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SOVIET STRATEGIC AIR DEFENSE:  
A LONG PAST AND AN UNCERTAIN FUTURE

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**SOVIET STRATEGIC AIR DEFENSE:  
A LONG PAST AND AN UNCERTAIN FUTURE**

The Soviet strategic air defense, hereafter PVO,<sup>1</sup> has usually pressed into Western view only with outrages against civilian aircraft or debacles in dealing with boy aviators. Along with the infrequent Soviet defector who leaves with a PVO airplane, such occasions have prompted rounds of condemnation and ridicule of both the operational prowess and the technological accomplishment of PVO, together with mass firings of senior leaders. The Rust incident has brought PVO under the command of General Tret'yak, a veteran ground force commander. He presumably enters with a brief to clean up the mess in PVO and to ensure its ability to carry out the strategic defense mission which has been the service's sole reason for being. General Tret'yak faces a number of challenges.

The most widely recognized challenge to PVO is U.S. introduction of a new generation cruise missile and the stealthy B-2 bomber. The new cruise missile (the Advanced Cruise Missile) combines low observables with increased standoff range. The B-2 combines low observables with man-in-the-loop responsive tactics. Many Western analysts believe the problems are insurmountable. Put most strongly, these analysts believe the current Soviet investment in strategic aerodynamic defense is a write-off, existing technologies cannot evolve to meet the new threat, new resource allocations cannot be justified in the midst of Gorbachev's drive to restructure the economy, and surely the Soviets must at last recognize that without a missile defense, an aerodynamic defense of the rubble remaining after a missile exchange is ridiculous. Nevertheless, many of these same points were equally true in past years during which PVO retained force structure and obtained substantial resource allocations to develop and field new systems.

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<sup>1</sup>Acronym for protivovozdushnaya oborony, literally anti-air defense.

Only a very narrow Western viewpoint can hold that the primary problems for PVO are the development of the ACM and the B-2. If deployed, they constitute a formidable technical challenge to the Soviet strategic defense. But there is no reason to take the Americans' word that they have developed invulnerable weapons. If Soviet military leaders and technologists argue that they can develop appropriate counters, then that should persuade the political leadership to investigate the proposed new systems. After all, from a Soviet viewpoint, American development of the B-2 and ACM acknowledges that these same Soviet scientists and engineers developed effective counters to the low-altitude penetrator.

More immediate challenges to PVO include the Soviet debate on military doctrine and restructuring. Even if a doctrinal commitment to strategic aerodynamic defense is reaffirmed, PVO faces the organizational challenge of winning the manpower allocations and reequipment programs necessary to maintain the force. Failures on any of these fronts could result in the reduction of PVO.

If PVO were abolished or significantly reduced in size, the Soviets accept vulnerability to American strategic bomber and cruise missile attacks and implicitly acknowledge that nuclear deterrence relies solely on a retaliatory response. The primary Soviet benefits of reducing PVO would presumably be economic: freeing industrial assets now devoted to construction of the high-technology aircraft, radars and missiles that equip PVO. The half-million men who serve in PVO could be demobilized or assigned to other duties. In addition, significant reduction in surface-to-air missile (SAM) forces should assuage chronic American fears of Soviet strategic ballistic missile defense breakouts utilizing SAMs in ballistic missile defense modes.<sup>2</sup>

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<sup>2</sup> This paper focuses on the strategic aerodynamic defense. The ballistic missile defense also under PVO has been given much more attention. There has been a continuing American concern over whether each successive SAM has a ballistic missile defense capability. Some of this debate is summarized in John Prados, *The Soviet Estimate: U.S. Intelligence Analysis and Russian Military Strength*, Dial Press, New York, 1982, pp.150-171. Only the large number of SAM sites located around cities, together with the large manpower and organizational base contained within the SAM troops, could provide the basis of an ABM "breakout" based on the traditional Soviet ground-based technologies.

International political benefits should be immediate as the Soviets further underline their commitment to reductions in tensions and abandonment of force structures that seem to embody a war-fighting posture.

