident in the early 1980s may have set back the application of metallic composite materials. A structural member constructed of metal matrix composites failed during the test of an unidentified aircraft. [redacted] 25X1

[5] *This view is held by the Director, Defense Intelligence Agency, the Central Intelligence Agency, and the Director of Naval Intelligence, Department of the Navy.* [redacted] 25X1

III. Influence of Technology on Possible Major Soviet Military Systems 1995-2010

For systems reaching operational forces in the mid-1990s and later, the Soviets will use the strong and sizable base of military technology advances they have made since the late 1970s. Soviet military equipment has been characterized by designs for weapons they believe can be produced and procured in quantity at the time a program is initiated. *The major portion of Soviet systems projected for the 1990s and early 2000s will involve evolutionary improvements in the types of systems now in service.* The capability of many systems may improve significantly as the enabling technology base provides the basis for higher performance increments per generation. [redacted] 25X1

A small portion of the new systems will provide capabilities new to the Soviets. For example, Soviet directed energy and kinetic energy weapons-related research had considerable momentum well before the United States announced the Strategic Defense Initiative (SDI) program. If proven feasible, these technologies will eventually allow them to begin weapon programs to meet their own strategic defense requirements. This extensive work is likely to proceed regardless of US advances in SDI. [redacted] 25X1

Our analysis leads us to conclude that the performance levels of any weapons scheduled to enter full-scale deployment by the turn of the century will be based on technology either now available to the Soviets or that will be by 1990. [redacted] 25X1

Technology available to the Soviets between the late 1970s and early 1990s will allow them to achieve significant performance upgrades in many mission areas. A steady stream of new and improved Soviet military technology developments will be available to Soviet planners and design engineers throughout this period. These new and improved technologies will allow military systems completing state trials between 1995-2010 to be more capable than their predecessors even though in individual areas of technical achievement the Soviets may lag the West. We believe the levels of technical achievement attained plus their large and continuous systems development effort will allow them to compete effectively in overall capability with US systems over the next 10 to 25 years. [redacted] 25X1

[redacted] 25X1 Figure 3 shows the time lines for some of the major system programs and for the key technology developments that preceeded the system programs. [redacted] 25X1

