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A Preliminary Study of the Soviet Civil Space Program

Volume 1: Organization and Operations

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Information contained in this document is thought to be current and valid at the time of publication. However, there remains a possibility of inaccuracy due to the rapidly changing state of Soviet affairs and misinterpretations of available information.

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EXECUTIVE SUMMARY

Most Western publications on the Soviet civil space program are devoted to technology assessments or catalogs of launches and missions, largely because information has been unavailable on other aspects of the program. This study, however, focuses on the organization, planning, and personnel of Soviet space, taking advantage of glasnost and improved foreign relations to explore a hitherto obscure subject.

The Soviet Union today is undergoing a great many political changes which are impacting the space program's operating environment. A newly empowered legislature, the Communist Party's declining influence; and a new executive presidency are altering the way in which the civil space program obtains approval and funding. High-level Party support of missions is no longer sufficient for resources and implementation. Rather, missions must be approved before the Supreme Soviet, and public opinion is beginning to play a greater role in the legislature's budget decisions.

Despite the number of political changes occurring, the Soviet civil space program remains a collection of disparate elements, not unified by any national, centralized space agency. The many space components fall into three categories: space industry, space sciences, and space services. In space industry, applied space research and the production of aerospace equipment occur in the industrial ministries, the largest of which is the Ministry of General Machine Building. Space sciences reside mostly in the Academy of Sciences, or, in the case of space medicine, the Academy of Medical Sciences. Operational services, such as tracking, launches, and flight control, are provided by the military's Strategic Rocket Forces.

Some of the major players discussed in the report are described briefly below:

The State Committee on Science and Technology (GKNT) analyzes the state of scientific research in the USSR and articulates long-term plans for applied research and development, including applied space research. The GKNT also allocates funding for national high-priority research projects, one of which is Mars exploration.

The State Committee for Hydrometeorology (Goskomgidromet) performs a financial/coordinating function similar to that of the GKNT, but in the area of Earth sciences. Likewise, the State Committee for the Protection of Nature (Goskompriroda) devises and coordinates national environment protection efforts and the use of national resources.

The State Committee for Public Education supervises all educational institutes, including those specializing in space engineering and design. Several of these, e.g. the Moscow

Aviation Institute, have close connections with the design bureaus of space industry and actively contribute to instrumentation and systems development.

The USSR Academy of Sciences oversees many research institutes involved in space sciences, such as: the Space Research Institute (IKI), the principal research facility for space sciences; the Vernadsky Institute of Geochemistry and Analytical Chemistry; and the Keldysh Institute of Applied Mathematics, which has a Ballistics Control Center. The Academy formulates long-term plans for fundamental research and development, which are combined with the GKNT's applied research plans for incorporation into the State Plan. Under the Academy's jurisdiction, an Interdepartmental Scientific Technical Council for Space Research formulates the future direction of space sciences research in a number of areas, including space physics, planetary exploration, and small body observations.
The Ministry of Defense's Strategic Rocket Force operates the launch facilities, tracking stations, and mission control center (TsUP) for most missions. The Air Force directs cosmonaut training and spacecraft recovery.

The Ministry of General Machine Building encompasses several scientific production associations involved in the design and construction of spacecraft and rockets. Among them, the Energiya Association oversees the design bureaus and production enterprises responsible for the Energiya launch vehicle, Buran shuttle, and manned spacecraft. The Lavotchkin Association primarily supervises the development of unmanned spacecraft for planetary exploration and astrophysics research, much of which occurs at the Babakin Research Center. The Association for Space Device Engineering develops instrumentation (cameras and radio/telecommunications equipment) for a variety of missions. Other associations work on composite materials, rocket engines and fuels, and meteorological, Earth observation and communications satellites. The Soviets' Deep Space Network is also thought to be owned by General Machine Building.

The Ministry of Aviation Industry plays a part in the Buran shuttle's development (airframes and systems) and the training of Buran pilots.

The Ministry for Public Health oversees the Academy of Medical Sciences, which is heavily involved in space medicine and cosmonautics.

The Ministry of Communications has a strong interest in commercial communications platforms and satellites.

In addition to detailed descriptions of the above components, this report brings out some interesting interplay between several of the organizations. For example, a certain demarcation exists between the space sciences and industry organizations, a tension brought about by the procedures for financing missions. Until recently, the Academy did not control the funds allocated for space sciences project development. Money for spacecraft development and instrumentation was given to General Machine Building, who then handed the finished product over to the Academy. The Academy did not have to pay for the

equipment or services rendered to it, but neither did it have much input into the design of the technology or the final outcome. Reforms are under way to correct this skewed financial arrangement, and contracting authority is to be given to the Academy institute leading the scientific investigation.

Another aspect of the space sciences-industry separation is the competition between General Machine Building's Glavkosmos and the Academy of Sciences' Interkosmos. Both organizations execute international interfaces, without actual planning or management power. Glavkosmos' mission is marketing Soviet aerospace products and services on the world space market for hard currency. Interkosmos, in contrast, handles international space science cooperation, a typically nonprofit activity. However, several Soviet space scientists believe that Glavkosmos is weakening Interkosmos' position and moving into its sphere of activity.

The Academy itself is not free from rivalries among its institutes. IKI and Vernadsky appear to be struggling over the control of Mars project funding, program definition, and relations with the US. Within IKI, the head of the Department of Radioastrophysics is attempting to move his group to the Lebedev Institute of Physics.

Within the space community generally, there has been an ongoing debate over the comparative virtues of manned and unmanned space exploration.

Much of this described interplay concerns the control of funding and resources. Recent economic trends and policies appear to be intensifying such concerns and creating an atmosphere of great budget anxiety. First of all, the Soviet Union's move to transform its centrally planned economy into one governed by market forces has thrown the planning process into disarray. For two years, the civil space program has been operating without an approved official plan, although the "Program-2005" is currently under consideration. The proposed program specifically emphasizes applied (and potentially profitable) projects such as communications platforms, cartography, navigation, meteorology, natural resources monitoring, and microgravity processing. Planetary exploration focuses on Mars, and astrophysics and solar-terrestrial physics missions are slated as well.

The conversion of defense and space industry enterprises to consumer production has also created economic uncertainty for the space program. The refitting of plants and retraining of personnel are costly and often only partially effected. At the same time, the policy of self-financing may encourage enterprises to deemphasize basic research in favor of short-term profits. Thus, the USSR risks losing its competitive edge in this high-technology sector.

In addition to the conversion plan, a new policy is under discussion for financing scientific research. For top-priority programs, the GKNT will coordinate and finance competitively selected projects. On the other hand, funds for other fundamental research will come out of the institutes' operating budgets. Finally, applied research will be done on a cost-accounting, contract basis. To date, however, none of these procedures has been officially

approved or implemented, so the old process of allocating money to space industry, in lieu of the leading Academy institute, is still operative. Considering such factors, the foreign marketing of space technology and international space cooperation are valuable, if not profitable, methods of easing the financial constraints placed on the Academy and General Machine Building.

Overall, the economic and political environment in which the program operates is extremely fluid, so this report is far from being the last word on the organization and processes of the Soviet civil space program. It does provide, however, a sense of which factors are critical to watch as perestroika proceeds.

I. INTRODUCTION

Most Western publications on the Soviet space program are devoted to technology assessments or catalogs of launches and missions, largely because information has been unavailable on other aspects of the program. This study, however, focuses on the organization, planning and personnel of Soviet space, taking advantage of glasnost and improved foreign relations to explore a hitherto obscure subject. Formerly classified establishments are now open to journalists, and more and more US scientists are visiting or hosting their Soviet counterparts. In fact, much of the detail contained herein was garnered from Western scientists who have interacted with the Soviets under the auspices of the US-USSR Agreement on the Use of Space for Peaceful Purposes (1987, revised 1988). Such interactions provide the starting point for drawing a composite picture of the Soviet civil space program. This study is an attempt to synthesize the information scattered among the media and various other sources.

Because this project originated in support of the US-USSR Joint Working Group on Solar System Exploration, the material emphasizes primarily the people and organizations involved in planetary exploration. Some material on Soviet solar-terrestrial physics, astronomy and astrophysics, Earth sciences, and space medicine activities is included as well. The Soviet military space program is not explored extensively in this document, but is addressed as it impacts civil space activities.

The general organization of the study is as follows: The first two sections sketch early organizational history, as well as the USSR's political system, to place the Soviet space program in historical and cultural context. Profiles of the various organizations follow, incorporating information drawn from Western aerospace scientists and journals and translations of the Soviet press (mostly Foreign Broadcast Information Service and Daily SNAP reports and the author's own translations). The final section details the program's operations, planning, and recent trends which are shaping the way these organizations interact. It is hoped that this study will provide a framework for better understanding and evaluating the Soviet Union's projects, direction, and potential as a cooperative partner in space.

II. BRIEF ORGANIZATIONAL HISTORY

Although not much is known about the early days of the Soviet space program, it appears to have grown out of research on military ballistic missiles. In 1924 the Soviet government created the Central Bureau for the Study of Problems of Rockets (TsBIRP). At about the same time the All-Union Society to Study Interplanetary Communications[1] (OIMS) was founded. In 1928, the Gas Dynamics Laboratory (GDL) of the Military Scientific Research Commission also joined the missile research effort. However, rocket engine research was disrupted in 1929-30, when GDL and OIMS were disbanded temporarily during Stalin's purges.

Rocket design, construction and flight testing continued however, under F.A. Tsander and Yu.I. Perelman who founded the Group for the Study of Reactive Motion (GIRD) in 1929. GIRD was divided into Moscow and Leningrad branches, and the Moscow branch, MosGIRD, was headed by S.P. Korolev, known to the Soviets as the "Chief Designer of Spaceflight." GDL in the meantime had resumed operations and was working on liquid fuel engines under V.P. Glushko. In September 1933, sections of GIRD and GDL merged to create the Jet Propulsion Scientific Research Institute (RNII) for solid and liquid military rockets, an organization whose activities continued throughout the 1930s. Under Stalin, rockets were considered primarily as ICBMs; rockets for space launches were not regarded as strategically important.[2]

Later, Khrushchev recognized the scientific and symbolic, as well as military, utility of space rockets. Encouraged by the successes of its intercontinental missiles, the Soviet leadership favored the development of an artificial Earth satellite. The Central Design Bureau of Experimental Machine-Building (TsKBEM) was created in the late 1950s under Korolev to spearhead this effort. As the chief designer of the sputnik, Korolev also directed the Coordinating Council for Space Research, under the Council of Ministers, where he supervised all research institutes and design bureaus working on satellite and rocket development. Although it is unclear whether this body still exists, Korolev's Council formulated the space program's long-term plans and distributed work among the research and production enterprises. Its membership probably included representatives from industry, the Communist Party, the military, and the Academy of Sciences.

After the successful launch of the world's first artificial Earth satellite October 4, 1957, money and people flowed into Korolev's bureau. Further successes followed, including the first animal to be launched (the dog Laika on 11/3/57) and the first human (Yuriy Gagarin

[1]The Russian word 'svyazi' is translated as communications or links, but its meaning in this context is interplanetary 'travel'.

[2]William A. Schauer, The Politics of Space: A Comparison of the Soviet and American Space Programs, (NY: Holmes and Meier, 1976):122.

on 4/12/61). With the Military Industrial Commission (VPK), Korolev also developed in 6 months the "Voskhod" orbital spacecraft by 10/12/64.[3]

By the time of Korolev's death in 1966, the space program under his direction had grown very large, and the Soviet leadership decided to decentralize his bureau. The planetary programs were given to Georgiy Babakin's design bureau, the Molniya communications program was likewise transferred, and two additional bureaus were spun off. The original Korolev bureau continued to design for manned spaceflight. It is thought that these entities were united under the Ministry of General Machine Building, which had been created for this purpose. General Machine Building has since produced the spacecraft, launch vehicles, and most instruments for scientific, as well as military and applied, missions. Allowing for some changes and expansion, the same structure essentially exists today; General Machine Building remains the sole source of high-technology space equipment.

While the space industry serves both civilian and military applications, fundamental space sciences have been distinctly civilian. M.S. Keldysh, honored by the Soviets as the "Chief Theoretician of Spaceflight," directed the study of space in the USSR Academy of Sciences. In 1955 the Academy formed a Committee on Interplanetary Communications to coordinate space studies. This committee was later renamed the Interdepartmental Scientific-Technical Council for Space Research. It is traditionally headed by the Academy's president, but was largely dormant since Keldysh's death in 1978 until a few years ago, when Academy President Marchuk reactivated the organization. Working groups operate under this council to coordinate the scientific effort of different aspects of space science research, such as the study of planets and smaller orbiting bodies.

Within the Academy, the Institute of Applied Mathematics, directed by Keldysh, worked very closely with Korolev's bureau on the lunar, Venus and Mars programs, contributing to radar mapping, aerodynamic design, attitude control, and landing parameters. Keldysh also established a Ballistics Control Center in the Institute, which still works today with the Flight Control Center.

In 1965, the Space Research Institute (IKI) was established within the Academy at the urging of Keldysh. It is reported that a large part of IKI's personnel came from the Applied Math Institute. IKI has since led the Luna, Venera, Mars, Interkosmos, Prognoz, and Vega scientific investigations, and will be heavily involved in the Soviets' upcoming Mars exploration initiative.

The Vernadsky Institute of Geochemistry and Analytical Chemistry, under V.N. Vinogradov, was also active early in the space program. The institute analyzed soil

[3]L.N. Kamanin, "1964 Flight of 'Voskhod' Spaceship with Three-Man Crew Recalled," Sovetskaya Rossiya, 10/11/89:4. Abstracted in Foreign Technology Division, Daily SNAP, 10/24/89:3-4.

samples and data from early Moon, Venus, and Mars investigations. Its Laboratory of Comparative Planetology continues such work today.

In the area of space medicine, biomedical research for manned spaceflight was begun in the early 1960s under the Academy of Medical Sciences, an affiliate of the Ministry for Public Health, and proceeds today under the same auspices.

As will become evident in the organization profiles, the number of factories and research institutes involved in space exploration and development has multiplied radically since the first sputnik. Even in the early days, the coordination of missions was a formidable task, achieved as much by the force of Keldysh's and Korolev's personalities as by any amount of resources made available to the effort. Today, however, without a centralized space agency or the clear predominance of one authority over all others, the components of the space bureaucracy pursue their own interests. As discussed in the next section, perestroika is changing the environment and the way in which organizations strive for their goals.

III. THE ORGANIZATION

A. Political Organization

No comprehensive discussion of the Soviet civil space program can be presented without first outlining the Soviet political system. The structure of the USSR's political life influences not only the space program's organization chart, but also its procedures, its financial future, and the authority of its personnel. This section provides a brief overview; a more in-depth exposition on space planning is presented in a later section. Figure 1 depicts the relationships between the various parts of the Soviet political system.

In the USSR, the government attempts to administer the entire national economy. As is characteristic of a planned economic system, the bureaucracy controlling the industrial sectors and social programs is concomitantly large. Planning necessitates extreme centralization, but such extensive government control has impeded the diffusion of technology in the economy. Furthermore, until recently there has been very little separation between the Communist Party and the Soviet state structure. From the very beginning of the Soviet regime, the Communist Party's dominance of the state apparatus was presupposed. Party membership went hand in hand with position in the government apparatus. Nomenklatura (party control of personnel appointments) and dual affiliations guaranteed party dominance. Even today, Gorbachev occupies the top posts of both party and state: General Secretary and President.

Gorbachev's program of perestroika, however, has altered not only the state's administration of the economy, but also the party-state relationship. In brief, a fundamental shift in the balance of power is under way: popular elections created a revived legislative branch in June 1989; a strong executive Presidency was approved in March 1990; and the Communist Party agreed in February 1990 to relinquish its monopoly on Soviet political life, its "leading role" in society. Nomenklatura as the modus operandi is diminishing in practice. Economically, decision-making is being decentralized; enterprises and research institutes will be self-financing. In other words, they will buy and sell products, as opposed to having them delivered according to the State Plan.

The changing Soviet political system has of course had an impact on the civil space program. Political support of the space program no longer depends greatly on the personal disposition of the top Party leadership. Instead, popular opinion has begun to influence state expenditures via the newly empowered Supreme Soviet and Congress of People's Deputies, especially now that the space budget is no longer a closely guarded secret. Scientists must now justify missions before Supreme Soviet committees, and project managers are legally accountable for finances and results. The following descriptions of the political system highlight the conditions under which the space program operates. The Communist Party's role is discussed first, followed by an explanation of the new legislative and executive branches and the government apparatus.

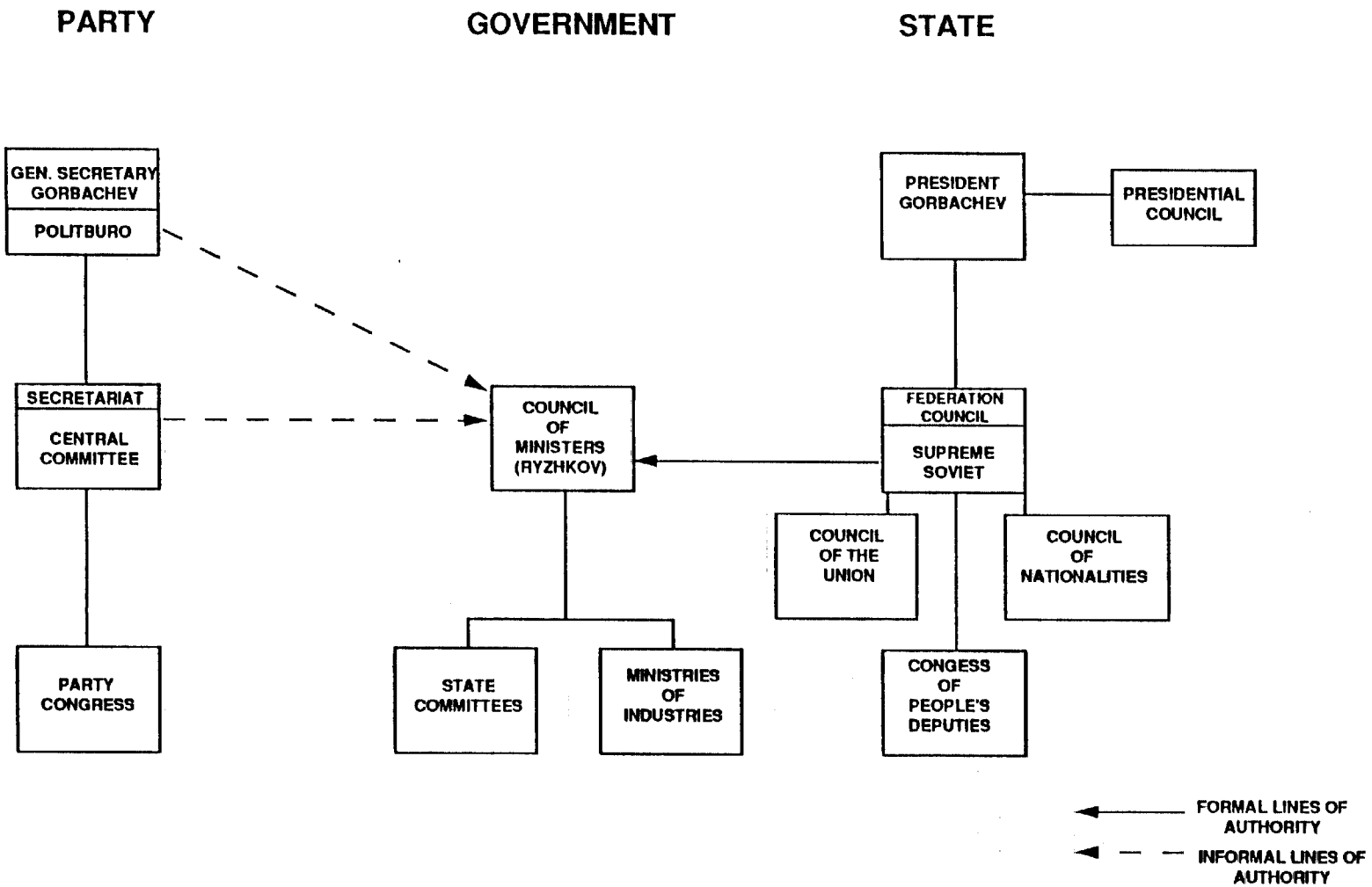

Figure 1. The Soviet Political System

The Communist Party

As the only legal political party, the Communist Party has always been extensively involved in policy-making for the USSR. The top leadership of the Communist Party established the state's priorities de facto and directed the government without formal authority. Control was exercised by nomenklatura, dual affiliations, and watchdog units of the party which paralleled the economic divisions of the production industries. The position of General Secretary of the Communist Party was the highest office in the country.

