

23594



~~Secret~~ Micro

Directorate of
Intelligence

CIA|SW -----|91-10053 X -----

Soviet Military R & D: Scaling Back and Taking Risks

An Intelligence Assessment

CIA HISTORICAL REVIEW PROGRAM
RELEASE AS SANITIZED
1999

~~Secret~~

SW 91-10053X
SOV 91-10053X
August 1991
Copy

29
ds
dl



*Directorate of
Intelligence*

~~Secret~~

Soviet Military R & D: Scaling Back and Taking Risks

An Intelligence Assessment

This paper was prepared by a joint working group of the Office of Scientific and Weapons Research and the Office of Soviet Analysis. The chairman was [redacted] OSWR; members were

[redacted] OSWR, and [redacted] SOVA. Analysts and managers in OSWR, SOVA, and the [redacted] contributed to the paper

Comments and queries are welcome and may be directed to the Chief [redacted] OSWR

Reverse Blank

~~Secret~~
SW 91-10053X
SOV 91-10035X
August 1991

Soviet Military R&D: Scaling Back and Taking Risks

Key Judgments

*Information available
as of 31 July 1991
was used in this report*

As part of an overall downsizing and restructuring of the Soviet defense establishment, the Soviets for the first time in over 20 years are cutting military research and development.

we conclude that the Soviets since mid-1988 have made:

- Small cuts—perhaps 5 percent—in the development of military systems. Of the 100 major systems we have identified in development, most seem to be progressing on schedule. Systems evidently affected by the cutbacks include the Madcap airborne warning and control aircraft, which probably has been canceled; the Utka wing-in-ground-effect ship, whose production evidently has been deferred; and two new nuclear-powered attack submarines, whose development may have been delayed because of demanding technical requirements and tight resources.
- Substantial cuts—perhaps 15 percent—in the development of military technologies, apparently by pruning parallel and alternative technological approaches to meeting military requirements. Although no major mission area has been immune to cuts, we judge that the Soviets are maintaining strong efforts in the development of the technologies that we view as critical for future Soviet military systems.
- Large, across-the-board cuts—perhaps 40 percent—in military support for basic research. These cuts were swift and deep, and no major area of research appears to have been spared. Nonetheless, we judge that the Soviets are continuing strong basic research programs applicable to antisubmarine warfare, directed energy, low observables, counter low observables, and other technologically challenging future military capabilities.

Our quantitative estimates of the Soviet R&D effort include considerable uncertainties, but the downward trends are clear.

The course of Soviet military R&D over the decade ahead, however, is far from clear. The nature and extent of change hinge on the strength of the Soviet economy, the resolution of who will determine security policy, and the view those leaders will have of military threats to the country. Further military R&D budget cuts probably are occurring in 1991, but the military leadership is fighting to stabilize funding.

On balance, given current policy directions and little further economic decline, the Soviets in the 1990s probably will finish the development of a large number of new and modified weapons and military systems, although probably somewhat fewer than the historical average of 350 per decade. Given the state of the Soviet economy and tight defense budgets, however, the Soviets probably will not move all of these systems into production and deployment. The vast majority of the new systems that do go into production will typify the historical Soviet approach to weapons development, that is, evolutionary improvements to preceding systems

We would expect that the Soviets by the end of the decade will have fewer systems in full-scale development than they do now. Fewer systems in development at the turn of the century, as projected from current trends in the economy and military policy, will mean fewer new systems fielded during the period 2000-2010.

We also would expect some further reductions in military-sponsored basic research and the development of military technology over the next few years. Future cuts probably will be small compared to cuts the Soviets have taken already in these areas. The pruning of alternate technological approaches that the Soviets have done to date and that we believe they will do over the next few years will still leave them with a good array of military technology for system development starts in 1995-2010—systems that would be deployed in 2000-2020. Because of their pruning, however, the Soviets probably will have somewhat fewer choices in technologies for systems and may well have some gaps in capabilities to meet future military requirements

Systems to be fielded after 2020 probably will incorporate a smaller contribution from military-funded basic research than previously, but the net effects on system capabilities are unclear. The cuts the Soviets have made to date in basic research essentially foreclose long-term contributions in many areas—areas that at present lack clear military relevance, but which probably have some potential applicability for systems to be fielded after 2020

In scaling back R&D the Soviets undoubtedly are taking greater risks than they have in the past. The consequences of R&D cuts for future weapon capabilities will depend in part on the success of Soviet efforts to offset their impact. Thus far, the Soviets appear to be maintaining the rigid but sound standardized process that defines the steps, sequences, and procedures they use to develop military technology and systems. Within the bounds of this standardized process, we expect the Soviets to take greater risks in the selection of technologies to be included in system designs. Although this

~~Secret~~

approach probably will result in program delays, in most cases the earlier selection will more than offset the delay. The Soviets also hope to gain greater access to Western technology through both legal and illegal means.

Dramatic change in Soviet defense policy and economic performance could produce very different futures for Soviet military R&D. If traditionalist leaders were able to reverse the decline in forces and defense budgets—especially if economic prospects brighten—the Soviets probably would hold system development, technology development, and basic research to levels near those of 1990. We would expect to see more system development programs started in the 1990s, but they would field new technology at about the same pace. Economic stringencies probably would serve for at least several years as a brake on efforts to increase efforts to 1988 levels.

If the economic crisis deepens and radical military reformers gain influence over policy, we would expect to see further large cuts in system development, technology development, and basic research during the 1990s. Consequently, the Soviets would develop new systems and field new technologies at much slower rates—particularly after 2010. Little new military technology would be available for systems to be fielded after 2020.

Most frightening to Soviet military leaders are prospects of an economic free-fall or the political disintegration of the USSR. Three-quarters of all Soviet military R&D facilities lie in Russia, and a successor state might successfully bargain for access to key research institutes, design bureaus, and test facilities that lie in seceding republics. Otherwise, R&D efforts could suffer much more than current trends would indicate for the USSR as a whole. Civil warfare, widespread civil violence, or economic free-fall probably would lead to a military R&D effort much smaller than we would expect under any other conditions.

Reverse Blank

v

~~Secret~~

Contents

	<i>Page</i>
Key Judgments	iii
Scope Note	ix
Changing Soviet Defense Posture	1
The R&D Dilemma: Do More With Less	1
Uncertainties Abound	3
Cuts Taken in R&D, 1988-91	4
System Development: Few Cuts So Far	4
Technology Development: Substantial Pruning	7
Basic Research: Heavy Cuts	10
More Cuts Likely, 1992-2000	13
Offsetting the Cuts: Acquiring Western Technology and Accepting Greater Risks in System Development	14
Implications for Future Weapons	17
Alternative Paths	19
Sustaining Military R&D	19
Deeper Cuts	19

Tables

1.	Key System Development Programs That Appear To Be Continuing	6
2.	Representative Sample of Soviet Technology Development Programs Shows Substantial Cuts	8
3.	[]	9

Insets

	Soviet Military R&D: A Historical Perspective	2
	Soviet Military Acknowledges Cuts in R&D	3
	[] Most Construction Projects Continuing []	7
	[] []	8
	Comments by Soviet Officials on Cuts in Military Funding for Basic Research	11
	[] []	12
	Risk Taking in Selection of Technologies for Military Systems	16

Scope Note

This paper assesses the changes the Soviets have made in military R&D since the late 1980s when President Mikhail Gorbachev redirected Soviet defense policy. It also projects additional changes likely to occur during the 1990s and discusses the implications of the changes for Soviet military capabilities. The paper addresses three key questions regarding changes to date:

- Are Soviet R&D resources being protected?
- Are specific program areas or phases of R&D being sheltered?
- Are the Soviets modifying their R&D process to do more with less?