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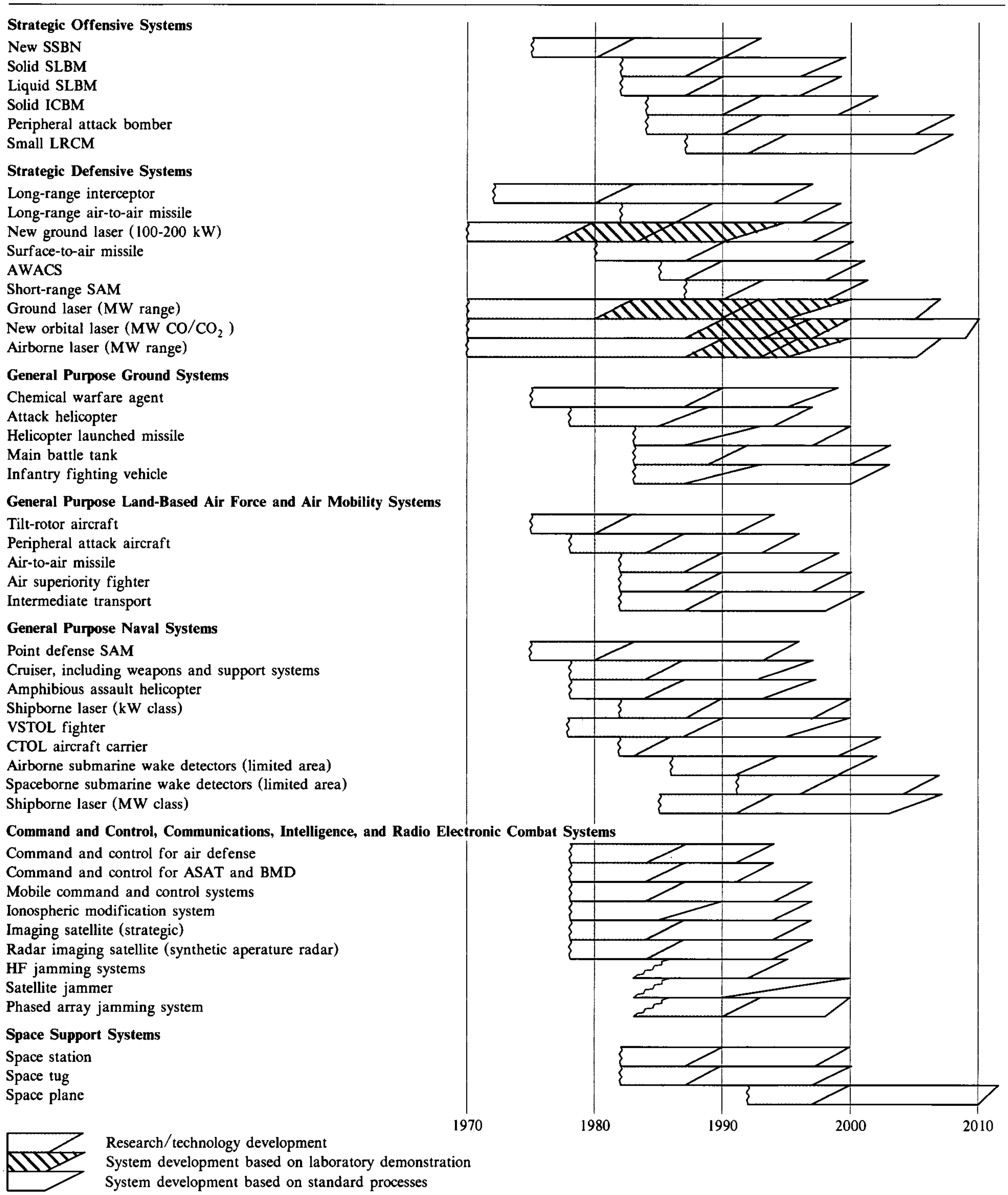
Figure 3
Possible Soviet Military System Developments for the 1990s and Early 2000s-Selected Projections



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We have attempted to project some representative Soviet systems, which they could choose to develop in the late 1990s and early 2000s, based on potential for improvement, identified completed research programs, established system trends, and the maturity of the pacing key military technologies. Particular weight is given to firm evidence of pacing technology for systems. We have concentrated on those systems that would depend on the availability of particular key technologies to achieve their performance, and have tried to anticipate their development schedule based on their availability for weapons planning. [redacted] 25X1

Advances We Expect In Specific Missions Areas

Technologies for Strategic Offensive Systems

The Soviet Union has continued to have a vigorous effort in research, technology development, system development, and deployment for strategic forces. It is the result of an unswerving commitment for the past two decades to build up and improve their strategic force capabilities. Since the mid-1960s, there has been substantial growth in Soviet strategic attack forces; intercontinental ballistic missiles (ICBMs), submarine launched ballistic missiles (SLBMs), bombers, and air-launched cruise missiles (ALCMs). [redacted] 25X1

Strategic nuclear attack capabilities will improve significantly as a result of incorporating higher levels of Soviet microelectronics, propulsion, guidance and navigation (G&N), structural materials, communications, signature reduction/low observables, sensors, and sensing technology levels than they attained in previous generations:

— Signature reduction technologies would have allowed the Soviets in the early 1980s to begin development of bombers and cruise missiles with reduced radar cross sections. Designs of the early 1980s attained 5 square meters and 0.1 square meter radar cross sections (RCSs) respectively. The Soviets will probably be capable of achieving respective RCSs of 1 square meter and 0.01 square meter in the early 1990s.

— Propulsion, G&N, and materials technologies will allow accuracy, payload weight, and range capabilities to improve so that the Soviets could significantly increase the lethality of deployed individual ballistic missiles against the US target set.

— Penetration aids, sensors for maneuvering reentry vehicles, structural materials and propulsion technology research is now being geared to provide the Soviets in the 1990s with the technological capability to begin designs of ballistic missiles reentry packages designed to evade or overwhelm US BMD systems.