The Politburo, probably still the highest decision-making organ in the USSR, is composed of party officials, approximately 50% of whom also hold government posts. The Politburo is supported by the Secretariat of the Communist Party's Central Committee, which oversees the management of the economic sectors. The Central Committee also monitors government bodies to gather information and insure the implementation of Politburo decisions.

The Central Committee is elected by the Communist Party Congress, which is held every 5 years. The Central Committee has several departments and commissions which advise it of national conditions relating to a variety of issues. The heads of these departments, or Secretaries, make up the Secretariat. The Central Committee has 251 full and 109 candidate members.

The Central Committee's Department of Education (which oversees the Academy of Sciences) and the Department of the Defense Industries are thought to be the departments most involved in the space program. O.D. Baklanov is the Secretary for Defense Industries (formerly Minister of General Machine Building), and his position as Secretary may have empowered him to offer the French a Soviet booster as a preamble to Gorbachev's meeting with Mitterand in July 1989. Baklanov is also thought to have been involved in selling the idea of Mars exploration to the top Soviet leadership. Within the Politburo itself, it is thought that L.N. Zaikov is responsible for the defense industries, which, corresponding to past practice, would make him the most informed Politburo member on space activities.

Now that the Communist Party has agreed to abolish its political monopoly, its influence on political decisions is sure to wane as multiparty democracy comes into effect. The size of the Communist Party will probably shrink as groups splinter off to form their own parties and the Communists go through a fundamental reappraisal of the party's platform. However, the party is still a force to reckon with and will probably influence political decisions and appointments for some time to come.

The Legislature--A New Locus of Power

As mentioned, another major change in the framework of party control over the state is

the ascendancy of the legislature. Although the new relationship has not yet solidified, the Supreme Soviet has been empowered as a significant actor in the policy arena. A Congress of People's Deputies was elected early in 1989 by universal, multicandidate elections--a first since 1921. Two-thirds of the 2250 seats were elected by popular vote, according to territorial and popular representation, the remaining third by "social organizations," like the Communist Party, Academy of Sciences, Komsomol, and other public organizations. Previously, Communist Party members alone had the privilege of electing a "rubber stamp" legislature.

Today's Congress is elected every 5 years and selects from its own ranks a smaller working parliament (542 members), called the Supreme Soviet. For this term only, the Congress also elected a President for a 5-year term. The Congress subsequently recessed, but its deputies are free to participate in any of the Supreme Soviet's committees (50% of all committee members are Congressional Deputies not selected for the Soviet). The Congress reconvenes regularly to deliberate on Constitutional changes, to approve the State Plan and Budget, and to instruct the Supreme Soviet to place certain issues on its agenda. The Congress may also review and rescind the Supreme Soviet's legislation and decisions taken during the Congress' recess.[4]

Approximately one-quarter of the Congressional Deputies became members of the Congress' Supreme Soviet, which is to be a permanent working body that meets twice a year. It has the power to review presidential and government foreign policy decisions, draft and adopt laws, assist in formulating the State Plan and Budget (drafted by the Council of Ministers' Gosplan), oversee government operations, and confirm government appointees. The latter power in particular points to the deterioration of the nomenklatura system. Every year, one-fifth of the Supreme Soviet Deputies are replaced by Congressional Deputies not initially elected to the body.

The Supreme Soviet is bicameral, consisting of the Council of the Union (providing representation by population and handling all-Union concerns like the economy, legal rights, foreign policy, and national security) and the Council of the Nationalities (providing regional representation). There are both joint and standing committees within the Soviet which work on various issues and present draft legislation to the full Soviet session for voting. If the draft laws prove unacceptable to the full Soviet, the legislation can be returned to committee for revision.

A Federation Council of the Supreme Soviet acts as its executive arm, but also has the power to issue decrees and awards, appoint or recall diplomatic officials, and grant pardons. The President, now M.S. Gorbachev, chairs the group, and its other m%+'(+ include the first Vice President, the Chairmen of each Council, 15 deputy chairs (the

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[4]"Verbatim Report of the USSR Congress of People's Deputies," Izvestiya, 5/28/89. Reproduced in Current Digest of the Soviet Press, v. 41/22, 6/28/89.

Chairmen of Union Republic Soviets), and Chairmen of the 22 Supreme Soviet standing committees and commissions.

Currently, the Council of the Union's Planning, Budget, and Finance Standing Committee reviews the State Budget and Plan, which ultimately determines space program funding. Scientists must now defend their space missions and plans before this committee. The Committee on Science, Public Education, Culture, and Upbringing (headed by Y.A. Ryzhov, rector of Moscow Aviation Institute) probably also plays a role in approving future space missions in which the Academy of Sciences takes part.

The New Executive Branch: The President and Presidential Council

In March 1990, the Soviet Constitution was amended to create a substantially strengthened executive President, to be elected by popular vote. The President chairs the Supreme Soviet sessions and has the power to issue decrees (as long as they are in accordance with the Constitution and existing laws), veto bills, and declare a state of emergency in a republic, with the assent of the republic or two-thirds of the Supreme Soviet. Furthermore, the President nominates a Presidential Council which may "elaborate measures to implement the basic thrusts of USSR domestic and foreign policy and ensure the country's security." These advisors, while serving as a "think tank," do not have the right to promulgate laws, decrees, or resolutions. In the near future, it seems likely that the Presidential Council will deliberate on space policy, particularly where it concerns international cooperation.

The Government

The government, an extensive bureaucracy of both economic and political entities, is subordinate to the legislative and executive branches and implements their directives. At the top of the government structure is the Prime Minister, currently N.I. Ryzhkov. Both space industry and space sciences are a part of this bureaucracy, as will be discussed.

The Council of Ministers is the highest executive organ of the government. The Council today receives instructions from the Supreme Soviet, presents the State Budget and Plan, establishes research and development targets, and has overall responsibility for executing the Plan. The Council itself consists of the Prime Minister, the First Deputy Prime Minister, several Deputy Prime Ministers, Ministers of the industrial sectors, and Chairmen of the State Committees and Advisory Councils. With such a large body, the power really rests with the Council's Presidium, a smaller working group. Apparently several bureaus assist the Presidium with the task of overseeing the economy. One such bureau is the Bureau for Machine Building, headed by I.S. Silayev, who probably oversees the Ministry of General Machine Building.

To summarize, the Soviet political system is moving toward a political system not unlike those of Western democracies. Power no longer resides with an ideological party, but in a secular state. An empowered legislature now oversees the government's execution and development of the Plan, reviews the budget, and appropriates funds for space missions.

Although this new political system is under development, no known decision has yet been taken to establish a new centralized management structure for the space program. As far as the literature shows, the program still consists of many disparate elements, as cataloged in the next section.

B. Space Program Organization

Soviet science and technology generally have suffered from a lack of coordination, and the civil space program is no different. So many different organizations have their own agendas in space that one could almost speak of space programs, as opposed to a single civil space program.

In addition, Soviet civil space activities are characterized by a separation between space industry, sciences, and services. On the one hand, most applied space research and space production are done in the industrial ministries. Space industry, consisting predominately of Ministry of General Machine Building entities, develops and builds spacecraft, launch vehicles, and instruments for the space sciences community (as well as for the military and industrial sectors interested in applied space research). On the other hand, space sciences are lodged in the Academy of Sciences, with the exception of space medicine, which falls under the Academy of Medical Sciences in the Ministry for Public Health. Operational services, like tracking, launches, and flight control, appear to be provided by the Strategic Rocket Forces and other military branches, with the assistance of General Machine Building personnel.

In the beginning of the space program, relations between industry and the Academy of Sciences were well coordinated and enthusiastic. Now, however, a certain tension has developed between the two sets of organizations. Academy institutes thus far have been "junior" to industry by virtue of the fact that scientists have had little leverage over the design of the equipment built for their use. However, new economic and political trends are transforming this unequal relationship. Monopolism in space production is under attack, and it is planned that the Academy institutes will control all project funding for future missions and will contract with industry for work. This development of a new working relationship is one of the more significant trends affecting the space program's organization.

In the area of planetary exploration, most activities occur in IKI, the Vernadsky Institute, and the Babakin Research Center of General Machine Building. For other areas of the space program, different entities play comparable roles. In Earth sciences, for example, the State Committee for Hydrometeorology and State Committee for the Protection of Nature (Goskompriroda) are very active. In space medicine, the Academy of Medical Sciences predominates.

Known organizations involved in space are described below, with reference to their functions, authority, and, when known, size and personnel. State committees are discussed first, followed by the ministries, the Academy of Sciences, and their subordinate organizations. Figure 2 provides an overview of the committees and ministries to be covered.

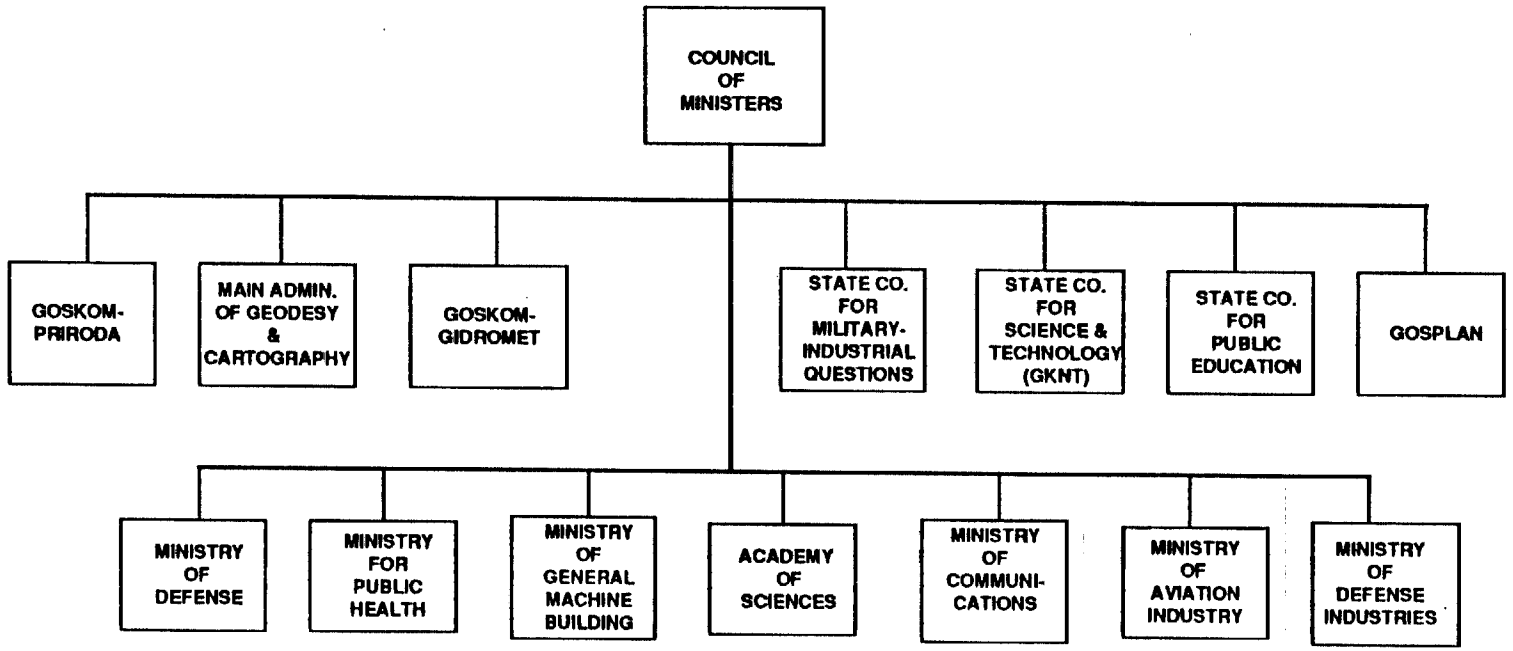
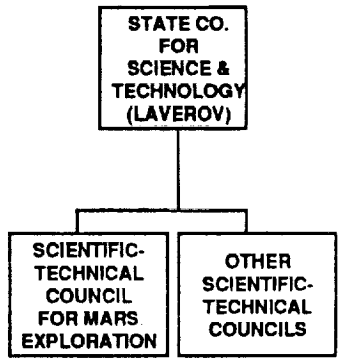


Figure 2. Broad View of the Government Involved in the Space Program

1. State Committee on Science and Technology (GKNT)

The State Committee on Science and Technology (GKNT) is directly subordinate to the Council of Ministers and has a status comparable to that of a ministry, if not higher. It essentially acts as a vehicle for government policy in an effort to centralize research and development policy. Today, for example, the GKNT bears responsibility for seeing that self-financing becomes the operating principle among research and development bodies. This committee also analyzes the state of scientific research, coordinates science programs and relates them to the national economy, and helps articulate with the Academy of Sciences the long-term plans for research and development. Research and development funds are also allocated by this organization.



The GKNT consists of councils organized to address major research and development tasks, as well as administrative divisions and branch departments, overseeing industrial sectors' programs. Many affiliated research organizations, scientific research institutes (NIIs), and interbranch scientific-industrial complexes (MNTKs) support the GKNT's goal to merge industry and research facilities.[5]

The GKNT's scientific councils assess competitive proposals for projects of national interest. Such councils then allocate the appropriate resources. Fifteen programs so far have been approved by the Council of Ministers as high-priority areas, including: High-Energy Physics; High-Temperature Superconductivity; Genetic Engineering; Ecologically Clean Electric Power; Information Technology; Effective Food Production; Building Progress 2000; Fight Against Common Diseases; High-Speed, Ecologically Clean Transportation; and **Flight to Mars.**

The existence of the GKNT is an outgrowth of the Soviet planned system's inability to overcome excessive barriers to the diffusion of knowledge and technology into the economy. The GKNT was named in 1965 to infuse the industrial production process with the Academy's research breakthroughs. With Gorbachev's program to reinvigorate the economy, the State Committee's stature has increased proportionately. The predecessor to the GKNT was the State Committee for the Coordination of Scientific Research, established in 1961. When in 1963 all engineering institutes were moved out of the Academy of Sciences and placed under the control of the relevant industrial ministries, this State Committee replaced the Academy as the primary coordinator for Soviet applied research. Only basic research remained under the Academy's jurisdiction.

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[5]For more detail on MNTKs and NIIs, please refer to S. Kassel's reports, "Soviet Advanced Technologies in the Era of Restructuring," RAND Report, R3653-DARPA/RC, April 1989, and "Soviet High-Technology Restructuring Drive: The MNTK Network," RAND Report, N-2612-DARPA, August 1987.

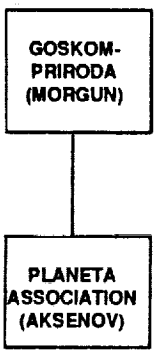
In July 1989, N.P. Laverov became both the Chairman of the State Committee for Science and Technology and Deputy Chairman of the Council of Ministers.

2. State Committee for Hydrometeorology (Goskomgidromet)

This organization was established in 1954 to monitor and report on meteorological conditions throughout the USSR. It seems likely that it performs a financial/coordinating function similar to that of the State Committee for Science and Technology, except that its realm is Earth Sciences. Goskomgidromet reportedly has a huge amount of money and an autonomous space communications center at its disposal for applied research in this realm.[6] Its current director is Y.A. Izrael.

The "Planeta" Scientific Production Association: This association resulted from the merging of all enterprises and divisions developing and operating satellites and a ground-based system for monitoring Earth resources. It was formerly called the State Science Research Center for the Study of Natural Resources (GOSNITSIPR). It places particular emphasis on studying ice conditions, optimum shipping routes, and rescue operations from space. Vladimir V. Aksenov, former cosmonaut and former director of GOSNITSIPR, now directs the association.

3. State Committee for the Protection of Nature (Goskompriroda)



This state committee was created in January 1988 to devise, coordinate, and direct national environment protection efforts and the use of national resources. Its functions were previously performed by the State Committee for Hydrometeorology and Environmental Protection, which was reduced in 1988 to today's Goskomgidromet. As a regulative body for natural resources, Goskompriroda is in fact funded by taxes on their use. According to reports, it has a receiving station for Earth satellite information. Its chairman is F.T. Morgun.

4. State Committee for Public Education

This committee was created in 1988, assuming the functions of two ministries and one state committee devoted to education. G.A. Yagodin chairs this state committee.

Higher educational institutes are very specialized in orientation and often come under the direct authority of a related ministry (like Communications or Agriculture). The rectors may even be appointed by the ministries or Academy of Sciences. Such specialized

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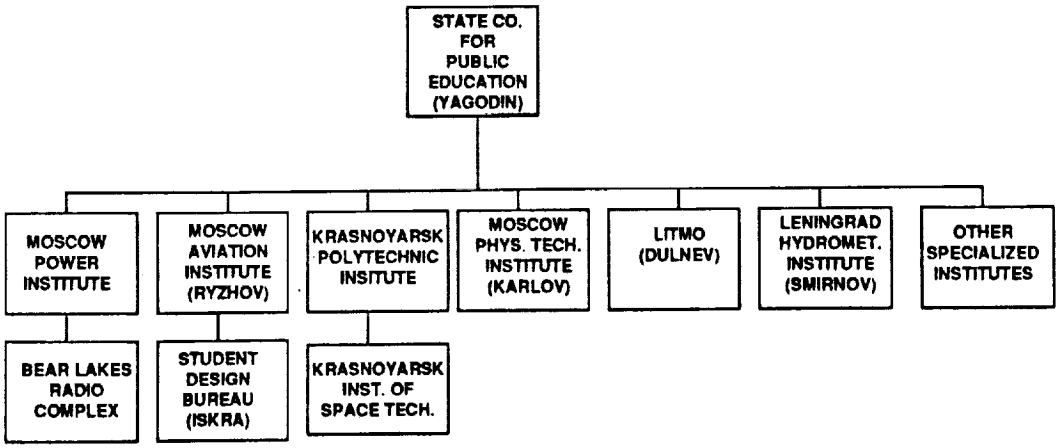
[6]Kondraityev, Chapter in Survey by Vestnik Akademii Nauk SSSR, "Space Research: Ideas, Priorities, Efficiency," no. 2, Feb. 1990. Reproduced in JPRS Science and Technology: USSR Space, 4/13/90.



institutes frequently perform contract work for ministries in the defense area. As much as 80% of the contracted funds, however, can be used by the institute to cover the needs of laboratories not involved in the contracted work.[7] Several of the known institutes follow:

Moscow Aviation Institute, Ordjonikidze (MAI): MAI is known as a training ground for space scientists and engineers and is reportedly involved in the development of rockets, jet engines, aircraft, and space systems.[8] MAI's rector, Y.A. Ryzhov, currently heads the Supreme Soviet's Committee on Science, Education, Culture, and Upbringing. MAI reportedly has a close working relationship with the Babakin Center of the Ministry of General Machine Building; students from its Space Student Design Bureau (ISKRA) have worked as candidates there and Babakin staff have taught at MAI.