The paper builds on several DI reports: [

] and Intelligence Assessment SOV 91-10009 [

] March 1991, *Soviet Military Development: General Staff Planning for the 1990s*.

Soviet Military R&D: Scaling Back and Taking Risks

Changing Soviet Defense Posture

Soviet President Gorbachev in 1985 inherited profound economic and political problems. Economic growth was declining, and living conditions were increasingly wretched compared to the rest of the industrialized world. Ethnic unrest in the USSR was growing, and resistance movements in Afghanistan, Angola, and Ethiopia were imperiling and increasing the cost of key foreign policy objectives.

Concurrent with these economic and political challenges, the USSR in the mid-1980s faced increasingly robust US and NATO military forces. The buildup in Western military power in the early 1980s—including advances in Western military technology—placed increasing demands on Soviet military R&D and production. The costs of supporting the USSR's ambitious military strategy were growing rapidly.

After Gorbachev's ascension to power, the Soviets began to articulate new concepts of defense—"reasonable sufficiency" and "defensive defense." These doctrines argued that Soviet forces should be smaller—yet still capable of reliably defending the USSR—and at the same time postured to reduce the offensive threat they appeared to pose to other nations.

When earlier attempts to modernize the civilian industrial base failed, Gorbachev by 1988 redirected Soviet defense policy to embrace the new concepts of reasonable sufficiency and defensive defense. Gorbachev clearly viewed the defense sector as a source of support for the faltering Soviet economy. He ordered major cuts in Soviet defense spending and directed major changes in Soviet force structure, including a slowdown in planned strategic force modernization, deep unilateral cuts in conventional forces, a withdrawal of Soviet forces from Eastern Europe and Mongolia, decommissionings of general purpose naval ships and submarines, cuts in weapon production and procurement, and conversion of weapon production facilities to civilian purposes

The R&D Dilemma: Do More With Less

Concurrent with these fundamental changes over the last few years, Soviet military R&D also has come under fire. The R&D establishment has been a crucial contributor to Soviet military power, but its successes have come at a high cost (see inset). Over the past two decades, Soviet military R&D has relied on:

- A consistent high level of commitment by the military and civilian leadership.
- Steadily increasing resources.
- Priority over other entities for scarce goods and services.
- An emphasis on long-range forecasting, planning, and resource allocation.
- A rigid, but sound, R&D process that is well suited to five-year plans and a centrally controlled economy.

For 1990 the Soviets announced a budget cut of 14 percent for military R&D¹ (see inset). Additional budget cuts probably are occurring for 1991:

-  the 1991 defense budget presented to the Supreme Soviet showed a reduction in constant rubles of 23 percent for military R&D—despite Gorbachev's argument that expenditures in 1991 should be kept at the same level as in 1990.
- The Supreme Soviet in January voted to reduce the total defense budget for 1991 by about 2 percent below the requested level.

¹ CIA's independent estimates of Soviet spending on military R&D exceed Soviet defense budget figures by nearly a factor of two. Soviet budget figures do not encompass the whole range of military R&D activities, but we believe that they do reflect general trends in spending

Soviet Military R&D: A Historical Perspective

Soviet Military R&D Has Delivered . . .

Large Numbers of Systems. The Soviets in the 1960s, 1970s, and 1980s fielded about 350 new and modified systems per decade. About 200 of these per decade represented significant improvements over previously deployed systems; by comparison, the United States in the 1970s and 1980s fielded roughly 100 major new and modified systems each decade. The Soviets achieved their rate by routinely reassigning design teams to new development programs upon completion of projects, rather than disbanding the teams

Timely Responses to US Developments. The Soviets over the last two decades often have demonstrated an ability to field timely and effective responses to US systems. These Soviet successes have hinged on two factors: early knowledge of US design goals and ready availability of design teams to undertake an effort in response.

But at the Cost of . . .

A Massive Infrastructure. The Soviet military R&D infrastructure comprises some 1,600 organizations and an estimated 3 million people. This infrastructure has accounted for about 20 to 25 percent of Soviet defense expenditures and about 4 percent of Soviet GNP. By comparison, the United States in the late 1980s spent about 12 percent of its defense budget and 0.7 percent of its GNP on military R&D.

Narrow Design Objectives. Of the 200 or so major new or modified systems the Soviets have fielded per decade, many have been designed to fulfill perhaps only a single, narrow mission assignment. This has been manifested in the development of a large number of weapon systems within general mission areas. For example, for the strategic offensive mission, the Soviets in the 1970s completed the development of four completely new ICBMs and three new SLBMs, plus 11 modified ICBMs and six modified SLBMs. The United States over the same time frame fielded two modified ICBMs and one new SLBM.

Conservative Technological Advances. The Soviet approach to the development of military systems has been characterized by gradual, but continuous, improvements through the fielding of modifications to systems already in the field. In many instances the Soviets have begun the development of a modification to a system before the original system has been fielded

Driven by incentives to meet development schedules, Soviet designers over the last two decades have been extremely conservative in selecting technology for new and modified systems. The Soviet military R&D process requires proof of producibility of a technology before the technology may be selected for use in a future military system. And Soviet designers for the most part over the last two decades have employed the most stringent criterion in judging proof of producibility—that the technology be certified for series production at the time it is selected for use in a new design

Poor Efficiency. Soviet military R&D is inefficient by Western standards in part because of a lack of modern equipment and support services. Large numbers of Soviet engineers are employed in modifying and copying designs and technical drawings—work that in the West is largely automated. The lack of computing power—both numbers and sizes of computers—means that Soviet designers often are unable to perform quick and inexpensive mathematical simulations of new systems.

Soviet military R&D has been inefficient in part also because of bureaucratic ossification. Soviet design teams have been granted monopolistic assignments of specialization and guaranteed continuous work. Multiple approaches in the development of military technologies have been fully funded, evidently with little regard for likelihood of success of the alternatives. Basic research has been supported by the military by providing continuous level-of-effort funding to large numbers of research institutes, and no competition for funding was required.

Soviet Military Acknowledges Cuts in R&D

Spending on certain major defense projects, (including) research and development, is lower (in the 1990 budget) than (in) 1989. Although this is something I do not agree with, we cannot help it. . . . a reduction in research and development spending is very undesirable . . . (but) it became necessary to revise the priorities of research and development work under way, so as to focus efforts. . . .

*Army General Vitaliy Shabanov,
Soviet Deputy Minister of Defense,
Fall 1989*

The approved appropriations (for 1990) are earmarked to finance the optimal volume of research and development. . . . A sizable reduction . . . was effected by terminating . . . projects . . . and also by switching . . . projects from the experimental prototype stage to scientific experiment status.

*Gen. Col. V. N. Babyev',
Chief of the Central Finance
Directorate,
Soviet Ministry of Defense,
February 1990*

Minister of Defense Yazov and the Soviet General Staff are trying to reverse the current downward trend in spending on military R&D. In February 1990 General Moiseyev, Chief of the General Staff, argued that ". . . the development of military science and experimental design work . . . cannot lag behind the leading states and their armies. . . ." In the same month Col. Gen. Yuriy Yashin, USSR Deputy Minister of Defense, stated that, "I wouldn't want theoretical, basic, and applied research and experimental design work to be reduced in any way. . . . one of the main ways to achieve reasonable defense sufficiency today is to carry out research and development work." The Defense Ministry Draft Reform Plan presented by Yazov in November 1990 calls for 10 percent more spending on military R&D during 1996-2000 than during 1991-95.