[redacted] 25X1

— Improved communications technologies will allow the Soviet NCA to improve their ability to coordinate strategic integrated operations retargeting and ensure continuity of authority, but retargeting of long-range assets against mobile targets will remain beyond their technical abilities to begin designs until the mid-1990s. [redacted] 25X1

Technologies for Strategic Defensive Systems

We expect that the Soviets will have the technology available to extend and intensify their already existing strategic defense capabilities. A variety of new technologies for orbital, ground-based, and airborne systems are in research, or are being developed with established technologies such as propulsion, materials, aerodynamics, radar, and computers. Some will require mastery and integration of new technologies such as lasers, particle beam propagation, and associated pointing and tracking systems. [redacted] 25X1

Strategic defense capabilities will improve with advances in radar, signal processing sensors, laser radar, laser pointing and tracking, laser power source, and directed energy technology research programs, which have received significant resources over the past 10 to 20 years:

— Early 1980s radar moving target indicator and signal processing technologies will allow development of systems with improved detection of low-altitude aerodynamic targets with large radar cross sections, but technologies to allow design of systems to detect aerodynamic targets with reduced radar cross sections will not be available until the early 1990s. Systems based on these technologies should be ready for deployment 10 to 15 years after design is begun.

— Significant portions of the directed energy effort in the USSR can now be identified as technology development rather than military system development. We expect further research efforts to produce laser airborne and space feasibility demonstrations by the mid-1990s, before system development programs are authorized. Initial ground-based laser ASAT capabilities may be in test by the turn of the century, but other directed energy damage systems are not likely to be available until much later for ASAT, BMD, and air defense applications.

Another view believes there is evidence that the Soviets may have started some high-energy laser weapon system development programs. Moreover, the holders of this view believe that, for some high-energy laser defensive weapon systems, comple-

[redacted] 25X1

tion of test devices—whether they are prototypes or feasibility demonstrators—could be considered a limited military capability.[6]

There is an alternative view that holds that there is insufficient evidence to determine that Soviet high-energy laser research has transitioned from technology development (NIR) to systems development (OKR), or to determine dates for Soviet achievement of such technology maturity.[7] [redacted] 25X1

Technologies for General Purpose Ground Systems

Tactical Ground Warfare capabilities will continue to be an area where Soviet systems will excel as the result of structural material, conventional explosives, microelectronics, laser ranging and designation, and BW/CW technologies available for new designs entering the engineering phase of the acquisition cycle in the 1980s and early 1990s:

— Soviet structural materials and explosives technology developments continue to provide tank and antitank missile designers with the capabilities to offset emerging US developments that are made known to Soviet planners by early open-source and intelligence collection.

— Explosives technology advances continue to provide Soviet munitions designers with improved lethality in conventional strike weapons for artillery and SRBMs.

— Lethality of conventional strike weapons will be significantly improved by the application of LSI/VLSI microelectronics to fire control systems and the introduction of solid state tunable lasers for target designation, ranging, and countermeasures for damage limitation.

— Development of third-generation chemical agents and toxins along with genetic engineering to produce new biological agents will continue to pose a significant threat.

— Propulsion, structural materials, and sensoring technologies will enable the Soviets to develop new helicopters including those for improved air-to-air warfare. Tilt-rotor aircraft are already under development based on technologies available in the early 1980s. [redacted] 25X1

Technologies for General Purpose Land Based Air Force and Air Mobility Systems

The majority of the improvements in aircraft will come from *evolutionary technological developments. Emphasis will be on aircraft survivability and weapon system efficiency.* We do not foresee signifi-

[redacted] 25X1

[7] *This view is held by the National Security Agency and the Deputy Chief of Staff for Intelligence, Department of the Army.* [redacted] 25X1

25X1

cant expansions in the overall flight envelopes for combat aircraft; however, it is likely that survivability will be attained through improvements in aircraft performance and application of signature reduction technologies. We can expect to see innovations in such areas as tiltrotors and reduced signatures. Future radars coupled with upgraded infrared search and track systems and laser rangefinders will further improve air-to-air capabilities. Advances in radar signal processing will allow designs of improved all-aspect, lookdown/shootdown capability. Finally, the maturity of analog fly-by-wire avionics technology in the late 1970s should allow application to new tactical air programs in the early-to-mid-1980s that will be deployed in the 1990s. 25X1