Krasnoyarsk Institute of Space Technology: This institute, an affiliate of the Krasnoyarsk Polytechnical Institute, was recently declassified after 30 years of existence. It is not known exactly what this institute works on, but its students often work in aerospace design bureaus and research institutes. Its president is G. Belyakov.

Moscow Power Institute: This organization runs the Bear Lakes (Medvezhdi Ozera) Radio complex for teaching and research. General Machine Building and the Academy sometimes contract with this facility on an ad hoc basis for the Soviet Deep Space Network. It is located 20 km northeast of Moscow.

Moscow Physical Technical Institute (MFTI) According to reports, MFTI was involved in the design of the space shuttle. It was created in 1952 to provide training in theoretical and applied physics, biology, chemistry, mathematics, aerodynamics, and flight mechanics. Its rector is currently N.V. Karlov.

Leningrad Mechanical Institute: The Marsokhod rover is thought to be a product of this institution.

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[7]Victor Yevsikov, "Re-Entry Technology and the Soviet Space Program (Some Personal Observations)," Delphic monograph series on the Soviet Union, Dec. 1982. p. 24.

[8]Peter N. James, Soviet Conquest from Space, (New Rochelle: Arlington House, 1974):76.

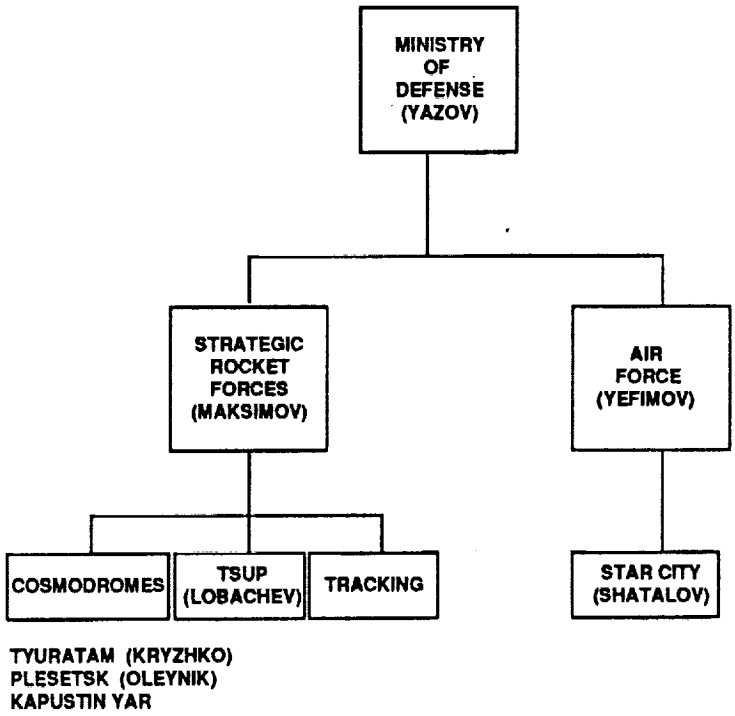
Leningrad Hydrometeorology Institute: In addition to teaching, this institute researches hydrology, meteorology, and oceanology. Its rector is N.P. Smirnov.

Leningrad Institute of Precision Mechanics and Optics (LITMO): Established in 1930, this organization develops optical, machine-tool, marine, measuring and photographic instruments. Accordingly, LITMO is involved in the VIMS-Omega (U.S.-French) instrument for the Mars '94 mission. G.N. Dulnev holds the position of rector.

5. Main Administration of Geodesy and Cartography (GUGK)

GUGK is an agency of the Council of Ministers, with a status less than that of a state committee. It is involved in coordinating or possibly allocating money for remote sensing and mapping from outer space. A subordinate entity, Soyuzkarta, markets cartographic products on commercial world markets. GUGK's current director is V.R. Yashchenko.

6. Ministry of Defense



The military has been a significant participant in the space program from its very beginning. Civil and military space programs continue to overlap in many respects today. Communications (Molniya and Elektron satellite series), rocket engines and propellants, and manned orbiting stations (Salyut-Soyuz) are examples of this synergism. One Soviet emigre asserted that "space research and development is in the main promoted because of its potential use by the military-industrial complex."[9]

Despite the common interests of civil and military programs, there is some debate over the actual jurisdiction of the Defense Ministry in space activities. A

[9]Yevsikov, op cit, p. 9.

few analysts see the ministry as managing all programs. More realistically, the military directs only projects with specifically military applications, but these constitute probably 80-90% of all payloads launched.[10] Western and even Soviet uncertainty in this regard is understandable, since the prolific Kosmos "scientific" launches often mask military flights or civilian applications.

Whatever may be the actual percentage, the Ministry of Defense has a strong interest in the manned space program and controls the launch vehicles and launch and tracking facilities for most missions, whether applied, scientific, or military.

Former Minister for Defense Dmitriy F. Ustinov was an acknowledged expert on defense industries and space; before becoming Defense Minister, he was a Party Central Committee Secretary and an authority on space. It seems likely that in his position on the Politburo until 1985 he significantly influenced the direction of the Soviet space program. The current Minister of Defense, Dmitriy T. Yazov, also a Candidate member of the Politburo, would be equally informed of military space activities.

The Military Branches: There are five military branches within the Ministry of Defense, and each, except the Army, plays some role in the space program. The Air Defense Force handles ASATs and early warning satellites; the Navy, rorsats and sea-tracking support. The other two branches, the Air Force and Strategic Rocket Force, have direct responsibility for space operations.

The Air Force directs cosmonaut training and spacecraft recovery, although formally the cosmonaut training facilities are under the administration of the USSR Academy of Sciences.[11] At Star City (Zvezdny Gorodok) the cosmonauts receive their training,[12] mission briefings, and medical checkups. Star City also trains the technical and medical support personnel for manned spaceflight. Unlike its U.S. counterpart, however, Star City performs no direct mission control; instead, the Strategic Rocket Force (RVSN) performs this function at the launch complex. General-Lt. V.A. Shatalov directs the cosmonaut training center at Zvezdny Gorodok.

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[10]The figures vary, depending on the spokesman. A. Dunayev, director of Glavkosmos and deputy minister of General Machine Building, says one-third of all launches (in terms of expenditures) are scientific. R. Sagdeev, former director of the Space Research Institute (IKI), Academy of Sciences, states that 2-4 launches out of roughly one hundred per year were scientific. ("View" News Program, Moscow TV Service 9/22/89. Transcript in FBIS Daily Reports: USSR, 9/27/89:105-106.) The military's share of spending on space is reported to have been 56% in 1989. (O. Moroz interview of Dunayev, p. 48).

[11]Congressional Research Service, Senate Committee on Communications, Science and Transportation, Soviet Space Programs 1976-1980, Washington, D.C.: Government Printing Office, December, 1982: p. 322.

[12]The Air Force is not solely responsible for cosmonaut training; scientists and design specialists also provide instruction.

The RVSN, which was established in 1960 as an elite branch of the military, conducts all military and civilian space launches. Its primary responsibility is strategic nuclear missiles, and it is thought to control all Soviet launch vehicles. The RVSN also operates launch facilities, tracking ships and stations, and conducts mission control at the Flight Control Center (TsUP), directed by V. Lobachev.

Located in the Moscow suburb of Kaliningrad, the TsUP monitors the crew and work conditions of launched manned projects. It provides operational guidance for the flight, coordinates the ground tracking stations, and controls the craft's orbit. TsUP has the ability to monitor four missions simultaneously and transmits information from launched experiments to the Academy and industrial research organizations. Ground tracking stations for satellites are located within the USSR's borders and on Academy of Sciences research vessels. These stations are linked to TsUP by communications networks.[13]
Among the cosmodromes run by the RVSN, the "Baikonur" cosmodrome, directed by Gen.-Lt. A.L. Kryzhko, has facilities for the integration of Soyuz launchers and the Soyuz/Progress spacecraft. Baikonur also contains assembly, integration, test, and support facilities for the Energiya/Buran system. Baikonur is actually a geographically misleading name for the cosmodrome; in reality the facilities are at Tyuratam, near Leninsk in the Syrdarya River region of Central Asia (several hundred kilometers southeast of the town of Baikonur). "Baikonur" was chosen as a site for ICBM development. It launched its first rocket October 4, 1957, and today launches most planetary spacecraft.

The Plesetsk cosmodrome, directed by Gen.-Lt. I. Oleynik, specializes in the launch of unmanned spacecraft. Plesetsk includes spacecraft assembly, testing, and launching facilities, as well as the "Mirnyy" military garrison. Molniya communications satellites, those of the Kosmos and Resurs series, and the Cospar-Sarsat system are launched from Plesetsk.

Kapustin Yar was the first Soviet cosmodrome, but it no longer appears to be fully utilized by the Soviet space program. It has been used for the Kosmos and Interkosmos spacecraft and launches of the Vertikal rocket and is now offered as a launch site on the world market.

The launch facilities and TsUP are depicted on the map located in the Appendix.

Main Intelligence Bureau (GRU): The GRU is the second chief directorate of the military's General Staff. It is an intelligence-gathering body, rival to the more pervasive and predominant KGB. The GRU and KGB perform similar espionage tasks, with the GRU placing a stronger emphasis on military information.

In all likelihood, a Space Intelligence Directorate exists within the GRU and screens data

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[13]V. Ryumin, Chapter entitled "A Few Words About the Flight Control Center," in his book, A Year Away from Earth: A Cosmonaut's Diary, (Moscow: Molodaya Gvardia, 1987). Reproduced in JPRS Science and Technology: USSR Space, 2/12/90.

transmitted to flight control from the spacecraft.[14] Although the GRU may monitor the downlink, it is doubtful that it actually controls access to the scientific data. The Space Intelligence Directorate reportedly has its own cosmodromes, a number of research institutes, a coordinating computer center and a huge amount of resources. Supposedly this directorate independently designs spy satellites and prepares them in its own workshops.

State Flight Commissions: The functions of the State Flight Commissions are not entirely clear. Historically, perhaps, the Commission played a strong coordinating role in the early space missions. Today, however, they may act as a flight readiness review board at the launchpad. The Commission may perform flight design tests, approve the flight program, and evaluate crew, launch, landing, and mission reliability. The composition of the State Commission is dictated by the type of mission: manned, unmanned, weather, biology, etc.

The Commission Chairman for the first launch, and the director of Kapustin Yar, was V.I. Voznyuk. For manned spaceflight, K.N. Rudnev chaired the first Commission, followed by L.V. Smirnov, then G.A. Tyulin, under whose direction Vostok and Voskhod flights occurred, as well as the first space walk. In 1962, Tyulin was appointed Commissioner for interplanetary spacecraft at Baikonur and oversaw Venera, Mars 1, and several Luna missions. Kerimov has headed commissions for both manned (Soyuz in 1967) and interplanetary spacecraft.

7. Military-Industrial Complex--the VPK

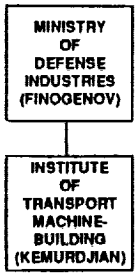
Although the RVSN controls the launch vehicles, it does not actually produce them. Instead, various "captive" defense production industries perform this job. The Military Industrial Commission (VPK), directly subordinate to the Council of Ministers, supervises these strategic industrial sectors, which include General Machine Building, the Aviation Industry, the Communications Industry, and the Radio and Electronics Industries, among others. The VPK supervises and facilitates the production of all military equipment and components, including those used for launch vehicles and military space systems. Military personnel frequently fill civilian posts in industry or may retain their active status and work as "military representatives" (voyenpreds) to control the fulfillment of military orders and the quality of production. Through these channels, excellent interface and control exist between the Defense Ministry and industry. The VPK also plays a part in Soviet acquisition of foreign technology for military and industrial production.

The defense production ministries that contribute most to the space program include the Ministry of Aviation Industry (parts of the Buran), the Ministry of General Machine Building

[14]according to Viktor Suvarev, a Soviet defector and former GRU official, in his book, Inside Soviet Military Intelligence, NY: MacMillan, 1984.

(rockets and space equipment), and possibly the Ministries of Radio and Electronics (space instrumentation).[15]

8. Ministry of Defense Industries



The Ministry of Defense Industries consists of many production associations devoted to manufacturing military goods, but its All-Union Scientific Research Institute for Transport Machine Building designed the lunar rover and is currently working on the Mars rover. Its Chief Designer is A. Kemurdjian. Personnel at this institute also analyze the physical-mechanical characteristics of planetary soils.

9. Ministry of General Machine Building (MOM)

The Ministry of General Machine Building was established from the decentralization of Korolev's bureau in 1965. Originally MOM supervised three main missile design bureaus: Korolev's Bureau (TsKBEM), the Yangel Bureau, and the Chelomai Bureau. Today it loosely encompasses several Scientific Production Associations, which join research and development bureaus and production enterprises to improve the design and construction of spacecraft and rockets. MOM is thought to employ 500,000 people and is currently headed by Oleg N. Shishkin (who formerly led the Energiya Association).

MOM was considered a ministry devoted primarily to defense production until the country's economic plight dictated the conversion of many plants to consumer goods production. (This conversion plan will be discussed in a later section.) In addition to consumer production, the ministry's work is turning to environmental and applied space activities, with its Energiya Association assuming the lead in several projects.

Aside from the testing stations belonging to its component design bureaus, MOM also operates major testing grounds at the cosmodromes. However, the proving grounds are thought to be manned by army personnel quartered within the cosmodromes.

The Soviet Deep Space Network[16] (DSN) facilities are probably owned by the Ministry of General Machine Building, but the facilities are staffed by personnel from several organizations. For example, during mission operations, IKI personnel perform science

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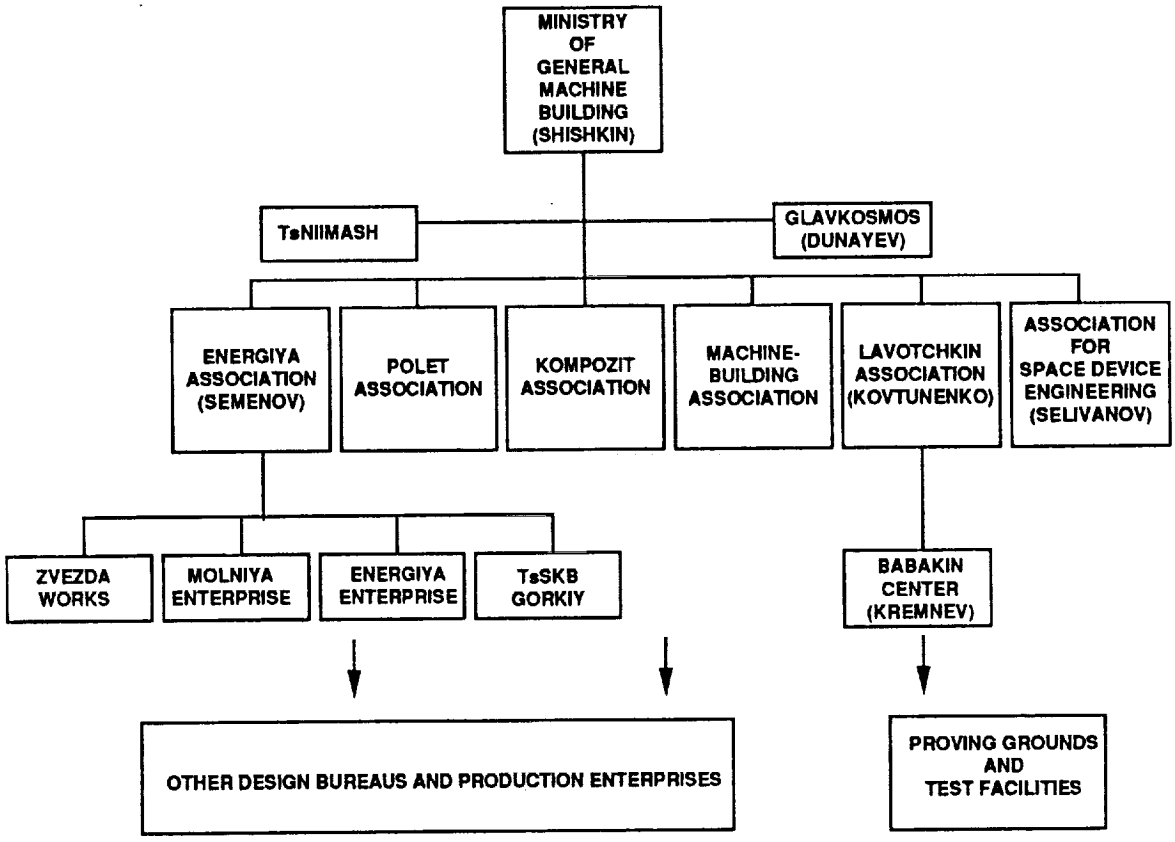
[15]Office of Scientific Weapons Research, Directorate of Intelligence, CIA. "Defense Production Ministries," Poster #316930 4/88.

[16]Technical details and photos of some of the DSN facilities have been collected by a recent NASA/JPL delegation which visited the sites in September 1989. Stations in Yevpatoria, considered the center for deep space communications, Ussurysk, Bear Lakes (on a contractual basis), and a site to be built in the mountains of Uzbekhistan comprise the DSN. For more information on the facilities' specifications, one may refer to their travel report, NASA report "Report on Visit to the Soviet Union DSN," Prepared by JPL, 2/15/90.



analysis, the Babakin Center performs spacecraft analysis, and the Lavotchkin Association performs DSN operations. At the Yevpatoria facility, a Spaceflight Control Group controls flights not monitored by TsUP.

The map of Soviet space facilities in the Appendix shows the location of DSN and other tracking stations.

Glavkosmos, or the Main Directorate for the Development and Use of Space Technology for the National Economy and Science Research.

Glavkosmos is essentially a marketing organization or department, established in 1985 by MOM, to facilitate its external relations without exposing its extensive military activities. The Director of Glavkosmos, A. Dunayev, also acts as a Deputy Minister to Shishkin.