And yet, there are good reasons for continued survival of strategic defense forces in large numbers. PVO has more than one-half million men in its current force. With more than 2000 interceptors in its inventory, it has approximately six interceptors for each bomber in the U.S. Strategic Air Command--PVO alone has more airplanes than the combined British and French Air Forces. PVO has SAMs ringing all major Soviet cities and defense installations. The current PVO reequipment program has deployed systems that finally permit effective engagement of the low-altitude penetrating bombing, a long-sought goal. These systems contain the basis for future technical and operational development to further improve prospects against the currently deployed American bomber and cruise missile force. Current strategic arms control negotiations may provide a cap on U.S. cruise missile deployments and remove the danger of simple saturation of the defense as a penetration tactic. At the same time, PVO capabilities have become more important for Soviet conventional operations and would become even more important with reductions in Soviet forward-deployed forces. These are hard-won capabilities, not to be lightly abandoned.

Within the next few years, the Soviets must determine the doctrinal commitment to and resource and allocations for meeting the strategic aerodynamic threats and balancing strategic and conventional air defense. However these decisions are determined, they will be made in the context of a large organization that has developed continuously since the end of the Second World War.<sup>3</sup>

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<sup>3</sup> English-language histories of Soviet aerodynamic defense are relatively rare. The best available are a doctoral dissertation and the air defense articles in the SAFRA annual. See John R. Lepingwell, *Organizational and Bureaucratic Politics in Soviet Defense Decisionmaking: A Case Study of the Soviet Air Defense Forces*, Ph.D. dissertation, Department of Political Science, Massachusetts Institute of Technology, September 1988. See also the article series "National Air Defense Forces" and "Air Defense Forces" by David R. Jones (1977-1982) and Richard G. Brightner (1983 on) in *Soviet Armed Forces*

## POST-WAR DEVELOPMENT OF THE SOVIET AIR DEFENSE

Before the Second World War there were Soviet military theorists who advocated Douhet-like theories of strategic bombardment and theorists who advocated air defense.<sup>4</sup> The purges dealt with all theorists in the same way. The theorists were replaced with a new generation of inexperienced commanders who were forced to take up practice without benefit of theory. The practitioners of the Great Patriotic War produced a great tactical air force, but they devoted no serious attention to either a strategic bomber force or a strategic air defense. The air forces that emerged from the Great Patriotic War were quite clearly a product of the greatest land campaign in history.

The elements of the air defense force that participated in the Great Patriotic War were credited with two protracted air defense operations,<sup>5</sup> but the majority of air defense combat actions were in defense of railheads and assembly points behind the fronts. The Soviet removal of critical industries east of the Urals and the Soviet Army's land campaigns pushed the Germans away from the capital and removed the requirement for strategic air defense.

At the end of the war, the Soviet Union was faced with a new situation in which the British and Americans had both demonstrated and accepted the long-range heavy bomber as a major instrument of strategic war. Moreover, the Americans possessed the atomic bomb. The time for a

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*Review Annual*, David R. Jones, ed., Academic International Press, annually since 1977. Histories in Russian are only a little more common: P.F. Batiskiy, Head of the Editorial Commission, *Voyska protivovozdushnaya oborony strany: Istroicheski ocherk*, Voenizdat, 1968; N. Svetlishin, *Voyska PVO strany v Velikoy Otechestvennoy voyne: Voprosy operativno-strategicheskoye primeneniya*, Nauka, 1979.

<sup>4</sup>See Major General A. S. Sherstyuk, "The Development of Theory of Combat Employment of Air Defense Weapons (1917-1941)," *Military History Journal*, April 1988, pp. 74-77 translated in JPRS-UMJ-88-010, 15 July 88, pp. 34-37.

<sup>5</sup>These operations were the air defense of Leningrad and the air defense of Moscow. The Northern Air Defense Zone is credited with a sustained defense of Leningrad over the period 1941 to 1944 with a destruction of 1561 aircraft. The Moscow Air Defense Zone is credited with a defense over the period 1941-1942 and the destruction of more than 1300 aircraft.