At the same time the Soviets are announcing cuts in spending for R&D and debating additional cuts, they are proclaiming an increased commitment to improve the quality of military equipment and to be prepared for a new type of war in the 21st century:

- The Resolution on Restructuring from the 19th Party Conference, July 1988, stated, "All defense building must henceforth be geared predominantly to qualitative parameters—with regard both to equipment and military science and to the personnel of the armed forces."
- High-ranking Soviet military officers have openly advocated a shift from the traditional Soviet evolutionary style of developing weapons to a style marked by qualitative leaps in capabilities.
- In open exchanges with US military officers in the summer of 1990, high-ranking members of the Soviet General Staff presented their vision of a 21st century battlefield—one that is markedly different from that envisioned for the 1990s in terms of weapons and technologies, as well as in force requirements and operations:²
 - Wars determined by a single massed strike by precision guided munitions.
 - Greatly improved conventional munitions.
 - Greatly improved systems for command, control, communications, and intelligence, including new families of space reconnaissance systems.
 - A virtual absence of traditional forces equipped with infantry, tanks, and artillery.
 - The retention of strategic nuclear weapons, but only in numbers necessary to attack the most extensively hardened targets.

Uncertainties Abound

Great uncertainty exists regarding the future development of the Soviet military in general and R&D in particular. Growing economic problems, republic

² Some elements of this vision may appear more urgent to Soviet planners as they assess the results of the US-led victory over Iraq; other elements almost certainly are envisioned for time frames well beyond the turn of the century

drives for independence or greatly increased autonomy, and public opinion are pressuring the military to institute radical internal reforms and are endangering the material and manpower assumptions of the late 1980s. Military R&D is further threatened by:

- An unpredictable process for setting annual budgets and the lack of a five-year economic plan, which together pose particular difficulties for planning R&D projects that require multiple years of funding.
- The conversion of many R&D facilities to self-financing, which means that defense planners will lose control of R&D assets that receive contracts from customers other than the Soviet military.
- Rising costs, particularly wages for scientific workers, which will put further strains on financing future R&D programs.

To deal with these key variables, we need to consider not only current trends in the USSR's military policy and economy but also major deviations from these trends. Current trends, including Soviet statements, force developments, and changes in military R&D, indicate broad directions in Soviet General Staff planning not only for the 1990s but for the early decades of the next century as well. At the same time, we believe that the alternative paths presented below reasonably bound the possibilities the Soviet Ministry of Defense would envision for the future.

Cuts Taken in R&D, 1988-91

In stark contrast to the steadily increasing Soviet effort in military R&D through 1987, we believe there has been a significant reduction in total effort over the last three years (see figure 1). Our understanding of the cutbacks is derived from our assessments of several hundred individual Soviet R&D programs. Our estimates of the Soviet cuts in military R&D between 1988 and 1990 are roughly consistent with openly published Soviet information on the USSR's defense budget, but are not based on these data. The cuts in R&D clearly are part of the overall downsizing

and restructuring of the Soviet military now under way. [

] we conclude that the Soviets have made:

- Small cuts—perhaps 5 percent—in the development of military systems.
- Substantial cuts—perhaps 15 percent—in the development of military technologies.
- Large across-the-board cuts—perhaps 40 percent—in military support for basic research.

Our quantitative estimates of the Soviet R&D effort include considerable uncertainties, but the downward trends are clear.

In scaling back military R&D the Soviets are taking greater risks than they have in the past. They are gambling that they will have the weapon systems, the military technologies, and the basic research they will need to meet military requirements. Thus far, however, the reductions the Soviets have made in their large R&D base appear to be a rational attempt to maintain an effective R&D effort in the face of declining resources.

System Development: Few Cuts So Far

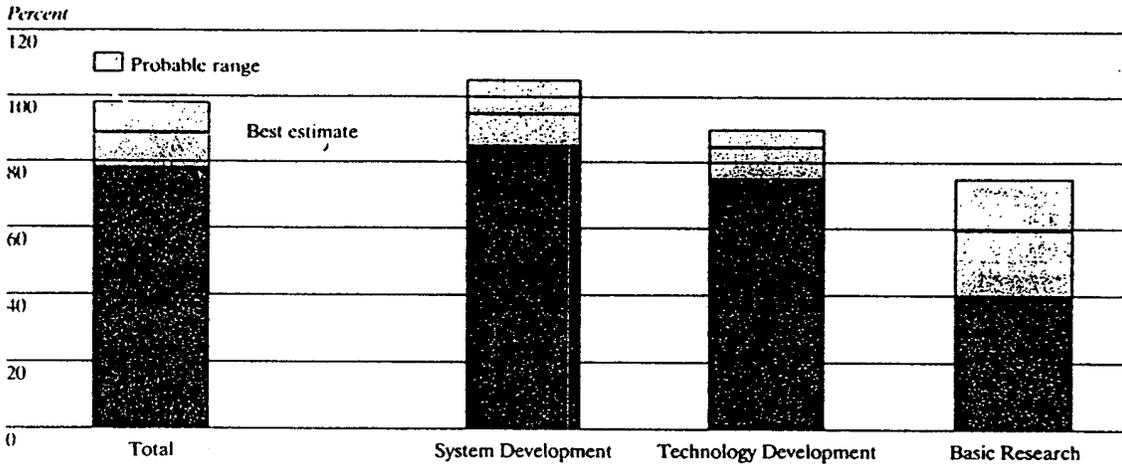
We believe the Soviets have made relatively small cuts over the last three years in the development of major military systems. Our best estimate is that the Soviets during 1988-90 reduced their system development effort by about 5 percent. This judgment is based on our assessment of the status of 100 major Soviet weapon and space systems in development. We believe these systems form a large and representative sample of the total Soviet system development effort. With a few exceptions these development programs seem to be progressing on schedule

The Soviets undoubtedly have in development dozens of additional systems: [

] During the 1960s, 1970s, and 1980s they fielded about 350 new and modified systems per decade. At any given time during the 1970s and 1980s we had evidence of about 100 major systems in development. Therefore, we believe that the total number of Soviet systems currently in development is not substantially different from the historical average.

Figure 1
Soviets Reduce Activity and Spending in
Military R&D, 1988-90

Soviet Military R&D: Estimated Level of Activity in
1990 as Percent of Activity in Mid-1988

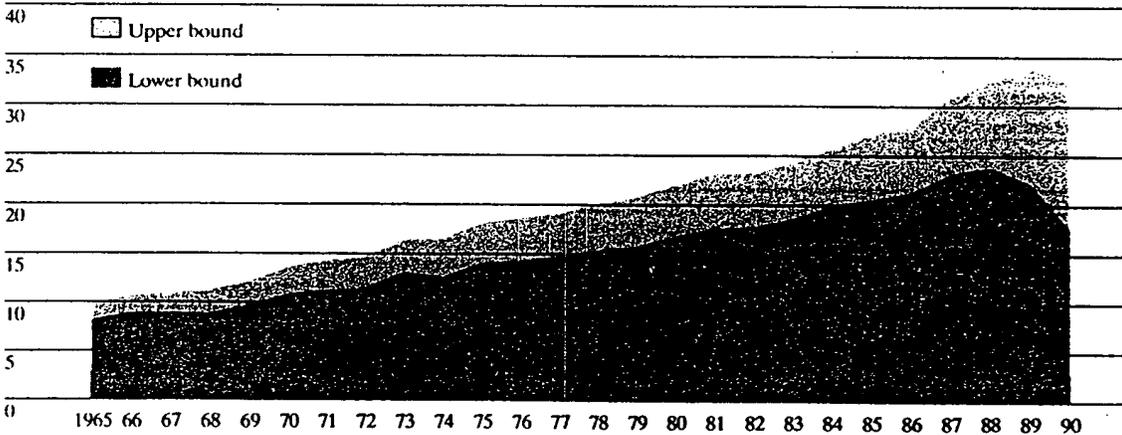


Estimates of activity in the three phases of R&D—system development, technology development, and basic research—are based on reporting on the status of several hundred military R&D programs. The estimate of

total R&D activity was calculated from the estimates of activity in the three phases, weighted according to information provided by knowledgeable emigres.