Although Glavkosmos is primarily a medium for external interfaces, it claims to plan and administer civilian international space programs, develop prospective plans for the creation of space technology, and organize the corresponding work in satellite design, construction, launching, information-collecting, and remote sensing. In other words, it claims for itself the role of a national centralized space agency. However, in view of its small size (35 "associates," per Dunayev, or possibly a total of 60 people), Glavkosmos cannot possibly run as much as it claims.

As a department of MOM, Glavkosmos actively markets space services. Its primary mission seems to be earning hard currency by offering launch vehicles and other aerospace services to foreign countries. Its agent in the Western market is the "Kosmos" firm of the All-Union foreign trade association, "Litsenzintorg" (chaired by V.V. Ignatov) which arranges the appropriate contracts and licenses. In the U.S., the Space Commerce Corporation (SCC), Houston, has established a joint venture with Glavkosmos to market Soviet aerospace goods and services.[17] According to the SCC, 20 launch sites at three cosmodromes (Baikonur, Plesetsk, Kapustin Yar) are available for commercial use, in addition to the many launch vehicles and various satellites. Through Glavkosmos, MOM has also sold a prototype Mir space station to a Japanese trading corporation, Horie Planning, in October 1989. In addition, MOM is now selling a database of space development technology (mostly manned spaceflight data) to the same corporation.

The Central Scientific Research Institute of Machine Building (TsNIIMash): The full scope of TsNIIMash's work is not clear; however, it has been credited with developing the "Program 2005," a list of planned missions and goals for space until the year 2005. Apparently it has also been delegated the task of finding new contacts and opportunities in remote sensing of Earth, ecology, forecasting, and natural phenomena.[18] TsNIIMash is also involved somewhat in standardizing Soviet space technology. Its deputy director recently expressed an interest in the work of the International Consultative Committee for Space Data Systems (CCSDS) in this area. TsNIIMash's current director is Professor Yuri Mozzhorin.

The Lavotchkin Scientific Production Association: The Lavotchkin Association was originally a design bureau which produced the LaGG fighter aircraft during World War II and later cruise missiles. In 1957, Lavotchkin switched to developing and producing spacecraft. Lavotchkin supervised the building of the lunar probes Luna 3 through Luna 16, as well as the Venera, Vega, and Mars spacecraft, the Lunakhod, and the Granat observatory. Lavotchkin also oversaw the design of the Phobos 1 and 2 missions and the Spektr (Spectrum astrophysics) missions. Lavotchkin has diversified its production recently to include furniture, and farming and packaging equipment.

Recent visitors to the Lavotchkin Association describe it as a large compound including design bureaus, laboratories, testing facilities, plants, and a museum of the organization's space projects. Lavotchkin specialists also staff the space communications centers at Yevpatoria and Medvezhdi Ozera to receive the information from Granat. Its current director is V.M. Kovtunenko.

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[17]Operation commenced January 1, 1989, although business has been slow due to US governmental regulations.

[18]Tarasov, Andrei. "Participants of Planned Soviet-US Cosmonautics Seminar," Pravda, 1/20/90:5. Daily SNAP, 900202, 2/2/90:1-2.

Lavotchkin oversees many design bureaus, reportedly more than 40 construction facilities and 140,000 employees. One of its entities, the **Babakin Research Center**, actually designed the first lunar and planetary probes. Babakin is also thought to be responsible for broad systems design, coordination and oversight of construction orders, and systems operations, while more detailed work on spacecraft is done in other facilities deeper within the Lavotchkin compound. A separate entity at Lavotchkin performs environmental testing (vibration and electromagnetic) for the Babakin design bureau and production shops.

Roald S. Kremnev currently heads the Babakin Center. Kovtunenko, currently Lavotchkin's director, may have been the Director of Babakin from 1978 until his appointment at Lavotchkin. Visitors to Lavotchkin report that the Babakin Center stands at an entrance of the compound, which leads one to believe that it has been acting very recently as a reception area for international interactions.
Another entity subordinate to General Machine Building is the Scientific Production Association for Space Device Engineering, directed by A.S. Selivanov. This Association reportedly has five departments working on (1) on-board magnetic memory; (2) on-board and ground radio communications for Earth applications; (3) on-board optical and mechanical devices and ground processing for Earth and planets; (4) on-board radio systems and ground hardware for deep space; and (5) civil radiolocation systems. The Mars, Venera, and Vega cameras, deep-space instruments, the Thermoscan instrument, and military radio/telecommunications equipment number among its products.

The Energiya Scientific Production Association: Originally the **Korolev Central Design Bureau of Experimental Machine Building (TsKBEM)**, the Energiya Association encompasses several design bureaus and production facilities which develop equipment for manned spaceflight. Energiya also manages the Energiya-Buran complex. During the mid-1970s, TsKBEM was subdivided into nine "complexes" for (1) orbital computations; (2) calculations for rockets, motors, reentry vehicles and software; (3) rocket and space systems design; (4) vehicles and modules; (5) solid and liquid rocket engines and materials; (6) life-support systems; (7) communications, control, and navigation; (8) materials studies; and (9) launchpad equipment. It seems likely that similar departments exist today within the association.

Korolev led this bureau until his death in 1966. He was succeeded by Vasiliy Mishin, who was followed by V. Glushko in 1974. At Glushko's death in 1989, Yu.P. Semenov took over. Work on the Energiya-Buran system began in 1974, after the man-on-the-moon program was abandoned.

The Energiya launch vehicle has been heavily criticized recently in the Soviet Union for its costliness and lack of immediate purpose as a transportation system. Several prominent scientists assert that the Energiya-Buran system was created because industry wanted to

assert itself over the Academy in space.[19] The project undoubtedly has a certain prestige value. Unfortunately, it is argued, by the time Energiya is needed for manned flights to Mars in a quarter century, its control systems and special equipment will be obsolete. Dunayev counters such arguments by asserting:

> The "Energiya-Buran" system was conceived primarily for defense purposes and it was deemed quite essential, and all other issues [its expense over conventional launch vehicles]...were to be secondary.[20]

According to reports, the Energiya-Buran system has eaten up a greater share of resources than the entire Mir station. The entire production process employs 1.2 million people, according to Glavkosmos spokesmen. The Energiya vehicle alone reportedly accounts for 2/3 of the total budget allotted to the whole complex.[21]

Within the Energiya association, the **Molniya Enterprise**, created in 1976, claims to be responsible for 90% of the Buran's development, while the **Energiya Enterprise** developed the launch rocket and certain systems of the shuttle, including an engine for orbital maneuvering. The Deputy Chief Director of the Energiya Enterprise is V. Filin.

The Energiya Association is now turning its attention to building a huge multipurpose space platform for communications and ecological monitoring. (Ecology is a very topical concern and provides an opportunity for the association to justify its share of the budget.) Toward this end, an additional booster will be added to the Energiya vehicle to handle such a large payload. The type of platform, however, has not really been decided upon yet: the Council of Ministers will hold a competition among the design bureaus for a space communications system of the future. Nonetheless, the Energiya Association is so confident that a large platform will be chosen that it plans to perform a demonstration launch of a large geostationary platform in approximately 3 years.[22]

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[19]These charges have been made by R. Sagdeev, former director of IKI, and Gringauz, chief scientist of IKI, in the Soviet press. See R. Sagdeev, Izvestiya, 4/28/88:3, Translated in JPRS Science and Technology: USSR Space, 1/18/89:32-33; and K. Gringauz, "Loss of Space Speed," Pravda, 3/25/89:3, Reproduced in Current Digest of the Soviet Press, v. 40(12), 1989:28-29.

[20]O. Moroz, interview of A. Dunayev, "Can We Economize on Space?" Literaturnaya Gazeta, 12/20/89:11, Reproduced in JPRS Science and Technology: USSR Space, 3/15/90: 47.

[21]Jeffrey Lenorovitz, "Low Mission Rate Planned for Soviet Energiya Launcher," Aviation Week and Space Technology, 9/11/89, p. 38.

[22]"Plans for Next Energiya-Buran Launch, Space Platform R&D Announced," Izvestiya, 11/15/89:6. Extracted in Daily SNAP, 891205, 12/05/89. And Kamnev, Ye., A. Rodimov, Yu. Semenov, B. Chertok,"Outlines of Future Communications System Using Space Platforms," Pravitelstvennyy vestnik, 10/89, no. 2112. Abstracted in Daily SNAP, #891117, 11/17/89.

The Energiya Association is also participating with the Scientific Research Institute of Applied Physics Problems and the Belorussian State University's design bureau in the development of the "Gemma-2 Video." This system obtains spectral images of the Earth's surface for agricultural, forestry, and oceanological analyses from the Mir station.

The **Zvezda Machine-Building Works** of the Energiya Association, directed by G. Severin, built the "flying armchair," or the new "Orlan-DMA" self-contained spacesuit, which Soviet cosmonauts tested in January 1990. Apparently the Works also developed previous spacesuits, such as the "Berkut," "Yastreb," and the predecessors of "Orlan".

The Central Specialized Design Bureau (TsSKB): The **TsSKB** or **Kuybyshev** Bureau develops the Vostok, Soyuz, and Progress launch vehicles. It was established in 1959 as the Gorkiy branch of Korolev's Bureau, with D.I. Kozlov as its manager and chief designer. Kozlov remains Chief Designer of TsSKB; G.P. Anshakov is First Deputy Manager, and G. Fomin Deputy General Designer. Supposedly TsSKB is becoming self-financing and has now concluded commercial contracts with France and West Germany. TsSKB has 60 doctors and candidates of technical sciences, several of whom lecture at a nearby aviation institute.

The Foton Design Bureau is subsumed under the TsSKB and reportedly develops the Foton (pharmaceutical manufacturing), Resurs-F, and Bions (space biology) experiments. Currently the bureau is working on a satellite system for studying Earth resources along with other space equipment.[23] The Foton Bureau is teamed with the "Progress" plant in Kuybyshev. Kozlov again acts as Foton's science manager, with Anshakov as his deputy.[24]

Although not explicitly stated, the Reshetnev Communication Satellite Association in Krasnoyarsk may also be part of TsSKB. (Kozlov is identified as the first deputy general designer.) The Reshetnev group concerns itself with navigation, geodetic and geostationary satellites and communications equipment (the Raduga, Ekran, Gorizont, Molniya series, and the Orbita network). The firm dates back to the early 1950s when it was an affiliate of the Korolev Design Bureau before the space program was decentralized.[25] It had at that time a core of 60 specialists, who moved the facility from Moscow to a permanent location in Siberia. Both the Ministry of Communications and the Ministry of Defense sponsor the Association's work.

The Polet (Flight) Scientific Production Association: This association in Omsk is thought

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[23]"Foton' Bureau Develops Space Systems," Sovetskaya Rossiya, 2/16/90, no. 40:2 Reproduced in Daily SNAP, #900315:3.

[24]"Photons' Are Born Here," Sotsialisticheskaya Industriya, 9/14/89, p. 3. Reproduced in FBIS, 9/21/89:81.

[25]Krivomazov, N. "Visit to Once-Secret Communications-Satellite Association in Siberia," Pravda, 11/13/89:1. Abstracted in Daily SNAP, 891130, 11/30/89:1.

to have existed for at least 50 years, albeit secretly. It was formed early during World War II for the production of high-speed bombers designed by A.N. Tupolev. Apparently, S.P. Korolev was deputy head of a shop at the Omsk plant before becoming its general designer. In the 1970s the enterprise was respecialized for rocket and space equipment production and now employs several thousand people. Supposedly, Polet personnel designed and built engines for the Energiya rocket, satellites for navigation and communications, and launch rockets for those satellites. Polet personnel also worked on the Kospas-Sarsat system. A satellite-aided system for monitoring the movement of refrigerator railcars is scheduled for introduction in 1991, and the association is reportedly studying problems of organizing satellite-aided communications for earthquake forecasting. Its Chief Designer is currently Aleksandr S. Klinyshkov.

Polet also supervises a state production association, **Mashinostroitel**, which is converting its facilities to produce household appliances and equipment for the food industry.

The Kompozit Research and Production Association: The Kompozit Association develops composite materials for rockets, spacecraft, stations, satellites, and the Buran shuttle. Its director, Stanislav P. Polovnikov, asserts that the plant will be converted to 35% consumer goods production in 1990.[26] It is not clear which design bureaus or research institutes are located within this association.

Machine Building Scientific Production Association: This organization may encompass the **Chelomai** Bureau, which reportedly has been delegated responsibility for the military versions of the Proton, Polyot, and Salyut, as well as SS missiles. Early in the space program, the Chelomai Bureau was assigned the responsibility for developing a powerful non-kerosene, liquid oxygen booster to send a cosmonaut to the moon.

The **Glushko** Bureau, which also concentrates on liquid-propellant rocket engines for ICBMs and launch vehicles, may also fall under this association.
Other facilities of MOM: General Machine Building undoubtedly has design bureaus and construction facilities other than those listed here. Those below may fall under an as yet unnamed association or belong to those listed above.

The **Yangel** Bureau developed rockets smaller than those designed by the Korolev bureau, apparently exclusively for military use. Its experimental research facilities are based in the Southern Machine Building Plant. The **Southern "Yuzhnoye" Machine Building Plant** has developed space equipment from the very beginning of the space program up to the present-day Energiya-Buran system. It will now be devoting some of its resources to producing domestic wares and agricultural equipment.

The **Isofiyan** Bureau may develop meteorological and Earth resources Meteor satellites.

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[26]TASS news, 5/3/89. Reproduced in FBIS, 6/6/89:55.

The **Kosberg** Bureau has been identified as working on liquid-propellant engines for upper stages.

The **Isayev** Bureau develops liquid-propellant rocket engines for spacecraft.

Other design bureaus and their specializations are less well known but have been alluded to in the open literature: a bureau for solid-propellant missiles is probably housed under the Ministry of Defense Industries, if not General Machine Building; and a bureau for retrorockets and spacecraft maneuvering systems, as well as a "Felostayev" Bureau have been mentioned. It is not unusual for the design bureaus to collaborate with each other on a single project. For example, the Kosberg Bureau reportedly worked with the Korolev Bureau on the Proton.

Along with design bureaus, specific construction plants have also been identified although not organizationally placed. The **Khrunitschev Machine Building Plant's** existence in Fili/Moscow was secret until the summer of 1989. In the 1920s, Khrunitschev produced automobiles, and in 1927 aircraft, until the 1960s, when it started launch vehicle production for the Defense Ministry. Since that time it has built and vacuum-tested all long-term orbiting stations, from the Salyut to the Mir and Kvant, as well as Kosmos-1443. The plant also does final assembly of the Proton, which is designed by the Chelomai Bureau. Like many of the MOM entities, the Khrunitschev plant is now turning to health care and "ecology" production; projects such as water "ozonizers," robotics for nuclear plants, prosthesis manufacture, and a "supertherm" installation for treating oncological diseases are planned. Director A.I. Kiselev, however, asserts that Khrunitschev is ready to engage in Mars exploration and the development of a new interplanetary vehicle.[27] The plant is a large facility in Moscow with a production/assembly hall more than 1000 feet long.

10. USSR Academy of Sciences (AN SSSR, Akademiya Nauk SSSR)

The Academy of Sciences, until recently perhaps, has been the most visible participant in the Soviet civil space program. Its involvement in space, particularly space sciences, has been long-standing. In 1955, the Academy formed under M.S. Keldysh a Committee on Interplanetary Communications to coordinate and direct the study of outer space. The Committee was later revived under the name Interdepartmental Scientific-Technical Council for Space Research, now headed by Academy President Marchuk. The Scientific Council probably encompasses several ongoing working groups who formulate studies on different space science areas (space physics, planetary exploration, small body observations, etc.).

At the governing level, the Academy of Sciences has a General Assembly which meets twice a year to decide basic policy and organizational questions. 300 Full Academicians and 600 Corresponding Members comprise the assembly and are elected every two years. In the

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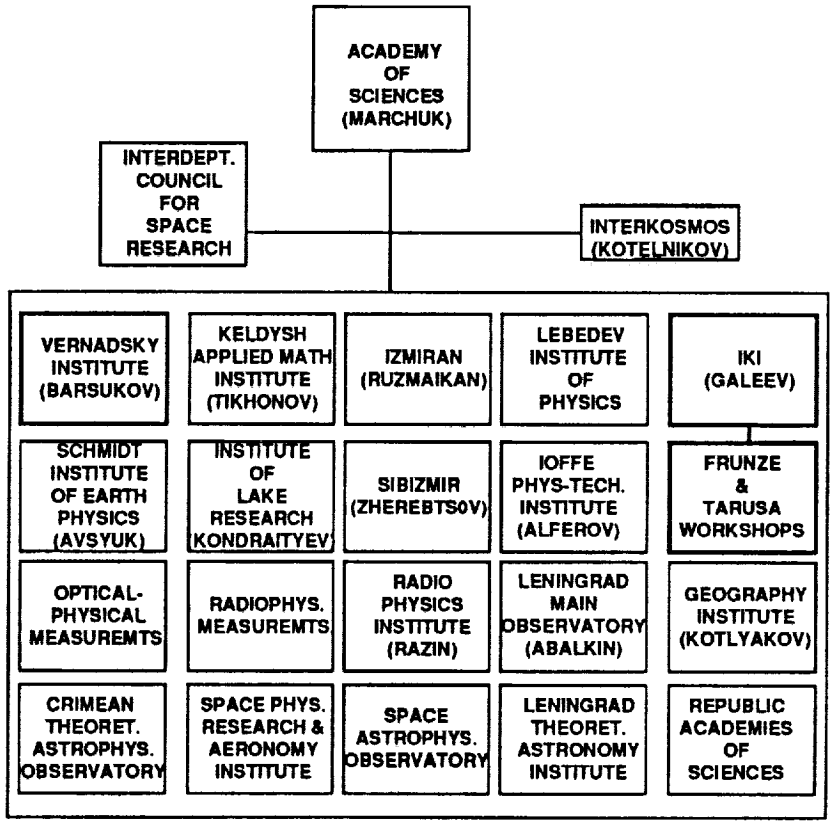
[27]V. Umnov, "The Secret at Fili," Komsomolskaya Pravda, 9/14/89, p. 1. FBIS, 9/26/89:90.



interim between General Assembly meetings, the Presidium manages the Academy of Sciences. Approximately 46 members make up the Presidium, including the President of the Academy, 11 vice presidents, a Scientific Secretary, and 13 elected scientists.

The Academy has planning authority similar to that of a ministry and develops with the GKNT the research and development section for the State Plan. However, the Academy's actual role in managing the space program has been probably very limited since the death in 1966 of Korolev, whose personal friendship with former Academy President Keldysh overcame much of the difficulty created by departmental rivalry and the systemic separation of Academy research and industry. Various reorganizations of the Academy have restricted its ability to control the administration of science and technology generally, and space projects specifically. The reorganization of 1963 removed the engineering and applied science institutes from Academy auspices, relegating the Academy to basic research. Avduyevsky noted that 90% of all space research (including military) is done outside the Academy of Sciences.[28] In 1988, the Academy got less than 9% of the money spent on science. Fortunately 1990 at least saw a 30% increase of its overall budget.[29]

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[28]"Perestroika: A Spot Check. Space--Does It Turn a Profit?" interview of V.S. Avduyevsky, Ogonyok, 6/89:6-8. Reproduced in JPRS Science and Technology: USSR Space, 9/22/89:72-76.