Soviet strategic air defense had arrived in earnest. In the last forty years, the strategic air defense has gone through a number of stages in response to changes in the character of the aerodynamic threat and changes in the technological and operational capabilities of the air defense itself. These four periods can be defined as follows:

- (1) The immediate aftermath of WWII: continuity with wartime tactics and introduction of the jet fighter.
- (2) The period of high-flying, fast jet bombers.
- (3) The period of the low-altitude penetrator with stand-off weapons.
- (4) The current period.

#### **The Immediate Aftermath of World War II**

In Khrushchev's words, "One of the most crucial problems facing us after the war was the superiority--both qualitative and quantitative--of our enemy's air power. We were surrounded by American air bases. Our country was literally a great big target range for American bombers from airfields in Norway, Germany, Italy, South Korea, and Japan."<sup>6</sup> As long as the number of atomic weapons remained small, it was clear that in any war fought in the near term the Americans and British would fight much as they had in World War II, with massive conventional bombing raids delivered against the industrial centers of the Soviet Union.

Stalin alone must have made the decision that removed the air defense organization created during the war from the Main Artillery Administration and eventually created PVO Strany<sup>7</sup> as an independent service. He was probably also the principal decisionmaker down to the level of technical decisions as evidenced in his personal involvement in the Kremlin meetings that led to the requirement for the MiG-15. In the particular case of the Yak-25, it appears that Yakovlev circumvented the formal procedures and went directly to Stalin.

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<sup>6</sup>*Khrushchev Remembers: The Last Testament*, Strobe Talbott, translator and editor, Little, Brown and Company, 1974, p. 35.

<sup>7</sup>"PVO Strany" (air defense of the country). PVO was officially made an independent service in 1954 after Stalin's death.



Starting with the largely tactical air defense units and weapons created during the war, the Soviets had to create a nationwide strategic air defense. A nationwide strategic air defense required both assimilating and integrating new technologies into the air defense forces.

The ground-based anti-aircraft weapons available immediately after the war could support an all-weather, day-and-night local air defense of critical installations. As in the wartime air defense of Moscow, large caliber and automatic guns, searchlights, barrage balloons and radars for warning and gun-laying could be massed in the immediate vicinity of the critical installations. The operating concept for the anti-aircraft guns probably remained the same as in the Great Patriotic War.

The fighters were a more complicated case. If the bombers came during the day in the massed formations of the 8th Air Force's daylight precision raids of World War II, the Soviet day fighters would have to be concentrated to conduct mass air battles against hundreds of bombers and escorts headed for key targets. If the weather was clear, the critical problem would have been to mass a large number of fighters along the route to the target. If the weather was not clear or the bombers came at night in the bomber stream tactics of RAF's Bomber Command or the U.S. raids against Japan, the defense problem would have been complicated by the end-game problem of bringing individual fighter aircraft into the vicinity of each individual bomber. At the time, the day fighters were not capable of instrument flying or the night intercept mission. The Soviets had not developed the specialized night-fighter types developed by the Germans, British, and Americans, although they had acquired some types under lend-lease and captured others from the Germans. If the fighter force was to be effective, both the day and night fighter forces had to be completely re-equipped.

The creation of an integrated command and control system built around radar was both a clear necessity and a new beginning. The Soviets had developed some radars before the war, but they had not engaged in an extensive radar war as had the Western allies and the Germans. The Soviets had, however, acquired significant numbers of late-

model sets of all types produced by the Americans, British, and Germans. The problem was to assimilate such ideas into a Soviet military electronics industry that would have to develop and produce native designs.<sup>8</sup> In the same way, the Soviets had instituted sophisticated command and control features that integrated radar into their frontal air operations. But such procedures had much more to do with the application of tactical air power than the defense against penetrating bombers.<sup>9</sup>

### **The Period of the High-Flying Bomber**

From the end of the Second World War until the early 1960s, each new bomber flew higher and faster than its predecessor. There were two approaches to defending against these aircraft: The first was the extension of the ground-based anti-aircraft systems to ever higher altitudes, first with guns and then with missiles; the second was the creation of specialized, heavily armed interceptor aircraft capable of climbing quickly to the bomber's altitude and destroying it.