Estimated Military R&D Spending, 1965-90

Billion 1982 Rubles



Estimates for 1989-90 are based on relative R&D activity in 1990 compared to 1988, as shown in bar chart above. Estimates for 1965-88 are based on R&D floorspace growth, size of the work force, and

estimated costs per worker for wages, benefits, equipment, materials, and other expenses.

Table 1
Key System Development Programs That
Appear To Be Continuing

that about 45 of these systems are scheduled to become operational in the early 1990s.) For the majority of the systems we have identified, the Soviet defense industry has already committed significant resources for development. For most of these systems, we believe the Soviet military will continue to try to fund their development through the 1990s to preserve the option to produce and deploy them later in the decade. Given the state of the Soviet economy and tight defense budgets, however, the Soviets probably will not move all of the systems into production and deployment.

Over the past two years, several prominent Soviet officials have said that a significant number of military-system development (*opytno-konstruktorskaya rabota*—OKR) programs had either been canceled or pushed back to the less expensive technology development (*nauchno-issledovatel'skaya rabota*—NIR) phase of R&D:

- Two senior Soviet military officials in March 1990 claimed during an interview with reporters from the military newspaper *Krasnaya Zvezda* that more than 100 OKR programs had been canceled in 1990.

- [redacted] in June 1990 declared that about 30 OKR programs had been shifted from OKR to NIR because of economic or technical considerations.

Although we have been unable to reconcile Soviet claims of large numbers of cuts with [redacted], the cumulative evidence leads us to believe that some major weapon systems have been canceled and that others are at risk.¹ A review [redacted]

¹ In claiming large numbers of program cuts, the Soviets may be referring in part to cuts in the development of small arms, communications gear, or other military equipment that is not included in our assessments of Soviet development of major military systems. It is also possible that the Soviet officials are referring in part to the cancellation of efforts to develop subsystems rather than complete systems; the Soviets account for many of these subsystem development efforts as separate OKR programs

Our information shows that most of the weapon systems currently evident to us entered development in the 1980s and, therefore, should be ready for deployment by the turn of the century. (We estimate

Most
Construction Projects Continuing

A review of 80 key Soviet military R&D facilities showed construction activity at 57 facilities during 1988-90. The construction projects under way in June 1988 were consistent with the general expansion of Soviet military R&D observed over the last 20 years—an overall increase of R&D floorspace and test structures of approximately 3 percent per year.

- Construction started before June 1988 continued many of these projects have been completed. Work on construction projects at has stopped.
- New construction projects were started after June 1988 some have been completed. With a few exceptions, the construction projects started, stopped, or continued since June 1988 involve relatively minor additions to already extensive facilities.

Although construction at R&D facilities is not necessarily linked to specific R&D projects, historically, much of it has been. The pattern of construction since mid-1988 suggests that, although some military R&D projects have been cut, most—particularly those in the advanced stages of development that require extensive test facilities—are continuing.

of key Soviet military R&D facilities shows that the Soviets have halted some construction projects, although most are continuing (see inset). We believe the Soviets are indeed trimming R&D expenses by delaying or canceling system development programs that are experiencing major technical problems or that are simply too expensive to develop in light of domestic economic restructuring:

- The tactical airborne warning and control aircraft, Madcap, was probably canceled in 1989 or 1990. A reported that the project was dead and surmised that it had been canceled because of problems in the radar.

- The Soviet Navy probably decided to delay or forgo procurement of the Utkra wing-in-ground-effect vehicle. According to a recently published Soviet book, the ship is too expensive to operate and its reliability is questionable.

- The development of two new nuclear-powered attack submarines (fourth-generation SSNs) may have been delayed because of demanding technical requirements and tight resources.

Recent changes in Soviet planning for future military forces evidently are also shaping weapon development in the 1990s. For example, Soviet writings and other evidence point toward smaller general purpose naval forces that will concentrate on the protection of the submarine-launched ballistic missile forces and the defense of the homeland in waters close to Soviet territory. The recent decline in production activity for new classes of surface warships and a lack of construction starts for additional classes are consistent with such planning and suggest the Soviets are putting their surface ship R&D resources toward the development of civilian vessels. The Soviets may have made other changes, including the cancellation of system development programs that are no longer relevant to current requirements, but we lack evidence of such changes.

Technology Development: Substantial Pruning

Soviet cuts to date in technology development appear consistent with a substantial pruning of parallel and alternative technological approaches to meeting military requirements. The Soviets in the past have more often than not tasked several research institutes for development of a particular technology. They have also fully funded multiple technological approaches to meet military requirements; examples include the development of both infrared and ultraviolet sensors for ballistic missile launch detection, the development of steel, titanium, and fiberglass for submarine pressure hulls, and the development of both diesel and turbine engines for tank propulsion. The Soviets probably have concluded that they can no longer afford to

Table 2
Representative Sample of Soviet Technology
Development Programs Shows
Substantial Cuts

Application	Programs Continuing, Uncut	Programs Canceled or Scaled Back
Total	260	65
Multiuse	41	16
Strategic offensive	9	4
Strategic defensive	51	11
Nuclear weapon	4	9
Chemical warfare	2	0
Aircraft	37	2
Tactical land	19	2
Tactical naval	36	4
Antisubmarine warfare	13	4
Space	38	9
Communications	10	4

review of [] the status of 325 Soviet military technology development programs. These programs represent almost 10 percent of the 3,500 to 4,000 total we believe the Soviets had ongoing in the late 1980s. We believe the 325 projects are representative of the whole and that the sample is large enough to form the basis for some conclusions (see table 2).

The data show that no major mission area has escaped cuts in technology development. The number of examples we have in each of the various mission areas is too small, however, to estimate what areas if any are being cut more or less than others. []

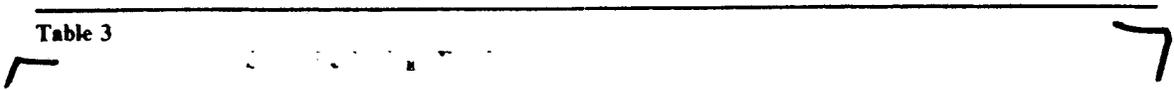
[] shows cancellations in technology programs that support the development of:

- Both strategic and tactical systems.
- Both offensive and defensive systems.
- Air, land, naval, and space systems.

fund as many parallel and alternative efforts as they did in the past. (See inset for an example of Soviet technology pruning.)