[29]Interview with R. Sagdeev, "Rockets into Ploughshares," The Economist, 3/24/90:94.

Until recently, the Academy research institutes did not control the funds allocated for project development. (However, neither did they pay for the equipment or services they received from MOM or the military.) Industry generally controlled the end results of the planned projects; Academy scientists often complained of being at the mercy of the design bureaus throughout the project's development. As Gringauz described it:

> Industry designers themselves determine the configuration of spacecraft, the specifications of its service systems, the weight and energy consumption of the scientific equipment, and then they offer it to the Institute of Space Research of the Academy of Sciences: If you want to, you can use it; if not, then don't, but there will be no other. One gets the impression that the fewer the experiments the scientists conceive the more satisfied the designers are--it is easier for them this way.[30]

For these reasons, the Academy of Sciences has been the "junior partner" in the space program, although recent changes may permit the Academy to alter the situation. R.Z. Sagdeev argued forcefully for a transfer of financial authority to the research laboratories.[31] As Gringauz notes, "If ... funds were allotted to the Academy of Sciences and if the design bureaus of Glavkosmos were financially interested in filling the order, the technical level of Soviet spacecraft and their development on earth would undoubtedly improve sharply."[32]

Measures have now been taken to strengthen the technical orientation of the Academy and to correct the errors of the 1963 reform. Interbranch scientific-industrial complexes (MNTKs)--which include more than one ministry--and scientific production associations (NPOs)--which involve only one ministry--are being formed around one leading Academic institute. In addition, two new divisions, Information Science, Computer Technology and Automation, and Machine Building, Mechanics and Processes of Control, have been added to the Academy's organization. New construction bureaus and factories are being built, and the Academy's production of scientific instruments is expected to double by 1990. Academic institutions are also to become self-financing; so far, contracted work accounts for 15% of most institutions' income.

More immediately, it is reported that program funding will no longer be channeled through the conventional route of the General Machine Building and Defense Ministries. Instead, funds earmarked for projects, such as Mars '94, will be distributed by the GKNT to the

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[30]K. Gringauz, "Loss of Escape Velocity," Moscow Pravda, March 25, 1989, Second Edition, p. 3. Translated in JPRS' USSR Space, June 28, 1989: p. 85.

[31]Roald Sagdeev, "The Organization of Science, Space Research: Let Us Not Put Ourselves in the Position of Junior Partner!" interview in Moscow Priroda, No. 1, Jan. 1, 1989, in Russian:33-46. Translated in JPRS' USSR Space, June 28, 1989: p. 76.

[32]Gringauz, Op cit, p. 86.

Academy's principal researcher, who will then contract with industry for mission implementation. Money will be approved only for use on a specific project, as opposed to giving blocks of funds to the entire institute.

For general space purposes, the Academy has 10 tracking ships (converted merchant vessels) for sea-based space support and operates some land-based tracking stations within the USSR. The Academy's fleet includes the "Kosmonavt Vladimir Komarov," which is being reequipped to conduct up-to-date collection and analysis of ecological data. Its former duties of tracking manned spacecraft and orbiting stations will be assumed by its sister science ship "Marshall Krylov." "Marshall Krylov" will also conduct studies of the upper atmosphere and radio wave propagation.

Among the Academy's many research institutes, IKI, the Space Research Institute, houses the main body of space scientists and researchers. The Vernadsky Institute of Geochemistry and Analytic Chemistry is also involved in space studies. These institutes and others are discussed below; however, the following descriptions in no way constitute a comprehensive list of all the academic institutes engaged in space sciences.

Interkosmos: As the international relations branch of the Academy, Interkosmos has the power to sign agreements with foreign organizations, as does Glavkosmos. It acts as the effective coordinating council for space science activities with other communist countries, but also oversees bilateral agreements with Western countries and has played an active role in the US-USSR Joint Working Groups and the IACG. Its current director is V.A. Kotelnikov.

Like Glavkosmos, Interkosmos may be considered essentially an interface organization, but one which focuses predominately on scientific endeavors, leaving industrial concerns to Glavkosmos. Sagdeev has complained that the appearance of Glavkosmos has weakened the research coordination role of Interkosmos.[33] Supposedly Glavkosmos' commercial line has distorted Interkosmos' function of international cooperation among space scientists.[34] Because the West's response to commercial Soviet aerospace opportunities has been low, there has been speculation that Glavkosmos may be expanding its operations into space science cooperation; Interkosmos' fate is unclear both financially and organizationally.[35]

IKI, Space Research Institute: The Institut Kosmicheskikh Issledovaniy, IKI, is subordinate to the Academy of Sciences' General Physics and Astronomy Department. It was founded

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[33]Pokrovsky, A. "Suggestions for Improving Science-Industry Teamwork in Cosmonautics," Pravda, 11/15/89:3. Abstracted in Daily SNAP, 891128, 11/28/89.

[34]A. Pokrovsky, "Where Are We Flying To? Space Sciences and Practical Cosmonautics," Pravda, 11/15/89:3.

[35]Belostotskaya, M. "Achievements, Plans Discussed at 20th Anniversary of First 'Interkosmos' Launch," Vechernyaya Moskva, 10/13/89:1. Extracted in Daily SNAP, 891030, 10/30/89.

in 1965 for the purpose of centralizing and coordinating civilian space science programs. Initially it had broad powers in coordinating and implementing space research, except for space medicine and certain applied areas such as geodesy and communications.

It remains the principal research facility for space sciences and employs approximately 1700 professionals and 300 support staff. IKI is responsible for some spacecraft/instrument interface and instrument design, while industry handles the largest portion of integration. Testing is done in IKI's Instrument Building Division, directed by V.M. Balebonov. Its departments are divided into science or engineering support divisions: work is performed on experimental and theoretical astrophysics, planetary exploration, space plasma, space gas dynamics, space materials science, and optical and physical studies. (Please refer to Figure 3.) IKI has been involved in a variety of missions, including Prognoz, Interkosmos, Intershock, Venera, Vega, Luna, Mars, and Phobos.

IKI has two Workshops or Special Design Bureaus (OKB) (e.g., Frunze and Tarusa) which develop and build space instruments. These shops were developed largely because the ministry production institutes were usually over-burdened with state orders and refused to help IKI with their problems.[36] The Frunze Workshop employs approximately 1200 people, the Tarusa approximately 600 people. The Frunze Workshop, located in the Kirghiziya republic, worked on the set of telescopes, Art-P and Sigma, installed on the Granat observatory, and also built the "Podsolnukh" platform. Frunze's director, Sultanbek Tabaldyyev, has also mentioned that the bureau has built power sources for computers, an X-ray camera, and a laser mass spectrometer. The Tarusa Workshop, located outside Moscow, is funded by contract and has its own director. Within the Yevpatoria deep space network center, IKI also owns the Computer Coordination Center for communications analysis and often contracts for work at the Bear Lakes facility.

Among the missions planned by IKI in the next 10 years are the Great Observatories missions, including the Spektr-R/RadioAstron telescope, supported by Syunayev's Astrophysics group, the Spektr-RG telescope, a project of Kardashev's Radioastrophysics group, the Spektr-UFT telescope (ultraviolet), and the Aelita telescope (submillimeter). There has been a rivalry between IKI's departments over the launch priority for the three Spektr missions, particularly between Kardashev and Syunayev. It is reported that Kardashev has moved his group to the Lebedev Physics Institute. However, a lack of space has forced Kardashev to wait for a new facility to be built, and his group has become quite insular within IKI.

IKI is also very involved in the Flight to Mars priority program, although support for Mars '94 has been unstable. Galeev reported that MOM had run out of funds for the research program, so money had to be borrowed from other projects to begin construction.[37]

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[36]Survey by Vestnik Akademii Nauk SSSR, op cit, p. 5.

[37]"Phobos Mission, Food for Thought," Science in the USSR, p. 27.

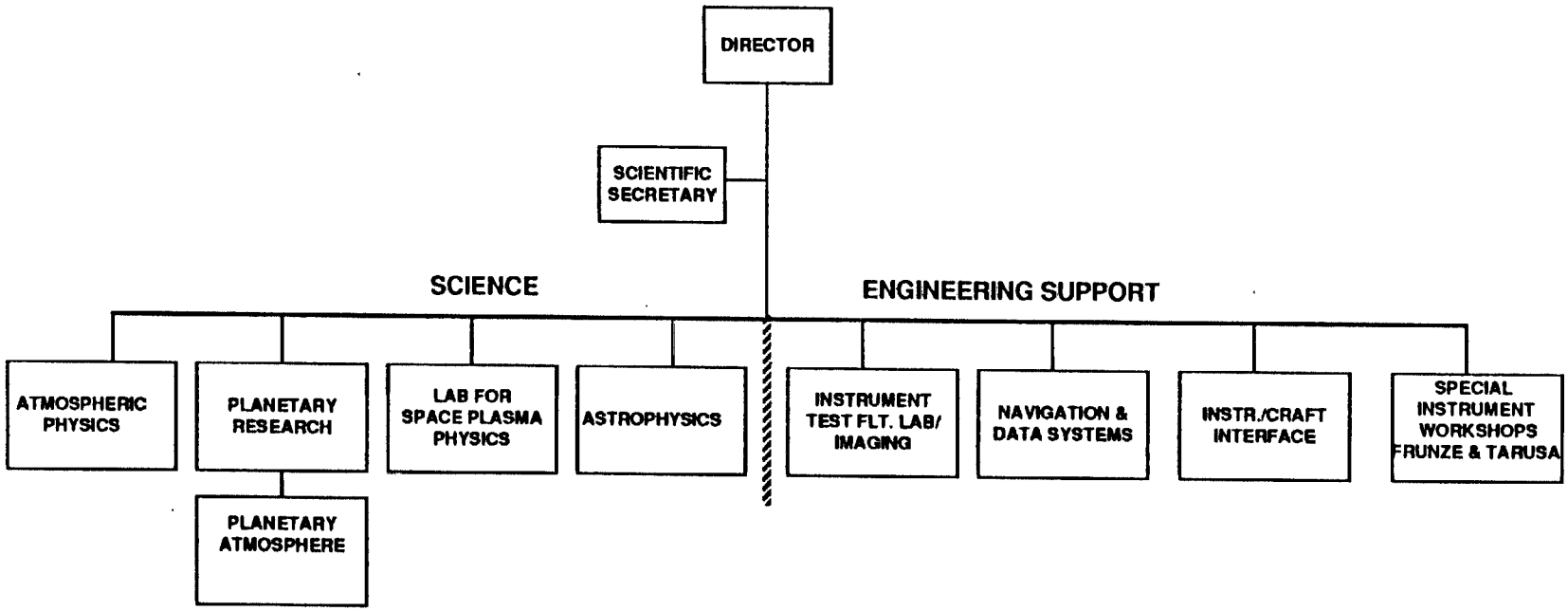

Figure 3. IKI (Space Research Institute) -- USSR Academy of Sciences

In a show of independence, IKI has also embarked, without MOM participation, on the design and production of a new type of satellite, called the "small space lab," for near-Earth space research such as the cosmonauts perform.[38]

The present director of IKI, Albert Galeev, succeeded Roald Sagdeev. Both of them worked in IKI's Lab for Space Plasma Physics before assuming the directorship. Interestingly, Sagdeev was the originator of the International Science Council (ISC) as an international supervisory body for missions--an example of glasnost before the official policy of openness.

Several IKI scientists teach at Moscow State University. Galeev, Sagdeev, and Kuzmin teach at the Moscow Physical Technical Institute (MFTI) whose curriculum combines teaching and research at IKI and other research institutions. A comparable program is believed to exist at the Moscow Physical Engineering Institute. Bogomolov, active on Venera 15/16, has connections with the State Committee for Public Education's Moscow Power Institute.

Vernadsky Institute of Geochemistry and Analytical Chemistry: From its title, the Vernadsky Institute seems an unlikely participant in the space program. However, its involvement in space is actually very long-standing.[39] Vernadsky's former director, Academician V.N. Vinogradov (appointed in 1947), was heavily involved in meteorites and geochemistry research. Beginning in 1966, the Vernadsky Institute conducted intensive research in space chemistry (the chemical composition of lunar, venusian, and martian samples and the nuclear chemistry of star formation). This space chemistry work was subsequently subsumed under Vernadsky's Laboratory of Comparative Planetology, which did lunar soil analysis (Luna 16, 20, 24). Vinogradov headed the very first US-USSR Joint Working Group for lunar samples and data exchange; this work was entrusted to V.L. Barsukov, his successor in 1975 and the current Vernadsky director.

Vernadsky currently has 17 laboratories in its Department of Geochemistry and 10 laboratories in its Department of Analytical Chemistry. Vernadsky also encompasses an Experimental Equipment Workshop, staffed by 60 specialists, which produces vacuum, radiation, laser, and electrical instruments and devices. Quite a few laboratories within the Department of Geochemistry are involved in space research.[40] But Vernadsky has large interests in other (mostly classified) scientific areas such as gamma-ray detection (for submarines) and deep ocean mining.

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[38]K. Gringauz, "Science or Ambitions? Fundamental Space Research Threatened," Science in the USSR, no. 2, March-April 1990: 22, 24.

[39]Refer to The Vernadsky Institute of Geochemistry and Analytical Chemistry, published by the Academy of Sciences in 1984, for the Institute's early history as a laboratory.

[40]for example, the Laboratories of Planetary Geochemistry, of Comparative Planetology, of Meteorites, of Magmatogene Processes, and of Thermodynamics of Natural Processes, to name a few.

There is currently a deep rivalry between IKI and Vernadsky for the control of Mars project funding, program definition, and relations with the US. Over the years, the influence of one institute over another seems to have swayed, depending on the personalities and influence of senior personnel. Since IKI was not created until 1965, Vinogradov had the advantage of experience and an established power base behind him. At the time of Vinogradov's death in 1975, R. Sagdeev was ascendant, but since his retirement as IKI's director, Barsukov has been on the rise. Now, as Co-Chair of the US-USSR Joint Working Group for Solar System Exploration, Barsukov has significant influence over US-Soviet cooperation in this arena.

Keldysh Applied Mathematics Institute: According to Dr. Akim,[41] of the Keldysh Institute, the early space projects were developed here in close cooperation with Korolev's bureau. For example, Institute personnel worked on the lunar program, including imaging the farside of the Moon and the first lunar landing (Luna-9), ballistics design for early Venus and Mars missions, radar mapping of Venus with Venera 15 and 16, and developing landing parameters and attitude control. Within the organization, Keldysh founded a Ballistics Control Center to study spacecraft motion control problems. Today it takes part in all types of missions, including Salyut, Mir, Voskhod, Vega, and Phobos. Not surprisingly, this Center cooperates closely with the Flight Control Center (TsUP). Dr. Akim claims that in 1968 some of the departments separated from the Keldysh Institute and formed IKI to deal with instrument construction and investigations, although this is at variance with IKI's founding date in 1965. Still, IKI and the Keldysh Institute are housed in the same building. Keldysh reportedly has 1300 people, half of whom are scientists. Dr. A.N. Tikhonov is thought to be the current director.

Lebedev Institute of Physics (FIAN): Established in 1725, this is the largest and oldest institute in the USSR. Its work covers lasers, quantum radiophysics, nonlinear optics, spectroscopy, plasma, theoretical astrophysics, particle physics, and theoretical biophysics. Its current director is L.V. Keldysh. As has been mentioned, Kardashev is moving his radio astrophysics department from IKI to this Institute.

A.F. Ioffe Physical Technical Institute: Under the direction of Z.I. Alferov, this organization researches semiconductor physics, mathematical physics, plasma physics, and astrophysics. It was established in 1918.

Radio Physics Scientific Research Institute, Gorkiy (NIRFI): NIRFI was established in the 1950s at Gorkiy State University to research plasma physics, spectroscopic systems, and high-power microwave devices. It also operates a radio astronomy observatory which is involved in the search for extraterrestrial life. Director V.A. Razin heads this research organization.

IZMIRAN: The Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation (IZMIRAN), located about 80 km from Moscow, has done work on the near-Earth radiation

[41]in an overview given to visiting US scientists April 1990.

environment and its effects. IZMIRAN also investigates spherics, radio astronomy, solar physics, and cosmic rays. IZMIRAN was established in 1939, and A.A. Ruzmaikin currently directs the organization. IZMIRAN may become involved in the NASA-Air Force project CRRES (Combined Release and Radiation Effects Satellite). With IKI it has developed an Earth plasma experiment, "Aktivnyy--Interkosmos."

SibIZMIR: The Siberian Institute of Earth Magnetism, the Ionosphere, and the Propogation of Radio Waves has a large complex for studying solar-terrestrial physics in Irkutsk. Directed by G.Z. Zherebtsov, SibIZMIR has several observation stations spread across a vast area, a solar-radio telescope, and other observatories and stations. It has proposed creating an All-Union international center for solar-terrestrial physics including itself, the Institute of Space Physics and Aeronomy in Yakutsk, and other organizations.

Schmidt Institute of Earth Physics: Established in 1954, this institute is the leading center for earthquake and seismic phenomena research. It is currently working with IZMIRAN on detecting ionosphere precursors of earthquakes from space. It has also done work on the geology of the martian surface and venusian craters. Yu.N. Avsyuk directs the organization.

Geography Institute: This organization was formed in 1918 as part of the Commission for the Study of Nature-Produced Forces, and it consequently places heavy emphasis on Earth observation and global change. It employs 650 people, of whom 500 are scientists, including more than 50 doctors and 150 candidates of science. Its current director is V.M. Kotlyakov. Its areas of interest include: natural environment and resources, nature-society interactions; economic and geographic population; and, most relevant to this study, methods of geographical investigation, which include observation from space. It has 16 departments, separated into three divisions.

Institute of Lake Research: Biosphere analysis/ecological monitoring is a mainstay of this institution's work. Its personnel have worked on planetary atmospheres. K.Y. Kondraityev is thought to be its director.

All-Union Scientific Research Institute for Optical Physical Measurements (VNIIOPhI): Established in the 1960s, this institute oversees research in the area of holography, electro-optics, crystallography, solid-state physics, and shock physics. It is involved as well in the VIMS-Omega instrument for Mars '94.

All-Union Scientific Research Institute of Radiophysical Measurements: This institute is reported to be the USSR's main organization for measuring the characteristics of electromagnetic fields in space and in closed channels. More than 40 types and five generations of measuring equipment have been developed.[42]

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[42]"Institute Leads World in Radiophysics Measurements," Kommunist, 12/8/89:4. Extracted in Daily SNAP, 900115, 1/15/90:4.

Leningrad Main Astronomy Observatory (GAO): Founded in 1839, this observatory investigates problems of celestial mechanics and gravimetrics, compiles catalogs of star positions, and studies cometary and planetary movements. V.K. Abalkin directs the establishment.

Crimean Astrophysics Observatory: Since 1948, this body has conducted solar, stellar and planetary research and investigated gas and dust nebulae.

Institute of Space Physics Research and Aeronomy, Yakutsk: This institute was established in 1962 as a center for the study of cosmic rays. G.F. Krymskiy directs this group.

Space Astrophysical Observatory: Located in Nizhniy Arkyz, this observatory was established in 1967 to conduct stellar, planetary and extragalactic research. It is the site of one of the world's largest radio telescopes.