As in the Great Patriotic War, the Soviets were brought onto the field of practice before the new air defense organization was fully developed. The Korean War was a major school for the air defense forces. Once the Chinese entered the war and the bounds of the war were redefined, units from the Soviet air defense forces were used in the battles in MiG Alley. The Soviets learned by practice and demonstrated their ability to deal with certain classes of threats. From the Soviet point of view, the series of air battles fought in October 1951 by ground-controlled MiG-15s in regimental-size units against daylight B-29 raids with fighter escorts demonstrated an ability to inflict crippling

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<sup>8</sup>See John Erickson, "Radio-location and the Air Defense Problem: The Design and Development of Soviet Radar 1934-1940," *Science Studies*, 1972, v. 2, pp. 241-263; Antung, M.M. Lobanov, *The Origins of Soviet Radiolocation*, Soviet Radio, 1975; S.S. Swords, *Technical History of the Beginnings of Radar*, Peter Peregrinus, 1986. The post-war situation is described in Alexander Steinhaus, *The Beginnings of Soviet Military Electronics, 1948-1961: A Personal Account*, Delphic Associates, 1986.

<sup>9</sup>Col Gen Avn B.F. Korolkov, "Improving Command System of Frontal Aviation," *Military History Journal*, May 1987.

losses against daylight bomber formations.<sup>10</sup> If the high U.S. bomber losses of the relatively short Korean exposures had been extrapolated to the longer penetration distances required of raids into the Soviet heartland, daylight bomber losses would have been prohibitive.

While the behavior of the individual interceptor pilots in Korea was important, even more significant was the Soviet deployment of an operational command and control system for integrated twenty-four-hour air defense. By 1952 the air defense network along the Yalu, centered on the airfield complex around Antung, included as many as 25 early-warning and 11 ground-control intercept radar stations. Either by day or by night, the ground stations were capable of vectoring interceptors to within 2 to 5 miles of bombers at ranges of 70 miles from the radar site.<sup>11</sup>

Even though the air battles in Korea showed a certain maturity in the PVO organization, the special circumstances of the air battles did not necessarily indicate the relative weights that PVO would give to the different arms in a truly strategic air defense. The contribution of point defenses to a Soviet strategic air defense could not be inferred from the air battles fought while the MiG bases and industrial centers were in a sanctuary. In the same way, the Soviet intent to produce an integrated air defense command and control system covering the whole Soviet Union could not be inferred from the high local density of radars permitted around the Antung complex.

The clear path of development for the western strategic bomber forces was individual or small-cell penetrations against individual targets.<sup>12</sup> The Soviet technical response was to increase the effective

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<sup>10</sup>Robert F. Futrell, *The United States Air Force in Korea 1950-1953*, Duell, Sloan and Pearce, 1961, pp. 376-380. Also, Col V.K. Babich, "U.S. Strategic Operations in Korea and Vietnam," *Military History Journal*, Aug 87, pp. 62-67, translated in JPRS-UMJ-88-002, 22 February 1988.

<sup>11</sup>Futrell, p. 473.

<sup>12</sup>This change in tactics was given organizational visibility with the transfer of SAC's five wings of strategic fighters to Tactical Air Command in 1957. See Robert J. Boyd, *SAC Fighter Planes and Their Operations*, Headquarters, Strategic Air Command, 1988.

engagement altitude of all components of the defenses, both guns and aircraft, and to introduce the surface-to-air missile (SAM). As late as 1955, the Soviets introduced a new anti-aircraft gun, the 130mm M1955, with a maximum altitude of above 60,000 feet. At the same time, research proceeded on both the SA-1 and SA-2 missiles, which were introduced in 1956 and 1958, respectively. All of these systems were equipped with radar-directed fire control systems that gave them an all-weather capability. Providing all-weather, day/night capabilities for the aircraft component was more difficult.