Our best estimate is that the Soviets during 1988-90 reduced their military technology development effort by about 15 percent. This judgment is based on our

Table 3



L

L

Partially offsetting the effects of cuts in technology development is an increased ability under *perestroika* for research institutes to work more closely and cooperatively with other organizations. For example,

[that the Yefremov Institute of Electrophysical Apparatus in Leningrad has formed a highly beneficial consortium with several plants that supply critical materials and equipment needed for the institute's development of high-current power-generation and switching technology applicable to directed-energy weaponry.

At the same time the Soviets have made substantial cuts in their technology development programs, they have continued most of their ongoing programs and have started some new programs. (The number of reported new programs is too small to form the basis for an estimate of which technologies are being enhanced.) The combination of cuts, continuations, and new starts seems to be a rational attempt to maintain an effective military technology effort in the face of declining resources. On the basis of all available information, we judge that the Soviets are continuing the development of all technologies that we view as critical for future Soviet military systems.

Basic Research: Heavy Cuts

[indicates that the Soviets, since 1988, have made major reductions in military funds for basic research. Our best estimate is that the Soviets during 1988-90 reduced military support for basic research by about 40 percent.

L The large cuts in military support for basic research probably reflect the longstanding dissatisfaction of the Soviet leadership with science that is insufficiently

relevant to currently perceived military requirements. An intent to make Soviet basic research more relevant to both the economy and the military was evident in the early 1980s in the establishment of new monetary incentives for technological innovation. Gorbachev's efforts during 1985-88 to channel Soviet science toward specific technological objectives and the formation of new organizations (Inter-Branch Scientific-Technical Complexes—MNTKs) that have both R&D and manufacturing responsibilities are consistent with this aim. For the most part, however, these initiatives failed to make Soviet basic research more clearly relevant to requirements of either the economy or the military

The cutting of the military's budget in the late 1980s probably provided the leadership the opportunity to exercise a meat ax on basic research. The cutting of military support for basic research was swift and deep. The loss of level-of-effort funding has provided unprecedented incentives for research institutes to seek contract work—work that invariably is more applied than what the institutes' researchers had been doing. Against the strong incentives that now exist is the reality that few institutes are finding new sources of funding for any work—no matter how applied and relevant to currently perceived requirements

A top-down view of cuts in military support for basic research was provided in speeches by leading Soviet scientists at the annual meeting of the USSR Academy of Sciences in July 1990 (see inset). Academician M. V. Popov stated that the order for reductions in basic research was issued in late 1988 during planning for 1989. Other speakers noted that state budget support for many institutes had been cut. Several speeches referred to problems in completing existing exploratory research and in financing such research in the future. Cuts in basic research at university institutes were noted in the speeches

**Comments by Soviet Officials
on Cuts in Military Funding
for Basic Research**

A number of "important" basic programs supported by defense sectors of industry ceased to be financed by them.

*I. M. Markov, Chief Scientific Secretary,
Presidium of the USSR
Academy of Sciences*

As a result of conversion in the defense sector, financing of university research has decreased and is creating an "alarming situation."

*R. A. Papilov, Chairman,
Central Committee of
Public Education,
Science Workers Union*

A number of (Academy) institutes and design bureaus previously were (but no longer are) concerned with problems of defense.

*K. V. Frolov, Vice President,
USSR Academy of Sciences*

For over 20 years the institute performed significant work under contract with the defense sector. This contract work was reduced from 17 million rubles in 1988 to 2 million rubles in 1989.

*V. Ye. Zuyev, Director,
Institute of Atmospheric Optics, Tomsk*

A reduction in funds from the military in 1989 forced the institute to eliminate the support of "researchers outside the institute."

*A. N. Dremin, division head,
Institute of Chemical Physics,
Chernogolovka*

[have provided details of wholesale cuts in military support for specific basic research projects, as well as cuts in level-of-effort funding by the military of institutes and universities. [reveals joint ventures to gain outside funding for besieged Soviet institutes. [seeking substantial disruptions of work in institutes doing basic research, to the extent that laboratories have stopped purchasing equipment and materials while drawing down funding reserves to cover salaries.

Partially offsetting the adverse effects of cuts the Soviets have made in basic research is increased civilian funding of some work formerly supported by the military. For example, key oceanographic research in the General Physics Institute in Moscow apparently now has civilian sponsorship. In general, however, research capabilities formerly supported by the military do not match well with the needs of the civilian sector.

In other areas of military research, including the development of advanced armor materials, the output of basic research institutes has outstripped the capacity of the Soviets to move research results through the technology development phase of R&D. Cuts in basic research on armor materials will have little if any effect on future military capabilities, given the continuation of the technology development bottleneck.

In spite of the widespread cuts to basic research that are evident, the Soviets clearly are maintaining some military support for scientific investigations. [

] we judge that the Soviets are continuing strong basic research programs applicable to antisubmarine warfare, directed energy, low observables, counter low observables, and other technologically challenging future military capabilities

The Soviets almost certainly are also counting on maintaining sufficient scientific breadth to take advantage of foreign scientific progress that appears to have military applications. The leadership seems willing to become more reliant on Western science—in addition to Western technology—as a source of new ideas

The ultimate effects of the overall Soviet cuts in basic research are far from clear. The Soviet military probably is counting on a new basic research infrastructure emerging that will be more relevant to both the military and the needs of the economy. In the

meantime, the military almost certainly hopes it can use contract funding to maintain the ongoing research it needs.

On the other hand, the current state of disruption of Soviet basic research could extend for many years, diminishing the value of what research the military is continuing to fund. Moreover, forcing Soviet basic research into more narrowly defined areas will blunt the ability of Soviet scientists to do good work in areas being researched nowhere else in the world—science that potentially could lead to unique technological capabilities with civilian as well as military applications.

In any event, the cuts that the Soviets have made to date in basic research will have little effect on fielded military capabilities until well after the turn of the century—probably after 2020. Canceled or disrupted basic research that might have contributed to the development of military technology during 2000-2010 probably would not be seen in fielded systems until 2020 or later.

More Cuts Likely, 1992-2000

The course of Soviet military R&D over the decade ahead is far from clear. The nature and extent of change hinge on the strength of the Soviet economy, the resolution of who will determine security policy, and the view those leaders will have of military threats to the country.

The means by which the Soviets attempt to control the R&D process is likely to evolve over the next few years. The recent conversion of some research institutes and design bureaus to either partial or total self-financing means that these organizations may become accountable to customers other than, or in addition to, the Soviet military. Moreover, the yet-to-be-adopted Ministry of Defense reform plan apparently would give the Ministry the ability to contract directly with R&D organizations—bypassing the Military-Industrial Commission (VPK) and industrial ministries. This would threaten the ability of the Soviets to command resources—a key historical strength of the Soviet R&D process—but it could force R&D organizations to be more efficient in responding to military

requirements. The net effects of these changes are unlikely to be evident to either the Soviets or ourselves for several years.

The increasing disruption in the Soviet economy, as well as social and political activism, almost certainly is undermining the ability of the Soviets to conduct military R&D, but we are unable to estimate how much

disruptions in institutes doing basic research are widespread and severe. And environmental activists have severely restricted the ability of the Soviet military to conduct underground nuclear tests. Other Soviet work in technology development and system development also appears affected, but to a lesser degree than basic research.

On balance, assuming current policy directions and little further economic decline, we believe the Soviets will make additional reductions in military R&D over the next decade. We base this judgment on

Soviet statements regarding their expectations for military R&D in the future, and our view of what the Soviet military and civilian leadership realistically hope to achieve through R&D over the next 10 to 30 years.