Leningrad Theoretical Astronomy Institute: This is the only specialized institute for theoretical and applied celestial mechanics. This institute also compiles astronomical yearbooks.

10a. Republic Academies of Sciences:[43]

In Byurakan, Armenia, an **Astrophysics Observatory** was established in 1965 in the Armenian Academy of Sciences. It studies the structure of the galaxy, nonstable stars, nebulae, stellar cosmogony, theories of superdense matter configurations and radiative transfer. It has a 2.6-meter telescope and is directed by V.A. Ambartsumyan.

The Azerbaijan Academy has an **Astrophysics Observatory**, established in 1953 and directed by G.F. Sultanov, and a **Space Research of Natural Resources Institute**, established in 1978 and headed by T.K. Ismailov.

The Estonian Academy has an **Astrophysics and Atmospheric Physics Institute** in Tartu, directed by V.A. Unt.

In Abastumani, Georgia, the Georgian Academy's **Astrophysics Observatory** is the highest astrophysics observatory in the USSR at 1650 meters. It studies the upper atmosphere, stars, planets, Sun, and Moon, doing research in modern astrophysics and stellar astronomy.

The Kazakh Academy of Sciences has an **Institute of High-Energy Physics**, which was established in 1970 and conducts investigations of nucleonics. It has established, with scientists from Moscow, Yakutsk, and Kazakh State University, detectors for recording atmospheric showers. One of the space-physics complexes is in the foothills of Trans-Ili

[43]Much of this information is drawn from Directory of Soviet Officials: Science and Education, Directorate of Intelligence, (Washington, D.C.: The Agency, May 1989).

Alatau. The detectors were built in Alma-Ata. I.Y. Chasnikov directs the institute. The **Astrophysics Institute** in Alma Ata is also under the Kazakh Academy's auspices. Established in 1942, it studies the physical properties of celestial bodies under the direction of T.B. Omarov.

In 1968, the Latvian Academy established the **Radio Astrophysics Observatory** in Riga to conduct photometric and spectral observations of stars and the solar system. It is currently directed by A.E. Balklav.

Directed by M.N. Maksumov, the **Astrophysics Institute** of the Tadjikhistan Academy conducts photographic, visual, and radar investigations of meteors, comets, and variable stars.

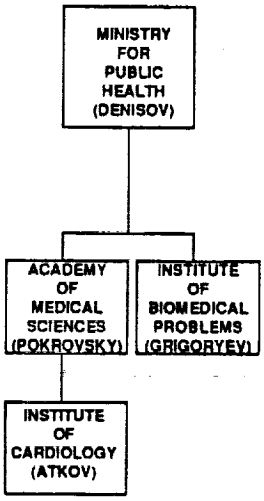
In the Ukrainian Academy of Sciences, the **Physical-Mechanical Institute (FMI)**, directed by V.V. Panasyuk, heads an interbranch scientific-technical complex (MNTK), which has worked on the Mars-6 and -7, Interkosmos-18 and -19, and Vega-1 and -2 experiments and has recently been enlisted in preparing the Mars '94 mission. Thirty percent of FMI's money is state-budget appropriated, and the rest comes from conducting projects on a cost-accounting basis. About 150 doctors and candidates of science are employed by FMI, and its facilities include a special design and technological bureau, experimental production facility, and a pilot plant. Its specialty is in corrosion protection of metals and researching brittle failures of metals. FMI has created, with the Ukrainian Academy's Institute of Applied Problems of Mechanics and Mathematics and Lvov University, joint chairs of instruction to train young specialists in contemporary mechanics.

Also within the Ukrainian Academy of Sciences, the Lvov **Physicomechanical Institute** developed the "Real" system for processing aerospace images of Earth. The Ukrainian Academy's **Institute of Electrodynamics** in Kiev developed the docking mechanism for the space "locomotion unit" which the cosmonauts have tested recently. The **Kiev Main Astronomy Observatory**, established in 1944, is also part of the Ukrainian Academy. It researches terrestrial rotation measurements, constructs coordinate systems of outer space, planetary atmospheric physics, and stellar physics. It is directed by Y.S. Yatskiv.

In Tashkent, the **Astronomy Institute** of the Uzbekh Academy of Sciences studies astrometry, solar and stellar physics, and the effects of variations in the Earth's rotation. It is directed by T.S. Yaldashbayev.

11. Ministry for Public Health

The Ministry for Public Health, directed by I.N. Denisov, is thought to have three main directorates, one of which concerns occupational health (cosmonautics, nuclear power workers, nuclear submarine staff) and is headed by Sholzenko. The Institute of Biomedical Problems, discussed below, probably reports to Sholzenko, whose budget comes directly from the Ministry of Finance, instead of being distributed through the Health Ministry. One



would expect that Sholzenko possesses a great resource base.

Institute of Biomedical Problems: Established in 1962, this Institute does biomedical research on problems related to long-duration spaceflight. Its Director is A.I. Grigoryev.

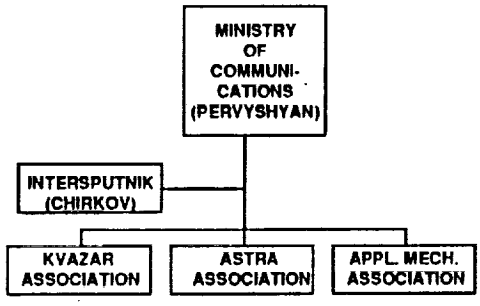
Academy of Medical Sciences: This Academy is distinct from the Academy of Sciences, subordinate instead to the Ministry of Public Health. It is heavily involved in space medicine and cosmonautics, and is directed by V.I. Pokrovsky.

An **Institute of Cardiology** exists under the Academy of Medical Sciences and is now headed by former Cosmonaut Oleg Atkov.

"BIOS" Test Center: This center was organized by the Ministry of Medical Sciences' Scientific Research Institute of Experimental Pathology and Therapy, the Ministry of Health's Institute of Biomedical Problems (see above), and the Ministry of General Machine Building's Kuybyshev Central Specialized Design Bureau. The biotechnical tests performed at the center are done to study the effects of reentry impact on clinical, physiological, anatomical, and other indicators, and the effects of g-loads and noise during reentry.[44]

12. Ministry of Communications

The Communications Ministry recently announced ambitious plans to launch three giant telecommunications satellites on the Energiya rocket in 1993 with the purpose of modernizing its communications system. Minister of Communications Pervyshin just signed the agreement with MOM to set up associations for developing such a commercial satellite communications system, which is to be called Marafon.



The Ministry of Communications supports in part the **Reshetnev Bureau**'s work on navigation, geodetic, and geostationary satellites.

Both the **Astra Scientific Production Association** and **Prikladnaya Mekhanika (Applied Mechanics) Scientific Production Association** are entirely devoted to space production. Formerly they covered military orders. Now their production has been

[44]"Once-Secret Testing Center's Facilities for Space Biology Studies," Sovetskaya Kirgiziya, 12/10/89:2. Extracted in Daily SNAP, 900111,1/11/90:1; and "Bios' Test Center Conducts Work in Space Research," Sotsialisticheskaya industriya, 11/26/89, p. 2. Reprinted in Daily SNAP, 891212, 12/12/89:2-3.

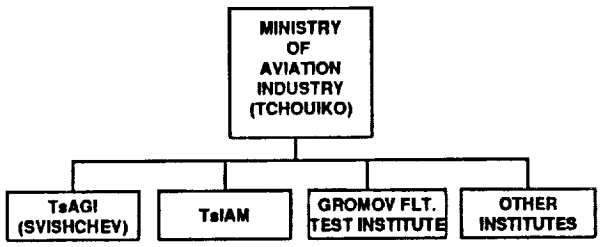
redirected to establishing the Marafon (Marathon) satellite communications network.[45]

The **Kvazar Scientific Production Association** works on communications satellites and geostationary platforms.

Intersputnik, or International Organization of Space Communications, directed by B.I. Chirkov, is also a part of this Ministry. It appears to coordinate international relations, as Glavkosmos does for MOM.

13. Ministry of Aviation Industry

The Ministry of Aviation Industry, directed by Tchouiko, produces aircraft, aerodynamic missiles, and defensive missiles. Its involvement with the space program is unclear; but its enterprises and design bureaus are known to have worked on the Buran. This ministry should be differentiated from the Ministry of Civil Aviation which provides commercial passenger service and general aviation support under the Aeroflot logo.



The **Tushino Building Factory** has claimed responsibility for building the Buran shuttle's airframes.

The **Central Aero-Hydrodynamic Institute (TsAGI),** located in Zhukovskiy, is currently directed by G. P. Svishchev. It was established in 1918 to do research on the aerodynamics of aircraft and missiles. Apparently it supports all aviation design bureaus and airframe research; it has extensive wind tunnel facilities.

The **Central Aviation Motor Building Institute, Baranova (TsIAM)** was established in the 1930s and does propulsion work.

The **Gromov Flight Testing Institute** trains test pilots and specialists, including those for the Buran shuttle.[46]

The **Myasishchev Experimental Machine Building Plant** in the 1950s designed the strategic bombers produced by the Khrunitschev Plant. In the 1980s it developed the replica of the Buran shuttle which was used for cosmonaut training and for preparing the automatic landing equipment. Other developments for the Buran include the cockpit, emergency rescue system, and life-support and temperature control systems. The plant reportedly has

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[45]FBIS Report on Cosmonautics Day, Moscow Television Service, 4/12/90.

[46]"Party-Government Delegation Visits Flight Testing Institute," Pravda, 11/17/89:4. Extracted in Daily SNAP, 891206, 12/6/89:2-3.

an information computing center capable of processing in real time 4000 parameters of the equipment being tested. With the **Noosphere Scientific Production Association,** the Myasishchev Plant took part in ozone studies over Moscow.

14. Other Organizations

— The All-Union Scientific Research Institute of Electromechanics Designs falls under the Ministry of Electrical Equipment Industry. It builds and services Earth resources satellites and offers them to commercial markets.

— The Leningrad State Design and Technological Institute (LGPTI), established in 1979, does design work for defense enterprises. It was responsible for the Buran's automatic landing system assembly, adjustment, and testing and seems to specialize in designing production processes and control plans. LGPTI has also worked on designing a circuit-board production facility. It is not known where LGPTI fits organizationally.

— The Moscow Institute of Engineering for Geodesy, Aerial Photography, and Cartography has recently concluded a financial agreement for Earth resources monitoring by the Mir cosmonauts. Its president is former cosmonaut V. Savinykh.

This long section of profiles is far from being complete or uniform, but it provides a good sense of the sheer number and variety of people and enterprises involved in Soviet civil space. These descriptions also highlight the tension between space sciences and industry and the rivalry between research institutes over the control of funding and resources. The next section presents the program's operations and further explores the recent trends which are shaping the way these organizations interact.

IV. THE SPACE PROGRAM UNDER GLASNOST AND PERESTROIKA

Under Gorbachev the space program has been subjected to a great number of changes and an unaccustomed amount of budget anxiety, as well as opportunities, particularly in international cooperation. This section should clarify the way the space program's components interact and are adjusting to new conditions.

Space Program Planning

The planning processes for space activities in the Soviet Union are not widely discussed. From what can be inferred, the Academy of Sciences formulates a proposed plan for fundamental research and development. Academy research institutes and individual scientists submit proposals for this document, which are competitively considered by the Academy's scientific advisory councils before being incorporated into the Academy's forecast. For applied research, the GKNT drafts a plan, after having chosen among several proposals from the industrial research institutes. These proposals are judged for their potential contributions to the national economy. The GKNT and Academy's drafts are then fused into a science and technology section for the Council of Ministers' review and incorporation into the State Plan, which must meet Supreme Soviet approval.

However, the Soviet Union's move to transform its centrally planned economy into one governed by market forces has thrown the planning process into disarray. The most recent attempt at long-term space planning was made in late 1989 in "Program-2005," a proposal formulated by the Central Scientific Research Institute for Machine Building (TsNIIMash), with the input of the Academy and GKNT, for consideration by the Council of Ministers. Prior to Program-2005, no space plan had been considered since 1988, when the Academy of Sciences' Interdepartmental Council had written a document for discussion. No action was taken, though, on the 1988 plan, and the Soviet Union has been operating for two years now without an approved program.

Program-2005, although developed by General Machine Building, is generally in accord with the 1988 Academy proposal. Excerpts follow.[47]

> **Communications:** Planned satellites include: Granit, Gelicon, Granit-M, Granit-2, Gelicon-2 and Informator for communications and TV. The Marafon project is planned as well.
>
> **Geodesy:** The Etalon and GEO-IK satellites constitute the first step toward building global and regional geodesic networks.

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[47]Col. M. Rebrov, "Cosmonautics, Year 2005," Krasnaya Zvezda, 8/23/89:4. Reproduced in Foreign Broadcast Information Service, Daily Report Soviet Union, 9/12/89:75-76 and 9/1/89:60-61.

Cartography: Continuing efforts in outer space surveys.

Navigation: The Glonass system of 24 satellites will assist sea navigation. The Nadezhda-M system of search and rescue will acquire new capabilities.

Meteorology: Visible and IR reception will be added to the Electro satellites' capabilities.

Natural Resources: The Almaz, Resurs, and Okean satellites will continue collection of data on the Earth's environment.

Technology: Increased investigation and production of organic and inorganic compounds under microgravity conditions are planned.

Science: The solar system, cosmic plasma, and interplanetary and near-Earth space will be investigated with the Relikt-2 and Koronas projects. Astrophysical research will be conducted by the Gamma observatory and the Spektr projects (Radioastron [Spektr-R], Spektr-RG [X-ray, gamma], Spektr-UFT [ultraviolet]). A solar probe will explore space adjacent to the Sun and carry out gravitation experiments. Other programs for solar-terrestrial physics and the Earth's magnetosphere and ionosphere are also planned.

Manned Spaceflight: In 1990 the Kristall technology module will be added to the Mir complex. The Mir-2 station will be launched, and the Soyuz and Progress vehicles will be modified. Regular flights of the Buran will begin, and several international expedititions are planned. The production of industrially useful materials is emphasized.

Mars Expedition: The use of balloons, penetrators, small landers, and possibly a small rover are planned for Mars '94. A sample return is hoped for in 1998. A manned expedition is foreseen between 2015 and 2017.

Program-2005 shows a strong emphasis on applied space missions, which is not surprising given the state of the Soviet economy. However, in terms of planetary science (see Table 1 below for more detail), the space program is and has always been, according to V. Barsukov, characterized by an "unjustified singleness of focus,"[48] which today is Mars exploration. (In the early years of space exploration, 24 vehicles were sent to the moon, but nowhere else. Later, 16 craft were sent to Venus, but to no other planet. A similar specialization is occurring with Mars today.)

Nonetheless, despite Program-2005, no plan has yet been approved, a condition which has

[48]Survey by Vestnik Akademii Nauk SSSR, op cit.

Table 1. Program of USSR Planetary Research Up to the Year 2005

Launch	*Mission Target*	*Number of Spacecraft*	*Mission Objectives*
1994	*Mars*	*2*	*High-resolution photography of surface of planet (TV complex); acquisition of global data on chemical and mineralogical composition of rock (collimated -spectrometer, IR spectrometer); study of distribution of temperature in atmosphere (thermoscan), humidity (neutron spectrometer), and deep structure (longwave radar). Two balloons are released into the martian atmosphere to an altitude of 3 km; they descend to the surface at night and ascend in the morning, for 10 days (atmospheric dynamics, ultrahigh-resolution survey of surface, etc.). Four to six penetrators are shot into the surface of the planet (determination of chemical composition of rock below oxidation zone, seismic observations, television survey), and 4 to 6 small weather stations are set up in various regions of Mars.*
1996	*Mars, Phobos, Asteroid Belt*	*2*	*Delivery of soil from Phobos, which is trapped by gravitational pull of Mars (development of return rocket from Mars). Second vehicle reaches asteroid Vesta in main asteroid belt 2.5 years after launch, fires two penetrators into surface, studies a number of other large asteroids with remote sensing on flyby trajectory.*
1998	*Mars*	*2*	*Landing of two long-duration (3 years) Mars rovers on Mars for studying surface and collecting samples. Samples returned to Earth on next mission.*
2001	*Mars*	*4*	*Return to Earth of rock samples from Mars. By this time, a special receiving station must be established on Earth for testing for biological activity of martian soil; from there, soil is sent to Academy institutes for study.*
2003	*Mercury*	*2*	*Mercury orbit, survey of surface, study of chemical and mineralogical composition of soil, firing of penetrators into surface.*
2005	*Venus*	*2*	*Delivery of a series of small stations to selected regions of Venus.*

Reproduced from V.L. Barsukov, "Return National Status to Space Research," Survey "Space Research: Ideas, Priorities, and Efficiency," in Vestnik Akademii Nauk SSSR, no. 2, February 1990. Translated in JPRS Science and Technology: USSR Space, 4/13/90:3.

prompted some space scientists to call for the creation of a centralized agency to impose some structure on the many space activities in the works.

Budget Glasnost

In addition to some allusions to the planning process, one of glasnost's benefits has been the recent disclosure of the traditionally secret space budget. In May 1989, Dunayev, head of Glavkosmos, revealed that the 1988 outlays for "peaceful" (non military) space research totaled 1.3 billion rubles, and total expenses for the manned program from 1986-1989 amounted to 1.47 billion rubles. Prime Minister Ryzhkov, in his report to the Congress of USSR People's Deputies in June 1989, stated that a total of 6.9 billion rubles (or approximately 1.5% of the State budget) has been devoted to developing space technology in 1989. Some 1.7 billion of these rubles were used for national economic and scientific purposes, 3.9 billion for military purposes, and 1.3 billion for the shuttle system. Dunayev

later reiterated these figures.[49] Moreover, the Academy of Sciences is operating with a deficit of 157 million rubles.

These budget figures resulted in an extensive public debate[50] over space expenditures; many people believe that lavish spending on the space program is misplaced when Soviet stores cannot stock basic consumer goods. Space sciences have taken the brunt of such criticism, but much of the public ire is misplaced: most launches have been military payloads under the guise of the Kosmos "scientific" label. Despite the public outcry, the Supreme Soviet Planning and Budget Committee "showed a negative attitude to a sharp reduction of the allocations for fundamental space research."[51]

Since 1986 Gorbachev appears to have made a commitment to space as a high-technology sector which will be an example and engine of growth for the Soviet national economy. As mentioned, the exploration of Mars was designated as one of 15 declared national priorities. Still, even high-level support may not be enough to get the program underway: Mars '94 will require some 500 million rubles for implementation, but only 20 million rubles have been allocated for the scientific work. Industry has not yet received anything for the spacecraft and boosters.[52] Thus, the tumult of perestroika and the declining standard of living work against prompt, large expenditures on space. Financial uncertainty has become a persistent condition confronting the components of the space industry, science and the military.

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[49]O. Moroz, op cit, p. 45.