After the introduction of day fighters into PVO with the MiG-15 and successive deployments of MiG-17s and 19s, the clear intent of subsequent acquisitions was to introduce only all-weather interceptors that could deal with all types of bomber penetration tactics. In all such aircraft, the principal requirement was the ability to climb to the altitude of a penetrating bomber while the bomber was within the coverage of a ground control intercept radar that could guide the interceptor to within a few miles of the bomber. If the bombers penetrated individually, interceptors need not be designed to engage in combat with fighter aircraft. Clear performance differences developed between tactical fighter and interceptor types.

The differentiation of PVO interceptors from frontal fighters was probably accelerated by the creation of PVO Strany as a separate service with a separate deputy commander-in-chief for armaments. The PVO deputy commander for armaments probably had the authority to issue independent requirements for new aircraft. The coordination of such requirements with those of the separate Soviet Air Force would have been done at the General Staff level rather than within the Soviet Air Force. Beginning with the appearance of the Su-9 in 1959, PVO inventory has been dominated by all-weather interceptors. Such aircraft were uniquely for PVO and did not appear in the inventories of the Soviet tactical air armies. One particularly noticeable feature of the long progression of PVO interceptor types is the large number of types that were equipped with only two air-to-air missiles. The limited armament and short ranges of these aircraft clearly indicate that the aircraft were intended only for a single, close control intercept.

Throughout the period of the high-flyers, the primary Soviet emphasis was on the creation of a system of point defense of critical facilities, primarily with the new SAMs backed up with interceptors. The increased effectiveness of such weapons was demonstrated by the destruction of a high-altitude U-2 by the SAM defenses of Sverdlovsk on 1 May 1960.<sup>13</sup> High-altitude bomber penetration could be aided by electronic countermeasures against the radars of aircraft and SAMs, but the appearance of nuclear warheads at SAM sites made it clear that ECM would be a winner at high altitude only if it could induce large miss distances. In the West there was general agreement that subsonic high-flyers were obsolete.

#### **The Challenge of Low-Altitude Penetrators with Stand-off Weapons**

Between 1960 and 1970, the Soviet concept of defense operations started in certainty and ended in disarray. At the beginning of the 1960s, with the new interceptors and SAMs, PVO had some confidence in carrying out a point defense of defended targets against high-flying penetrators. Border SAMs and coastal airfields provided linear barrier defense. At the same time, the extension of the radar network and improvement in the data handling of the command and control network provided a true zone defense. All of this presumed that the penetrators would come in high enough and remain within the coverage of individual radars long enough to complete the intercept.

The Soviet estimate of their own effectiveness against high-altitude penetrators must have been high. Yugoslav planning factors for the probability-of-kill of SA-2s (given launch inside engagement parameters) were 0.8. Similarly, the handbook probability-of-kill of the air-to-air missiles on Victor Belenko's MiG-25 was 0.86.<sup>14</sup> These

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<sup>13</sup>The exact altitude at which the U-2 flown by Francis Gary Powers was shot down is still disputed. See Michael R. Beschloss, *Mayday: Eisenhower, Khrushchev and the U-2 Affair*, Harper & Row, 1986, p. 359. Even the lowest altitude mentioned was above the ceiling of the bombers of the time.

<sup>14</sup>Yugoslav estimates from the early 1960s given in David R. Jones, "Air Defense Forces," *Soviet Armed Forces Review Annual*, v 6, 1982, p. 158. Belenko interview with author, 1982.

are end-game probabilities of kill in Western analytic jargon. If the PVO command and control system could enforce at least two end-game engagements for each penetrator, the bomber attrition would have been estimated as above 0.95.