In projecting a smaller effort in military R&D by the end of the decade, we assume the Soviets will develop their future forces in the direction suggested by existing military programs, recent policy declarations, and ongoing arms control negotiations. We assume that the economy experiences no growth through 1995, while socioeconomic pressures force continued defense spending cuts and prompt the conversion of defense-industrial facilities to civilian production. We assume Soviet military requirements evolve in a manner consistent with Gorbachev's military policies combined with perceptions of a reduced threat bounded by arms control agreements.

Under these conditions, future R&D cutbacks probably will fall most heavily on the development of systems. We expect that over the next decade the Soviets will have decreasing numbers of military systems in full-scale development:

- We expect the Soviets during the 1990s to start fewer system development programs than they have started during previous 10-year periods.

- For systems nearing the end of development and testing (IOCs during 1991-93), we expect few, if any, cancellations before the results of full-scale testing are in hand. The Soviets may choose to forgo production and fielding of some of these systems.
- For systems midway through the development cycle (IOCs scheduled for 1994-97), we expect to see some cancellations, particularly of systems that the Soviets view as having narrowly defined mission capabilities or as providing marginal improvements in capabilities over existing systems.
- For systems that entered full-scale development during the last five years and are still in the early stages of development (IOCs scheduled for 1998-2005), we believe many will be vulnerable to cancellation.

Regarding resources for military-supported basic research and the development of military technology, we believe that the Soviets over the next few years probably will make further reductions. We expect these cuts to be relatively small, however, compared to cuts they appear to have taken already in basic research and technology development:

- The Soviets almost certainly will want to maintain military support for selected basic research efforts. We expect military sponsorship of basic research increasingly to focus on specific topics at the expense of long-term level-of-effort funding of institutes.
- We expect the Soviet level of effort in the late 1990s in technology development to be closer to the 1988 level than will be the case for either system development or militarily supported basic research. This judgment is based on the fact that the Soviets evidently are scrupulously continuing development work in critical military technologies—even though they may be pruning parallel and alternative approaches—and on Soviet statements from officials at all levels that affirm the importance the Soviets place on maintaining a vigorous technology development effort.

The reduced numbers of Soviet systems we expect in full-scale development in the 1990s are consistent with our understanding of General Staff planning for smaller forces. We believe the Staff is planning on:

- Smaller and increasingly mobile strategic offensive forces that will be able to meet damage goals because of improvements in weapon lethality and reliability.
- Smaller strategic defensive forces that will moderate, but not prevent, damage from a large-scale strategic attack.
- Smaller restructured theater ground and air forces deployed on Soviet territory for deeply echeloned defense of the homeland.
- Smaller general purpose naval forces that will concentrate on the protection of the SSBN force and defense of the homeland in waters close to Soviet territory.

If our view of Soviet planning is accurate, we would expect to see two changes in Soviet efforts to develop military technologies and systems:

- More emphasis on defensive systems, space reconnaissance, and command, control, and communications.
- Less emphasis on naval surface combatants and offensive land and air weaponry.

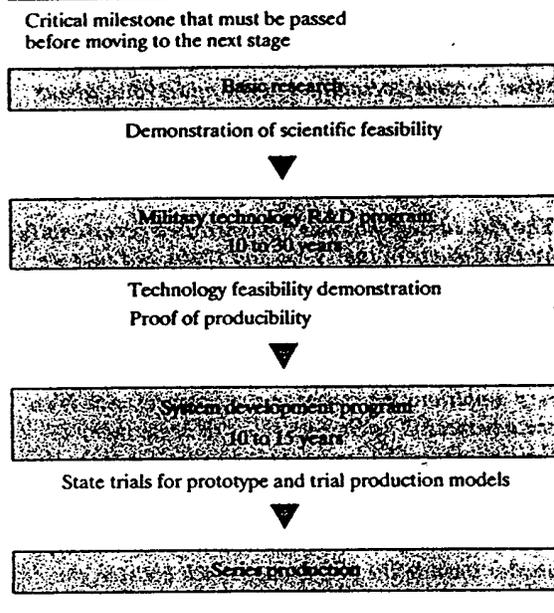
A more multimission approach to weapons design in the 1990s is also very likely to contribute to a drop in the numbers of Soviet systems in development. For example, the Soviets may choose to develop and deploy combat aircraft that are capable of both air-to-air and air-to-ground missions.

Offsetting the Cuts: Acquiring Western Technology and Accepting Greater Risks in System Development

The Soviets hope to gain greater access to Western technology through both legal and illegal means.

[

Figure 2
Soviets Maintain Rigid but Sound R&D Process



The Soviets to date appear to be maintaining the standardized process by which they have developed military technology and systems for the last 20 years. This process defines the time-phased stages of Soviet military R&D and the formal procedures for moving from one stage to the next. Soviet development of military systems is guided by a set of state standards adopted in 1971. The process the Soviets use to develop military technology, although less structured than the system-development phase, is also governed by formal legal requirements — specifically, there are requirements to prove feasibility and producibility of a technology before it may be selected for use in a new military system being designed. Our tracking of well over 100 Soviet system development programs, as well as several hundred technology development programs, indicates no changes in the R&D process as a result of Gorbachev's redirection of the Soviet defense establishment in the late 1980s.

Soviet intentions to develop a network of long-term third-country agents to illicitly acquire sensitive US technical information. These operations will focus on putting in place agents whose work will bear fruit in the next century. The Soviets anticipate a period of several years before agents are fully productive. This appears consistent with a strategy by the USSR to absorb advanced US technologies that may emerge in the first decade of the 21st century.

We also expect the Soviets to take greater risks in the selection of technologies to be included in system designs (see inset). They can do this without modifying their so far unchanged standardized process that defines the steps, sequences, and procedures they use to develop technology and systems (see figure 2).

Taking higher risks in the selection of technologies for systems offers two potential benefits:

- In a few cases the Soviets would field a particular level of technology significantly more quickly—perhaps five years earlier—than they would have using their historically conservative approach.
- Assuming an unchanging threat, they could more readily meet a given military requirement through the development of a single new system instead of the successive development of a series of new and modified systems.

Risk Taking in Selection of Technologies for Military Systems

We have known for some time that the Soviet R&D process requires—at a minimum—pilot production of a technology to prove its producibility before it may be selected for use in a military system being considered for development. We know through a recent analysis of Soviet technical literature that the Soviets view the selection of a technology as "high risk" if its producibility is understood only through pilot production. (In the development of a US system, such a selection would be viewed as "low risk.") The Soviets view a technology as "moderate risk" if it is in trial production on a series-production line and as "low risk" if the technology is already certified for series production.

Our recent assessment of technology selections for Soviet system development programs shows that over the last two decades the Soviets for the most part have selected technologies already certified for series production—"low-risk" selections (see figure 3). But on occasion they have made higher risk selections. For example, the Soviets in the early 1970s evidently began development of both the Pechora large phased-array radar and a modified MiG-25 interceptor (Foxbat D), the designs of which included use of microelectronic chips that were in pilot production at the time development of the radar and modified interceptor started—"high risk" technology selections. The Foxbat D reached IOC in the mid-1970s, probably on

schedule, and about five years sooner than it would have reached IOC if the Soviets had waited until the microelectronic chips were in series production before beginning development of the aircraft. The Pechora radar became operational in the mid-1980s, about five years after the scheduled IOC, but probably no later than it would have been completed using a "low-risk" approach.