[50]See, for example, S. Leskov, "Space and the Kopeck. Cosmonautics Remain a Closed Bastion to Free Discussion," Izvestiya, 3/22/89:2; translated in JPRS: USSR Space, 5/2/89:79-81. TASS Report,"Space Geared to the Economy," Pravda, 2/8/89:2; translated in JPRS: USSR Space, 5/2/89:79-81. V. Golobachev, "What We Are Finding, What We Are Losing," TRUD, 4/12/89:1,4; reproduced in JPRS: USSR Space, 6/28/89:94-96. TASS, Dunayev Stresses Benefits from Manned Program, 5/23/89; reproduced in JPRS: USSR Space, 9/22/89:58-59. Moscow Domestic Service, Economic Benefits of Space Program Stressed at Cosmonaut Press Conference, 5/23/89; excerpted in JPRS: USSR Space, 9/22/89:59-60. V. Kh Doguzhiyev, "Examined in the Presidium of the USSR Council of Ministers: Space--Outlays and Returns," Pravitelstvennyy vestnik, 5/89:2-3; reproduced in JPRS: USSR Space, 9/22/89:50-53. TASS, Party Secretary Baklanov Defends Space Program, 5/18/89; reproduce in JPRS: USSR Space, 9/22/89:50. G. Lomanov, interview with Yu. Semenov, "Where is Buran Flying," Sotsialisticheskaya industriya, 5/30/89:4; reproduced in JPRS: USSR Space, 9/22/89:53-56. "Profit from Space--R2 Billion a Year, Ambitions or Benefit?" Argumenty i Fakty, 6/10-16/89:6; reproduced in JPRS: USSR Space, 9/22/89:68-69.

[51]K. Gringauz, "Science or Ambitions?" op cit, p. 25.

[52]O. Moroz, op cit, p. 46. And quote of Galeev in TASS International Service report, Mars Mission Financial Difficulties Discussed, Foreign Broadcast Information Service, 4/16/90:79.

Conversion and Self-Financing

Along with the new budget constraints and processes, the space program as a whole is facing financial uncertainty due to the difficulties associated with conversion and economic accountability.

The current plan is for all scientific institutions, including affiliates of the Academy and of the defense complex, to make the transition to economic accountability and self-financing in research and development. Although most funds will still come from the central government, institutes must now keep track of their allocations and expenditures, giving them greater financial responsibility than previously. Some scientists fear, though, that self-financing tends to deemphasize basic research. Enterprises will become short-sighted, interested in accepting contracts for quick profits. At the local level, projects for specifically regional needs will be supported over federal projects.[53]

Furthermore, the economic situation in the USSR today is such that previously defense-oriented plants, including those of MOM, must convert their production to consumer goods. Toward this end, a National Commission for the Promotion of Conversion has been appointed under the directorship of space scientist V. Avduyevsky. A central scientific research institute is also to be set up under the Commission for Military-Industrial Questions. It remains to be seen exactly what functions these two bodies will perform and with what authority.

A Conversion Plan for the period through 1995 (submitted by Gosplan, the State Committee for Military-Industrial Questions and the Defense Ministry) has been accepted by the Council of Ministers for consideration. The Supreme Soviet Committee for Defense and State Security has also examined the proposed program. Essentially, conversion is approached from three directions, the most immediate of which is the reorientation of defense facilities to food, consumer, computer, medical, civil aircraft, and communications production. In 1990-91, 14% of the defense complex will be subject to conversion, and defense expenditures as a portion of the state budget are to fall by one-third by 1995. A total of 500 enterprises will be affected. In 1990 alone, 100 defense enterprises are to be respecialized. Among them, the Molniya Machine-Building Plant will produce dairy equipment. The Khrunitschev Plant has cut production of the Proton reportedly by one-third and will produce goods like bicycles, ski poles, kitchen furniture, and sleighs.[54] It is estimated that the share of civilian goods in the production output of General Machine Building will be 25% in the next year.

In addition, the Conversion Plan advocates investment in the construction of new facilities

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[53]Mosin, I. "Academy Head Discusses Proposals for Strengthening Basic Research," Pravda, 3/5/90:3. Abstracted in Foreign Technology Division, Daily SNAP, #900307, 3/7/90:3.

[54]Lomanov, G. "Moscow Machine-Building Plant Makes Space Stations, Medical Equipment," Sotsialisticheskaya Industriya, 9/22/89:2. Extracted in Daily SNAP: 891016, 10/16/89.

for needed consumer items. Thirdly, the formation of new organizational forms (like cooperatives, associations, information centers, and concerns) is encouraged by the Conversion Plan to increase innovation, collaboration, and economic utilization of defense technologies.

Conversion is problematic, however. The inefficiency of incomplete conversion threatens the well-being of the space technology industry and the economy generally, as Academician Avduyevksy notes:

> Perestroyka is only hitherto supposed to have given us one thing--glasnost. That is wrong. The new defense doctrine and conversion policy proclaimed by M.S. Gorbachev are equally or, possibly, even more important. [However], Military and civilian production are too interwoven in our country. [Conversion in the USSR] is mainly a case of what is usually described as diversification, i.e., the simultaneous production of both military and civilian output....which is inefficient...This is why all defense enterprises engaged in diversification are currently experiencing tremendous difficulties.[55]

Already scientists are voicing concerns about a loss of the USSR's competitive edge in high technology and space because high-technology plants will be making simple items, under-utilizing the plant's capabilities. As B.V. Rauschenbackh points out, "It's easy to forfeit leading positions, but it's much harder to catch up."[56] There is also the problem of conversion's remaining in the hands of the military, precisely the group which would like to preserve the Defense Ministry's production capabilities. Military secrecy still monopolizes commercially useful technologies.

In addition, the refitting of plants and retraining of labor is costly and time-consuming, and the lack of entrepreneurial capital and equipment hinders these activities. The Plan does propose, however, that an innovation fund be set up under the GKNT, as well as a network of commercial innovation banks to finance high-risk, potentially high-yield projects. Essentially centralized management of the defense industries has been abandoned, but the market mechanism is not yet operative, especially since a differentiated wholesale pricing system is not yet in place.

International Marketing and Cooperation

The declining budget base for space enterprises discussed above has probably prompted in large part the USSR's decision to enter the world space market. Glavkosmos' declared assignment is foreign commercial interaction to earn hard currency. Previously secret space

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[55]V. Konovalov, interview with V. Avduyevksiy, "Defeat of the Militarized Economy," Izvestiya, 2/7/90:2. Reproduced in FBIS, 2/14/90:117-121.

[56]Survey by Vestnik Akademii Nauk SSSR, op cit, p. 13.

facilities have been opened to Western journalists, businessmen, and scientists to demonstrate the USSR's capabilities, and it appears that some progress is being made toward this end. For example, three Soviet space organizations, the Molniya Design Bureau, the Energiya Association, and the Zvezda Machine-Building Plant, have created a manned-flight association with the French companies Avions Marcel Dassault-Breguet Aviation and Carrar. The French hope to gain access to Soviet technology instrumental to the development of the Hermes shuttle.[57] In addition, the Ministry of General Machine Building sold to the Japanese trading company, Horie Planning, a Mir space station prototype in October 1989 and has made a deal to sell a space technology database to the same company. The Glavkosmos-Space Commerce Corporation joint venture meanwhile seems to be stalled by US regulations on technology transfer. However, there has been talk recently of building Soviet-designed launch facilities in Cape York, Australia, and selling Soviet vehicles to the Australians for operation, servicing, and marketing, thereby breaking into the Western market.[58]

Aside from commercial interactions, the USSR has always had a strong international scientific cooperation program, although it was biased toward Soviet bloc countries. Today, however, it appears that relations of this type are being pursued vigorously with Western countries, particularly the U.S., France, West Germany, and Great Britain. International scientific cooperation is certainly desirable, considering the financial constraints placed on the Academy and the diplomatic value of such cooperation.

A New Science Policy

In addition to the trends of foreign interactions, conversion, and budget uncertainty, a new governmental science policy will impact space missions and project management as much as any other factor. Science policy codifies the procedures and relationships between the different organizational components and sets the rules for obtaining money.

The GKNT and Academy of Sciences recently sponsored an All-Union Scientific and Practical Conference on Problems of Managing Scientific-Technical Progress. Several ideas on science policy were discussed, including the creation of a Council of Science and Technology under the President, legislation on scientific democratization, intellectual property, and taxation, and closer linkage between higher education institutions and the Academy of Sciences. In essence, the state will continue to influence science by tax and wage incentives, but not by strict command and planning. Rather, the state will indirectly regulate and indicate broad priorities for the national economy. Three models for scientific

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[57]"French, Soviet Business Team could Aid Hermes Development," Space News, 2/26-3/4 1990:1,20.

[58]V. Golovachev, interview of Minister of General Machine Building O. Shishkin, "Plants Beyond Earth, Settlement on the Moon..," Trud, 4/12/90:1,4. Reproduced in Foreign Broadcast Information Service: Daily Report Soviet Union, 4/24/90:68. Also James Asker, "Australians Pitch Cape York Complex as Best Way to Ease Soviets into Launch Market," Aviation Week and Space Technology, 4/9/90.

funding have been delineated: for priority fundamental research, basic research, and applied research.[59]

The first model of funding is for priority fundamental research, to be budgeted directly by the central government. Long-range forecasting and financing will be coordinated by the GKNT, especially in areas such as the environment, social programs, and defense. So far, fifteen national priority areas have been identified and programs approved by the Council of Ministers, one of which is Mars exploration. These programs were chosen as areas "whose success would cause a chain reaction of achievements."[60] Previously, funding for targeted programs was given to the ministries involved, but now the money will be distributed by the GKNT to the principal investigator. The GKNT will also apply for the licenses and acquire the materials needed to support the programs. It is expected that the GKNT will not only channel funds and approve projects, but will now also share in the responsibility for implementing the programs under contract terms.

Projects for these 15 programs are selected on a competitive basis. In 1989, 6200 projects competed and 3860 received money.[61] In 1990, 765 million rubles have been allocated for the 15 priority programs. For a program like Mars Exploration, the program director and council (drawn from the scientific community), for example, select the most promising proposals for projects, one of which is Mars '94. Once selected, money will be transferred directly to the project leader, rather than to the care of the project leader's institution. The project leader is then responsible for funding all supporting activities for the mission (i.e., the Academy of Sciences manager will contract General Machine Building enterprises for launch services, components, etc). In this way, it is hoped that the Academy will have the prerogative of defining equipment design specifications. (Nonetheless, in Western market terms, the "buyer" will still not have a great amount of leverage so long as General.Machine Building is the sole manufacturer of needed equipment.)

The second method discussed for financing scientific research is to have the research institutes themselves devote part of their operating budget to fundamental research. Thirdly, applied research may be funded by contracts, subject to cost-accounting principles. The institutes would be responsible for competing and soliciting work from other enterprises. Arguments have been made that such contractual work should not comprise more than 50% of the institute's total income.

More specific to cosmonautics, as opposed to science generally, suggestions have been made

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[59]Moscow TASS report on Conference on Improving Scientific Progress, 3/19/90. In Foreign Broadcast Information Service: Daily Report Soviet Union, 2/21/90:115.

[60]Laverov, in an interview with B. Konovalov, "Time for Change," Izvestiya, 3/13/90:3. In Foreign Broadcast Information Service: Daily Report Soviet Union, 3/16/90:90-92.

[61]Interview with R. Sagdeev, "Rockets into Ploughshares," The Economist, 3/24/90:94.

to have an expert review of the space budget and programs under the Supreme Soviet. Arguments for the creation of a truly centralized state space agency also appear to be circulating in the context of the science policy debate, although no steps have been officially taken in this direction.

In summary, the fact that the political system is in a great state of flux has had an affect on the space program's budget and the interactions of its components. For the first time, scientists must present and justify their plans and missions before the Supreme Soviet. Popular opinion increasingly affects financing decisions and the level of state commitment to the space program. Budget pressure is also creating incentives for international cooperation and a preference for applied, commercially profitable space projects. A sharpening of institutional rivalries for money and projects is not a surprising response to the new constraints. Overall, a large element of uncertainty has been introduced into the Soviet program, as the system gropes toward defining new processes and a new science policy.

V. CONCLUSIONS

As this study details, the Soviet space program is characterized by a profuse number of institutions and enterprises involved in space research and technology. Fortunately, glasnost has made the features of these many elements more accessible than ever before to Western analysts. In this regard, it is hoped that this study's attempt to catalog and delineate the relationships between the components proves helpful. Generally speaking, the space program consists of many disparate elements, without a single centralized agency at its head. As a result, there is little or no coordination of independent associations' efforts, and the planning process relied on previously to set priorities and allocate resources appears to be currently inoperative or in a state of flux.

Moreover, one sees the civil space program moving in new directions: towards budget tautness, more international interactions, an emphasis on civilian over military applications, commercialization, and fiscal accountability. As these trends progress, it will be interesting to see how responsibilities are sorted out among the players, for the new procedures are still largely untested. How will institutions with no previous program management/general contracting experience cope with coordinating an entire mission? How willing will General Machine Building be to give up its management prerogatives, especially since it remains the sole manufacturer of space technology and is likely to remain so for some time? Will a centralized space agency emerge?

The answers to such questions cannot be given here, for they depend predominately on the success of perestroika and conversion. Organizations' acceptance of new procedures and roles are contingent not only on a belief in the new political system, but also on an improvement in socioeconomic conditions. This study is a snapshot of a dynamic subject, but hopefully one which has highlighted the critical elements to track.