Even before the loss of the U-2 in May 1960, both the U.S. Air Force and the R.A.F. had recognized that new weapons and tactics would have to be introduced to deal with SAM defenses. The weapons of choice were stand-off weapons that could be released at distances so far from the targets that the carrier aircraft were not exposed to the defenses. The Americans developed the Hound Dog missile with a stand-off range of some 500 nmi while the British developed the Blue Steel with a range of about 200 nmi. During the same period, both air forces also introduced low-altitude bomber penetration tactics--tactics which did not rely on technology as much as on the skill and courage of the aircrew.

The extension of the interceptor component into a true zone defense could probably have dealt with the stand-off ranges of the first-generation stand-off weapons--the Hound Dog, Blue Steel, and SRAM (Short Range Attack Missile)--if the penetrators remained at high altitude. The introduction of low-altitude penetration changed the prospects completely.

The R.A.F. low-level penetrator threat against the Soviet Union dates from the early 1960s when the Valiant component of the British V-bomber force was assigned to operational control of SACEUR. Rather than modernize the Valiants with the ECM equipment intended to retain a high altitude penetration capability, the Valiants were given a low-altitude penetration mission. The first of the Valiant squadrons was declared operational at low level in August 1962 and the remaining two squadrons were operational at low level in April 1963.<sup>15</sup>

SAC introduced low-altitude training flights in 1959. Even as the vulnerability of the penultimate American high flyer, the RS-70, was debated, the strategic low-altitude threat was communicated to the Soviets with a declaration by Defense Secretary McNamara that research

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<sup>15</sup>Andrew Brookes, *V-Force: The History of Britain's Airborne Deterrent*, Jane's, 1982, p. 130.

and development programs for both high-level and low-level penetration would be undertaken.

The low-altitude penetrator completely negated the PVO system of defense. The then-current SA-2 variant probably had no capability whatsoever against aircraft below 5,000 feet. The interceptors then in inventory had no ability to "look-down" and detect bombers flying against an earth background.<sup>16</sup> But the situation was even more complicated for the interceptor force than the end-game detection. The limited time a low-level penetrator would be within the horizon-limited detection range of any particular radar precluded the launch and vectoring of an interceptor from ground alert. Given the limited endurance of the interceptors then in the inventory, Soviet interceptors could only carry out intercepts from ground alert rather than an airborne CAP (Combat Air Patrol).

PVO's response to low-altitude penetration was first evident in an increased deployment of SA-3 SAMs in both the point and barrier defenses. From a Soviet perspective, the increase in the SA-3 force may have reestablished a point defense against low-altitude penetrators. In order to cover a fixed site against low-altitude penetrators, many SA-3 launchers and engagement radars were required. Such a defense had the disadvantage that the horizon-limited detection and even smaller engagement radius guaranteed only a single engagement with a transiting bomber. This limited engagement opportunity contrasted with the multiple engagement opportunities high-flying penetrators provided to SA-1s and SA-2s. Modifications to existing SA-2s were less visible but included changes in the fire control to accommodate optical guidance and improve low-altitude performance. Meanwhile, the low maximum altitude capability of the SA-3 (about 40,000 feet) demanded that high-altitude

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<sup>16</sup>"Look-down" should properly be interpreted to refer to geometries in which the extension of the interceptor-bomber line intersects the ground; that is, the radar's primary lobe impinges on the ground, and the bomber and the clutter are in approximately the same range cell. A "depressed-angle" capability is a less-stressing case in which the interceptor is above the bomber but the radar's main-beam does not intersect the ground.

SAMs be kept in place because penetrating bombers could still penetrate at high altitude if the Soviets did not defend that altitude band.

The case of the interceptor component of the air defense was more complicated. The "look-down" problem drew most of the attention. PVO first received the MIG-23, an aircraft developed for the tactical forces, which had a radar with some depressed angle capability. Later, MiG-25 aircraft were modified to the same standard. The modifications improved the end-game performance of the interceptors, assuming the interceptor could be brought to the end-game situation. Providing the interceptor with a "look-down/shoot-down" capability in the end-game engagement was a challenging technical problem, but it was a problem that could be solved given sufficient effort. That effort could come from either the radar engineers of the Soviet design bureaus or the overseas intelligence officers of the GRU. Both paths were followed and the results appeared in PVO inventory with the FOXHOUND and FLANKER.