The risk taking that was demonstrated occasionally by the Soviets in the 1970s and 1980s and that we project to be more common in the 1990s is in reality quite conservative compared to risks taken in the late 1950s and early 1960s at the insistence of Khrushchev. During these years the Soviets started several very ambitious new programs to compete with Western advances. The Soviets chose to begin many of these programs by including in the designs technology whose feasibility and producibility had never been demonstrated. Significant numbers of failures occurred in space, aircraft, and missile programs; examples include the N-1 space launch booster, the Tu-144 supersonic transport aircraft, and a solid-propellant SLBM. Under Brezhnev, the Soviets adopted the acquisition process currently in use, which allows for risk taking, albeit carefully controlled risk taking.

On the other hand, this approach probably will result in program delays, although in most cases the earlier selection of the technology probably will more than offset the delay—perhaps to a net gain of a year or two. A few programs probably will be delayed for extended periods (by five or more years).

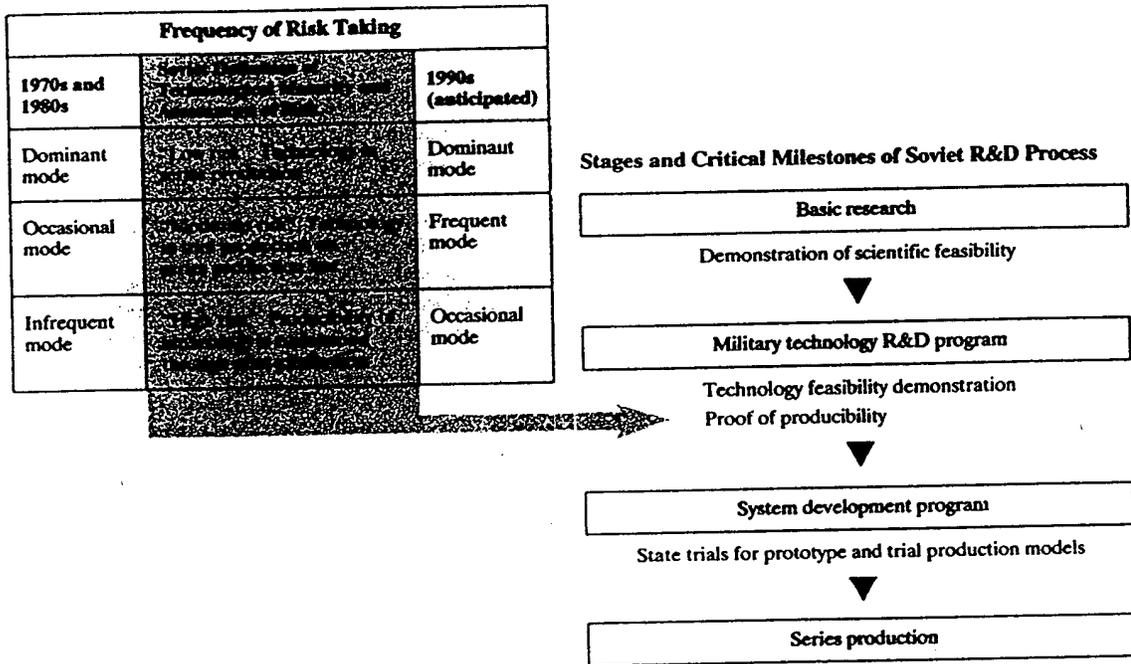
Assuming the Soviets take greater risks in some of their technology selections in the early 1990s, the resulting systems could be fielded in the late 1990s at the earliest. We lack evidence of specific risks the Soviets have taken or plan to take, but we would anticipate the "high-risk" selections would be for

systems whose mission requirements could be met only with higher levels of technology; such possibilities include precision-guided systems, reconnaissance systems, and systems for command, control, and communications

Implications for Future Weapons

Even greater than our uncertainty in predicting the course of Soviet military R&D over the remainder of the 1990s is our uncertainty in predicting the

Figure 3
Anticipated Soviet Risk Taking in Selecting Technologies for Military Systems



combined effects of changes already made and changes yet to come. The full implications of these changes will be seen in operational military equipment only after the passage of several decades:

- Decisions and changes the Soviets make in the development of military systems will become manifest as fielded capabilities five to 15 years after the decision point.
- Decisions made and courses taken in the development of military technologies will typically be seen in operational hardware 15 to 30 years after the decision point.
- Decisions made regarding basic research will typically be reflected in operational systems 20 to 40 years later

Given these long stretches of time, any predictions of future Soviet military capabilities are fraught with uncertainty. Nonetheless, we believe that the broad scope and sheer size of the Soviet military R&D effort, coupled with our long history of assessing Soviet R&D programs and the Soviet R&D process, enable us to make some general projections

The Soviets in the 1990s will finish the development of a large number of new and modified weapons and military systems, assuming current trends in the

economy and military policy. Nevertheless, fewer starts of programs in the early 1990s to modify older systems and the cancellation of some ongoing programs probably will result in fewer than the historical average of 350 new and modified Soviet systems per decade reaching the end of the development process. And given the state of the Soviet economy and tight defense budgets, the Soviets probably will not move all of the systems into production and deployment.

The systems that will be fielded in the 1990s are mostly systems that were designed in the 1980s using technology that the Soviets had in hand before 1988. The vast majority of these new systems typify the historical Soviet approach to weapons development—evolutionary improvements to preceding systems.

Systems to be fielded in the first two decades of the next century probably will reflect scaled-back Soviet military strategy and a pared list of missions. There probably will be many fewer systems deployed per decade during 2000-2020 than was the case in the 1970s and 1980s. Many of the systems are likely to include technologies that were selected with "moderate" or "high" risks

The pruning of alternate technological approaches that the Soviets have done to date and that we believe they will do over the next few years would still leave them with a good—although somewhat diminished—array of military technology from which to choose for system development starts during 1995-2010. These systems would be fielded during 2000-2020. Because of their pruning, the Soviets probably will have somewhat fewer choices in technology and may well have some gaps in capabilities to meet future military requirements

Notwithstanding the possibility of some technology gaps, the Soviets during 2000-2020 probably will be able to field advanced technology at a somewhat faster rate than would have been the case using their former highly conservative approach to weapons

development. Risk taking in selecting high-payoff technologies for systems will give the Soviets a few capabilities substantially earlier than would have been the case using their highly conservative approach. The risk taking probably will also cause many program delays, but most of the delays probably will be more than offset by the earlier selection of technology.

The fielding of new technologies, although likely to occur overall at a faster rate than in the past, will become more difficult for the Soviets to accomplish on predictable schedules. This lack of predictability will, to a certain extent, disrupt the ability of the Soviets to accurately forecast the timing of future fielded capabilities and to readily integrate new weapons into coherent forces. Substantial delays in development programs—likely in a few cases—could create significant gaps in previously planned military capabilities.

The heavy cuts the Soviets have taken in basic research have implications for military capabilities to be fielded after 2020. Systems to be fielded after 2020 probably will incorporate a smaller contribution from military-funded basic research than previously, but the net effects on system capabilities are unclear. The cuts the Soviets have made to date in basic research essentially foreclose long-term contributions in many areas—areas that at present lack clear military relevance but which probably have some potential applicability

The long-term implications of military R&D conducted during the remainder of the 1990s vary widely, depending on the political and economic conditions assumed. On the basis of current trends, we would expect the Soviets to maintain strong efforts in areas of basic research that have clear military applications; this work would feed Soviet technology development after the turn of the century—technology that would be incorporated in Soviet systems fielded after 2020.