Technologies for General Purpose Naval Systems

The Soviet Navy will continue to improve the capability of its general purpose forces to protect its SSBNs, counter-Western naval forces, provide support for ground operations, and disrupt enemy sea lines of communications. The Soviets will attempt to expand the areas in which they can conduct sea denial, improve the combat capabilities of modern principle surface combatants for operations well beyond the range of land-based fighter aircraft protection, and develop increased operational capability for combined arms tasks. 25X1

Technologies for National Command and Control, Communications, Intelligence, and Radioelectronic Combat

Forthcoming improvements in operational command and control capabilities will continue to stress the national command authority's more rapid and survivable control of forces and weapons. Command, control, and communications for the next decade will be limited by microelectronic and power supply technologies that are either now mature or will be in the near future. Technology available in the 1980s will lead to decisions on systems that will allow the Soviet leadership command and control systems that have improved technical capability to more rapidly executive ICBM strikes on tactical warning, or preemptively. Real-time crisis management systems may become possible through integrated intelligence displays and automated decisionmaking aids fed by a network of strategic sensors and weapons status monitors in the strategic forces. The Soviets will have the necessary technology to implement automated centralized battle management functions at theater, front, and fleet command centers. Technology to make communications and signal-processing terminals more survivable will be available in the mid-to-late 1980s for new system designs. Technology now available for new designs will allow for the extended use of coding for error correction, adaptive routing with packet switching, adaptive high frequency (HF), spread-spectrum, exotic frequencies (including

[redacted] 25X1

millimeter wave and optical bands), and intersatellite links to increase the survivability and reliability of communications circuits. Technology [redacted] 25X1

25X1

Technologies for Space Support Systems

We expect the Soviets to make improvements to the new space boosters they are now developing throughout the 1990s. The increased lift capabilities of these vehicles over predecessor SLVs will result in many new missions and improved capabilities over the next 20 years. The Soviets may have a far-term goal to develop a completely reusable, horizontal takeoff-and-landing, hypersonic two-stage vehicle for earth-to-space transport. Mature propulsion and guidance technologies will allow the Soviets to begin design of a space tug in the late 1980s. [redacted] 25X1

Soviet industry should, in the mid-1990s, after 20 years of modernization, retooling, and management shifts, be capable of more rapidly assimilating high-technology military products into production. The defense industrial production sector should also be less restrictive on technology choices for new designs entering development—perhaps as soon as the mid-1990s. Payoff for the Soviets in high-volume, high-productivity output even if modernization is successful is not likely until the 2005-2010 time frame. Moreover, the improved management of technology development will have further increased the pace of technology maturation. A more efficient design base probably will no longer require significant expansion to conduct more complex product development programs. We do not know at this point in the modernization—due to present difficulties—whether they can keep up with the steady pace of modernization that is continuous in the West. [redacted] 25X1

Production and deployment rates observed for new high-technology military equipment show a trend toward fewer but better individual systems. We expect this trend to continue into the 1990s and beyond. During unit modernization the Soviets have been replacing more than one older system with a more capable single new system. This has resulted in, for example, smaller numbers of aircraft in a regiment and lower submarine force replacements as old units are retired. The Soviets face difficult choices in deciding whether to replace equipment on a one-to-one basis for a more powerful force capability or on a less than one-to-one replacement rate that would allow growth in force capability at a reasonable cost. [redacted] 25X1

[redacted] 25X1

If the Soviets somewhat accelerate the pace of technological development and still supplement their indigenous efforts with Western advanced technology, they would be in a better position to effectively respond to US high-technology systems developments—SDI, for example. How the Soviets maintain their capabilities over the longer term would depend on the pace of high-technology systems development established by whomever seizes the lead. If the United States set a high rate of SDI system modernization, for example, after attaining a lead it would still be difficult for the Soviets to develop competitive systems without major changes in commitments to existing types of programs, reallocation of design assets, and/or an increased overall military effort. [redacted] 25X1

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