APPENDIX

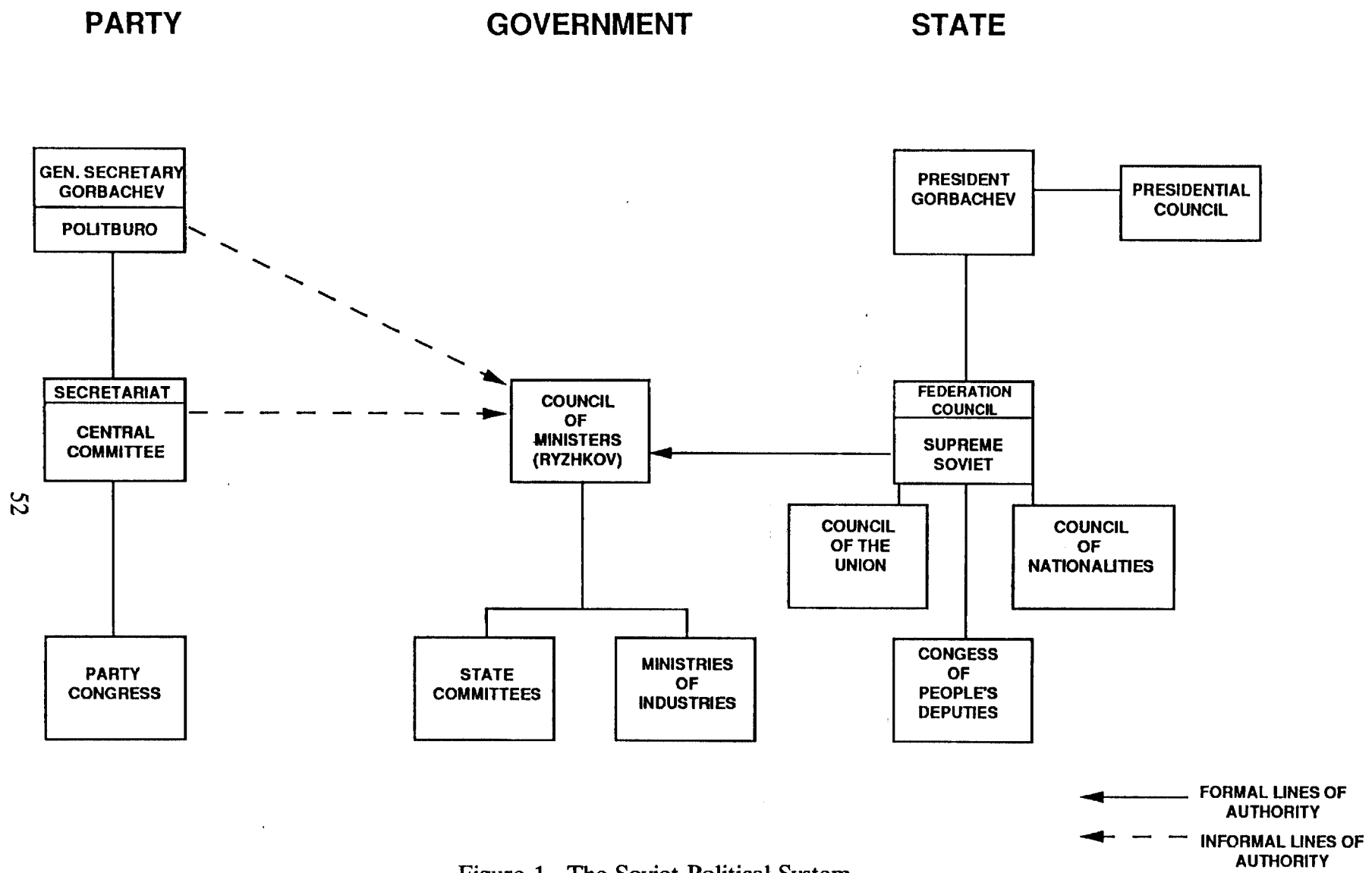

Figure 1. The Soviet Political System

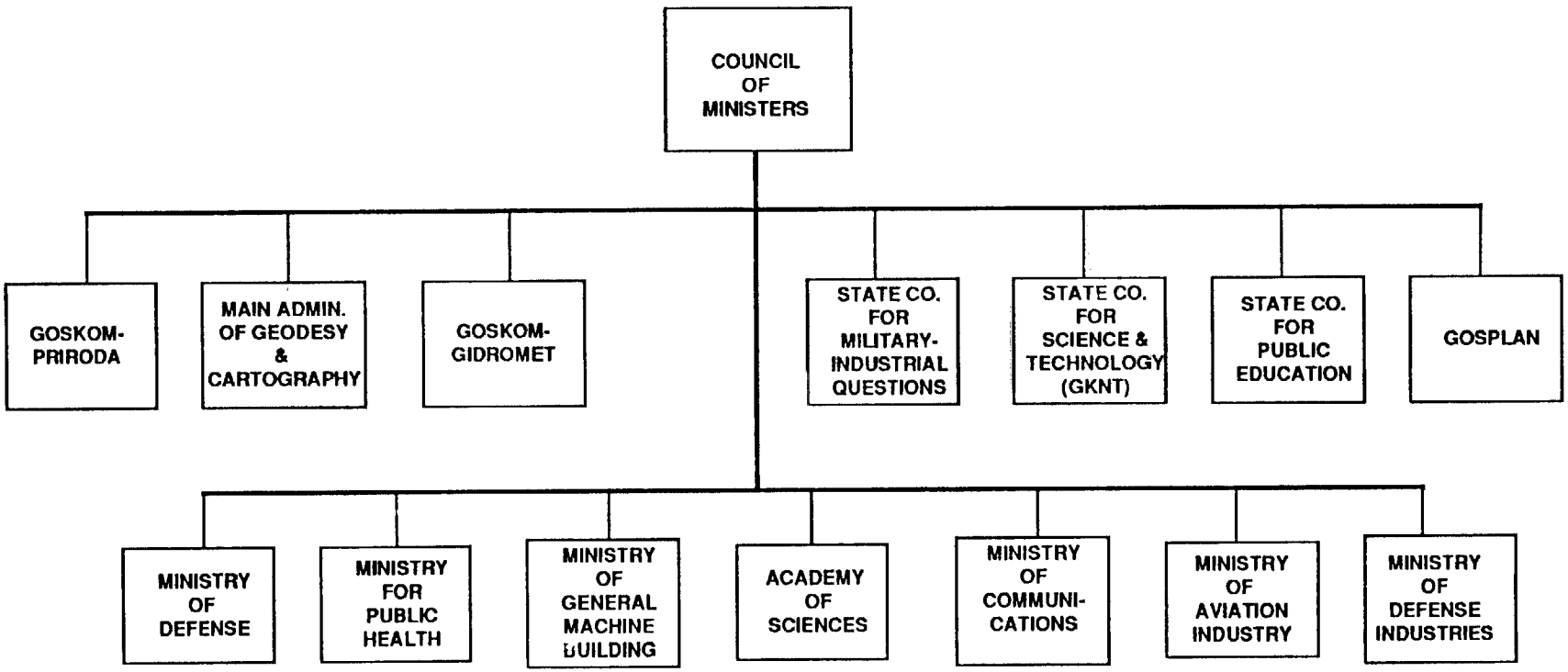

Figure 2. Broad View of the Government Involved in Space Program

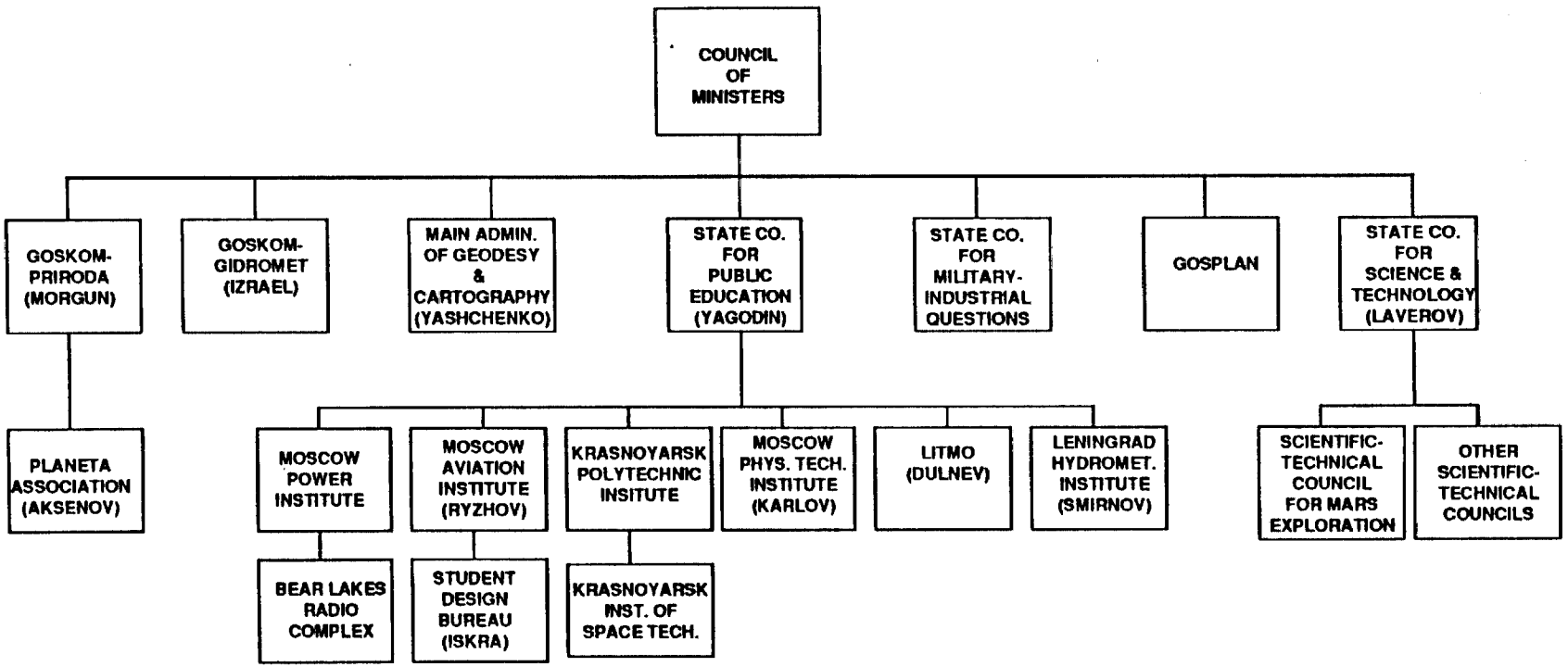

Figure 3. Integrated View of Space Organization Components: State Committees

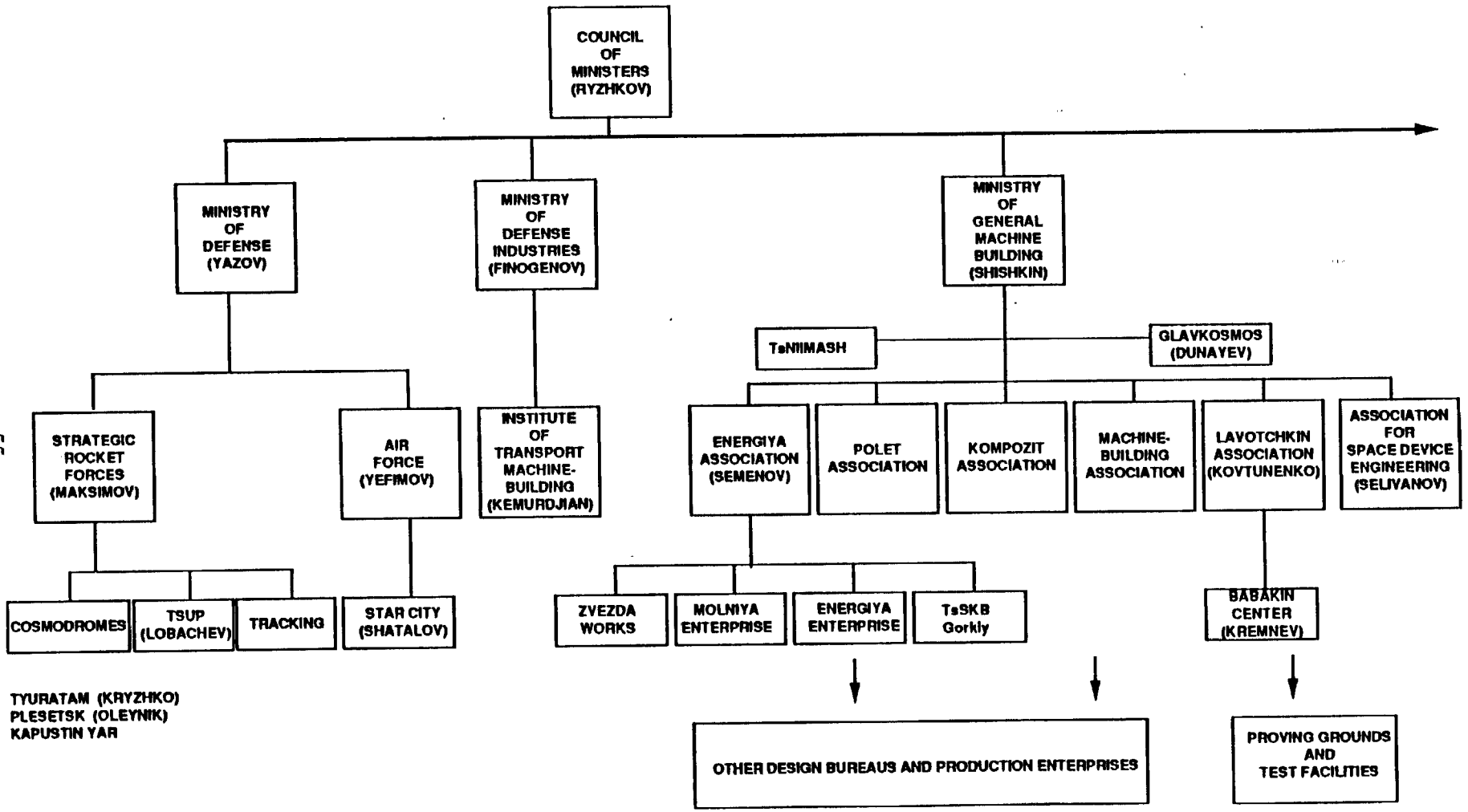

Figure 4. Integrated View of Space Organization Components: Ministries

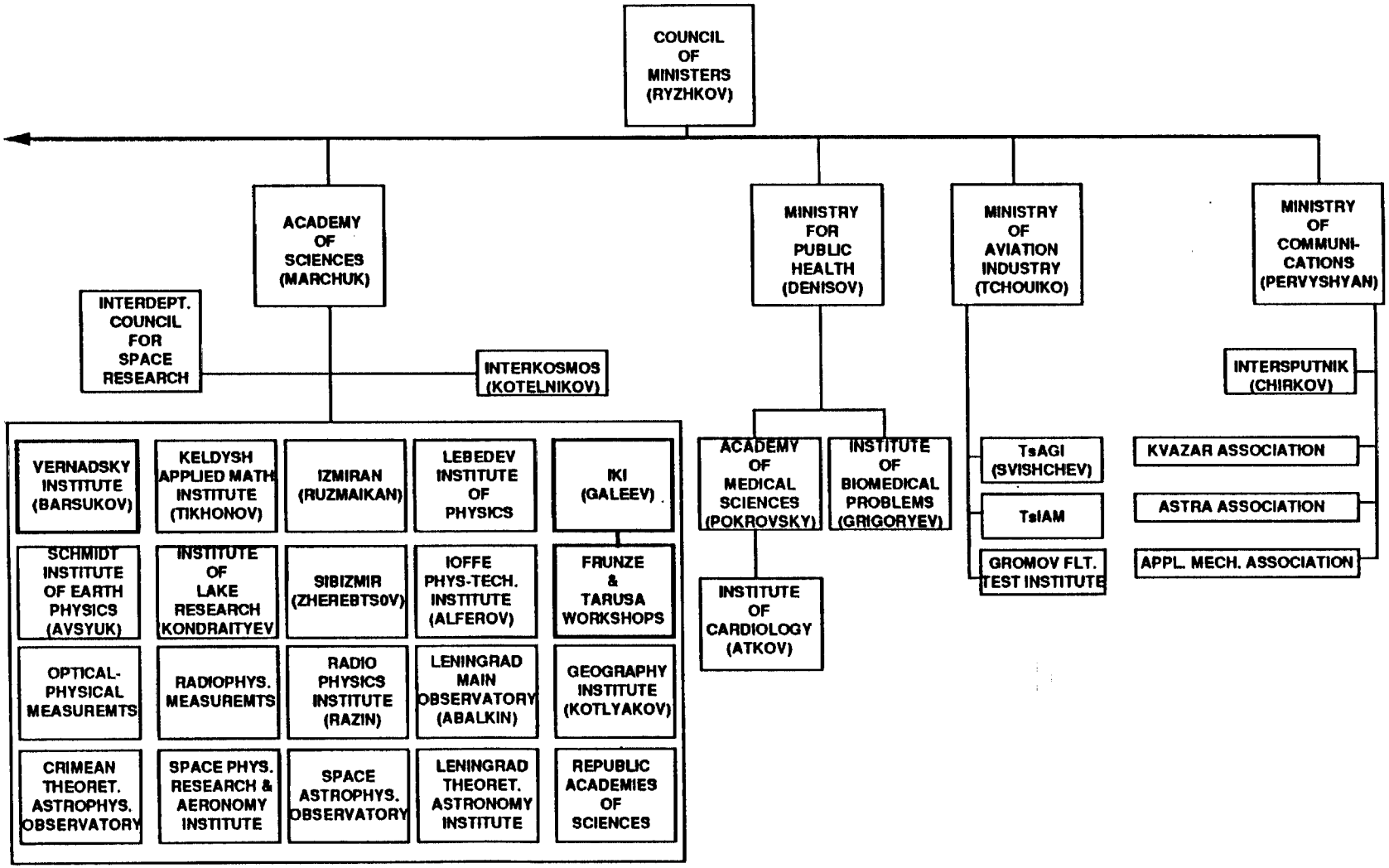

Figure 5. Integrated View of Space Organization Components: Ministries and Academy of Sciences

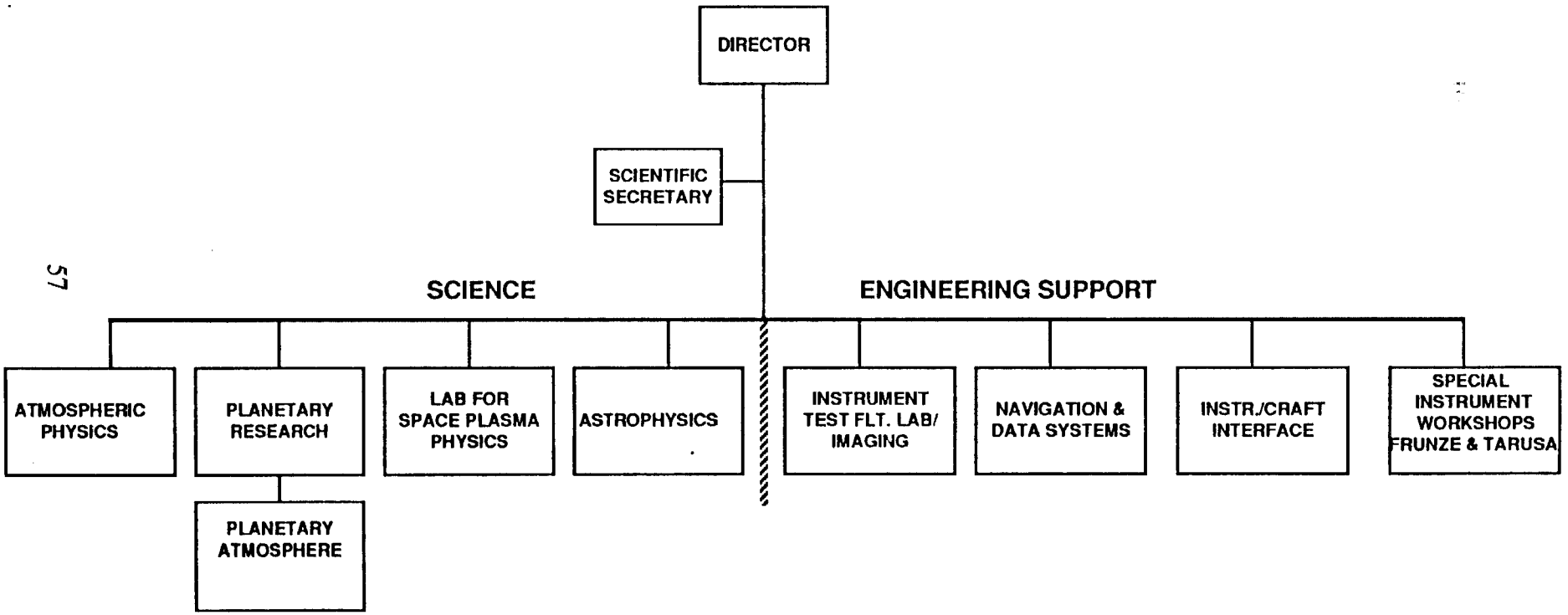

Figure 6. IKI (Space Research Institute)

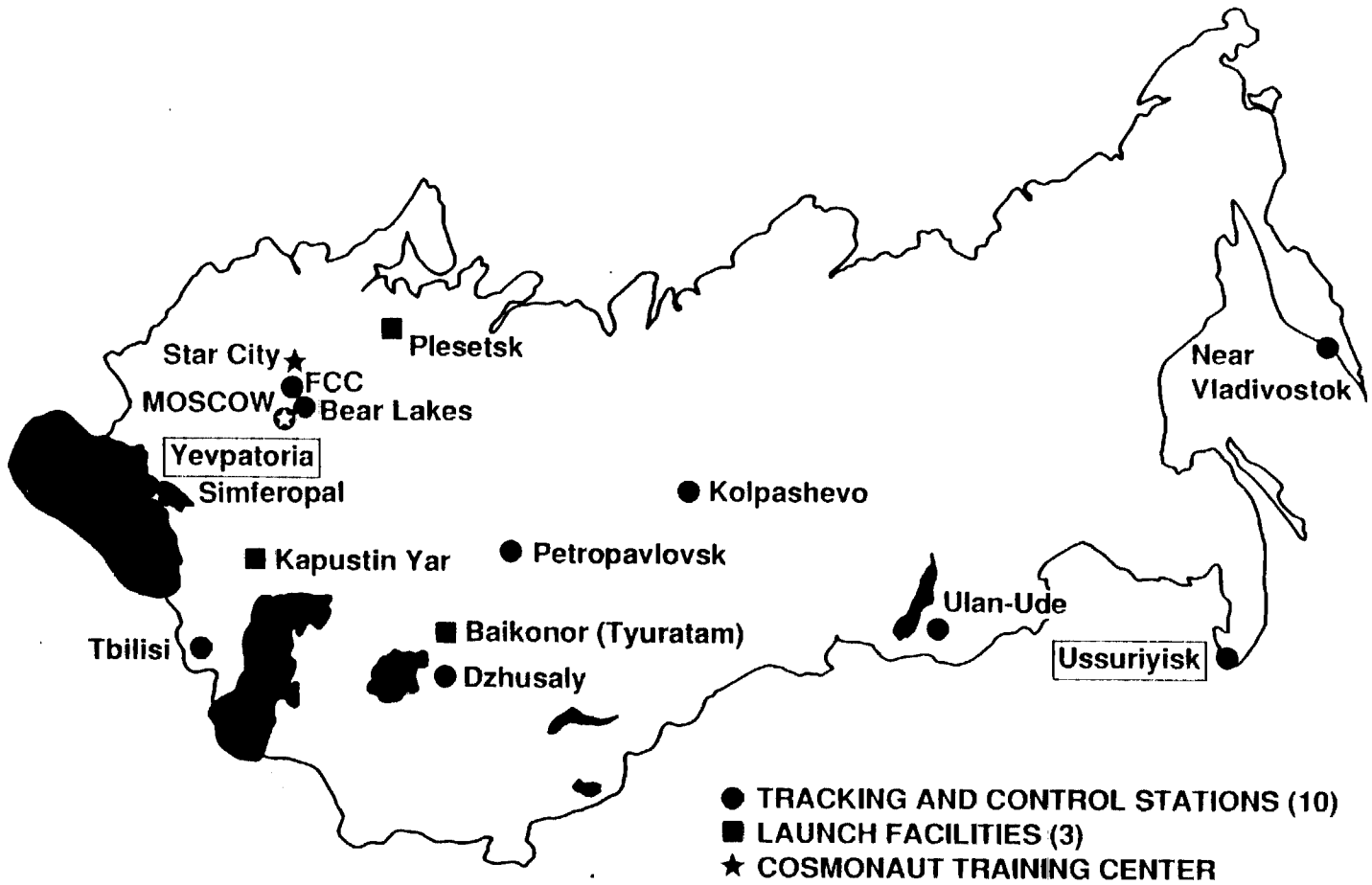

Figure 7. Map of Soviet Space Facilities

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