Alternative Paths

Dramatic change in Soviet defense policy and economic performance could produce very different futures for Soviet military R&D. Traditionalist leaders could work to reverse declines in Soviet forces and defense budgets, especially if economic prospects brighten. On the other hand, pressures for even deeper cuts in military R&D could well intensify if reformist leaders gain power or if the economy continues the steep decline that is occurring in 1991. Moreover, military R&D would be severely disrupted by the economic or political disintegration of the USSR.

Sustaining Military R&D

If traditionalist leaders were to reverse the decline in Soviet defense budgets, the Soviets would probably hold system development, technology development, and basic research to levels near those of 1990. They probably would finish the development of more new systems than indicated by current trends but would field new technology at about the same pace. We would expect to see more system development programs started in the 1990s and few new cancellations. Economic stringencies probably would serve for at least several years as a brake on efforts to increase efforts to 1988 levels

The major long-term benefits the Soviets probably would see for military R&D in an attempt to halt the current downward trend would be greater stability in programs and greater control of the R&D process. Renewed tight control of the R&D process would diminish the prospects of the chaos and inefficiency that appear possible based on current trends and highly probable if deeper cuts occur.

Deeper Cuts

Alternatively, the Soviets could confront a continuation of their deepening economic crisis, while military force developments proceed in accordance with the more radical Soviet views on defense. A benign international environment codified by arms control agreements—and possibly a new European security arrangement—could provide the rationale for a much-reduced Soviet military. A rapid transition to a market economy might cause economic dislocation and for several years disrupt the defense industries.

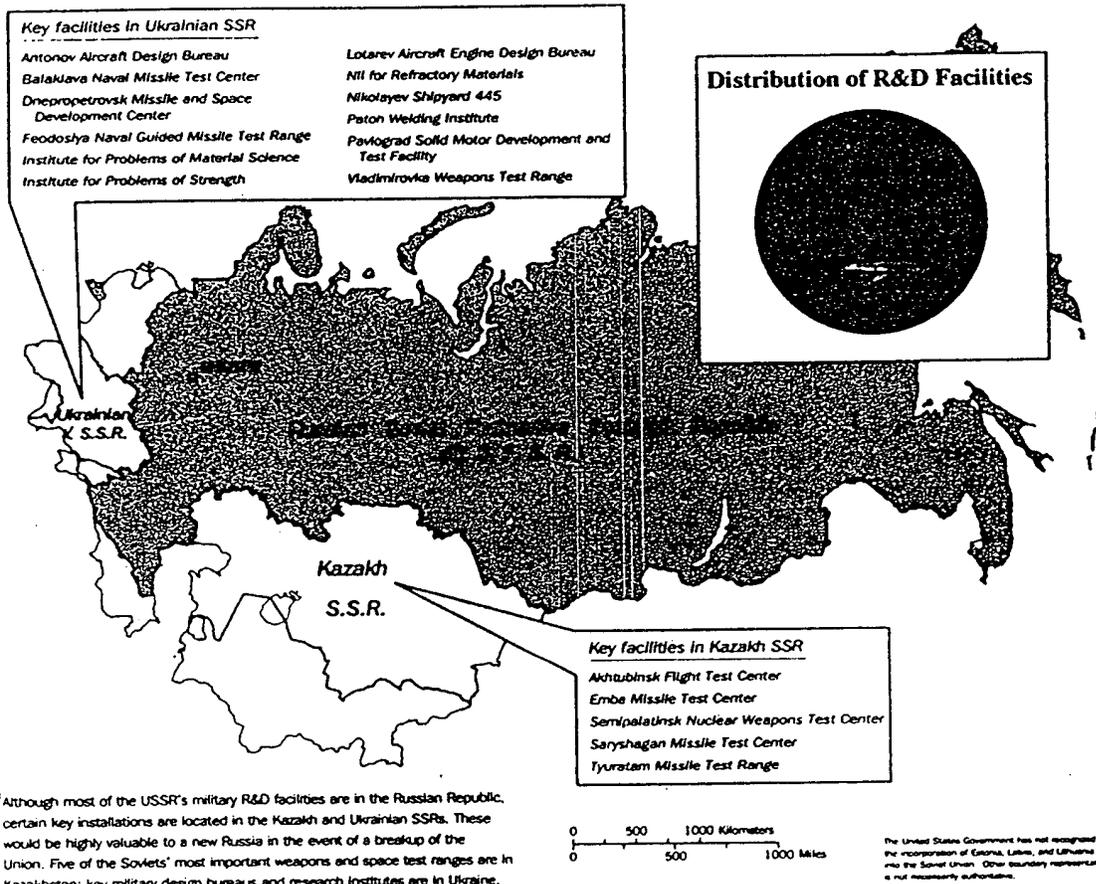
Under these conditions, system development, technology development, and basic research during the 1990s would probably all experience large cuts in addition to those already taken. Economic pressure and lowered expectations for future military forces probably would lead to cancellations of system development projects—perhaps bringing the total effort in the mid-1990s to less than half the 1988 effort. Efforts by the military to protect at least a few near-term system development projects would erode resources for technology development to perhaps half the 1988 level. Military support for basic research probably would fall to a quarter of the 1988 level.

Consequently, the Soviets would develop new systems and field new technologies at much slower rates. Disruptions in the defense industries would probably delay the completion of many weapon programs started in the late 1980s until after the turn of the century. Poor economic conditions probably would force cancellation of a substantial number of weapon programs. The manifestation of large cuts made in the 1990s in technology development would be less capable weapons fielded—particularly after 2010. Dismantlement of technology development, as well as basic research in the 1990s, would mean that little new military technology would be available for systems to be fielded after 2020.

A primary goal in the development of military technology under the conditions of deep cuts would almost certainly be to maintain and extend the lifetimes of systems fielded in the 1980s and 1990s. The fitting of new subsystems and components into previously fielded weapons would give Soviets some improvement in military capabilities at a fraction of the cost of new systems

Coupled with fewer resources for R&D in the remainder of the decade is the prospect of a rapid erosion of the ability of either the civilian or military leadership to control the day-to-day exercise of the R&D process. Such an erosion of control and the resulting disruptions in the timely delivery of equipment, materials, and components would further diminish the value of the limited resources that are likely to be available for R&D, given cuts deeper than those indicated by current trends

Figure 4
Key Military Installations Outside the Russian Republic ^a



Most frightening to Soviet military leaders are the prospects of an economic free-fall or the political disintegration of the USSR. In either case, the Soviet military could expect unpredictable and possibly incoherent additional cuts in R&D:

- If a peaceful devolution of power to the republics produces a successor Russian state, some 75 percent of all Soviet military R&D facilities would fall

within the new Russia, but key test facilities and design bureaus would remain outside (see figure 4). Economic and political developments will affect R&D effort more than will the change in political geography. Indeed, if a new Russia were successful in bargaining for access to test facilities and for the services of key institutes and design bureaus outside

the state, the effects of a breakup on the output of Russian military R&D could be only slightly worse than those indicated by current trends for the USSR as a whole. But if bargaining for key facilities and services is unsuccessful, the effects on the R&D output of a new Russia could be much more severe than projected for the USSR from current trends in military policy and the economy.

- Given civil war, widespread civil violence, or economic free-fall, the Soviet leadership necessarily would focus inward. Under these conditions, we would expect R&D to be severely diminished—to levels much lower than we would expect under any other conditions