A more challenging problem was changing the command and control system so that close control intercepts could be brought to the end-game on the basis of the intermittent coverage of different radars. With low-altitude penetration tactics, even a subsonic bomber is within the coverage of any particular radar for only minutes. The most direct approach to solving this problem is the "internetting" of radars so that a penetrator's continuous time in radar coverage is made long enough to permit completion of a controlled intercept. Another Soviet effort in this area was the development of airborne warning and control aircraft. The higher altitude of the airborne radar platform permits greatly expanded coverage regions against even low-altitude targets, provided the target can be detected in ground clutter.

During this period, the Soviets began to show their first interest in extending the air defenses forward--perhaps far enough to reach the bombers before they initiated low-altitude penetration tactics.<sup>17</sup> That is a reasonable interpretation of the Soviet introduction of the long-

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<sup>17</sup>Robert P. Berman, *Soviet Airpower in Transition*, Brookings Institution, 1978 and Bill Gunston, *Aircraft of the Soviet Union: The Encyclopedia of Soviet Aircraft Since 1917*, Osprey, 1983.



range Tu-28 (FIDDLER) and its frequent companion, the Tu-126 (MOSS) AWACS aircraft, and the preferential basing of the Tu-28s along the northern periphery of the Soviet Union.

In 1964 the SAC ICBM force of 931 missiles first equaled the alert bomber force.<sup>18</sup> Besides representing a significant change in the form of a strategic attack, the missile force presented a new threat to the operating environment of the air defense. Missile attacks presented the Soviet air defense with the question, What exactly would be left for a strategic air defense to defend after an initial missile exchange? The United States abandoned any serious attempt to defend itself against an air attack. The Soviet military never explicitly acknowledged that missile attacks would leave the cities in rubble but did recognize that air defense installations would be targeted by missile weapons. PVO would thus have to survive an initial suppression attack before it could begin its defense of the homeland.

PVO ability to survive a nuclear missile attack was problematic. The new interceptor aircraft then entering service (in particular, the Su-15) did not have the rough field capability of the early post-war designs; instead, the Su-15s required long take-off and landing runs on hard-surface runways. In the same way, the SA-2 and SA-5 missile systems designed to deal with high-altitude penetrators were merely transportable, not mobile, and required considerable time to relocate to a new site. Nevertheless, the PVO literature of the time is filled with the problems of the maneuver of PVO forces and operations from field airfields.<sup>19</sup>

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<sup>18</sup>J.C. Hopkins and Sheldon A. Goldberg, *The Development of Strategic Air Command 1946-1986 (The Fortieth Anniversary History)*, Office of the Historian, Strategic Air Command, 1986, p. 124.

<sup>19</sup>See, for example, Col N. Svetlishin, "The Maneuver of PVO Strany Forces," *Military Thought*, September 1968, translated in *Selected Readings from Military Thought, 1963-1973*, selected and compiled by Joseph D. Douglass, Jr. and Amoretta Hoerber, G.P.O. More practical aspects are discussed in Maj Gen V.V. Drekalov, "Flights from Unpaved Runways," *Air Defense Herald*, June 1964, pp. 41-43 and Lt Col Pakhomov, "Dirt Strip Aircraft Service and Maintenance," *Air Defense Herald*, July 1964, pp. 58-60. Several chapters of *Handbook for the Aviation Rear Specialist* by A.G. Blok, V.K. Buzunov, S.B. Neroslev, and I.Ya. Skorkin, Voenizdat, 1972, describe both procedures for protection against nuclear strikes and the reconnaissance and movement to a new airfield.

At the end of this period, the bulk of the interior-based interceptors had little prospect of successfully completing a low-altitude intercept. Nevertheless, PVO retained the force structure of the interceptor component while programs were initiated to provide full look-down/shoot-down capabilities and improve the control system.

#### **PVO in the Current Period**

In the current period, PVO development has been dominated by two major factors:

- (1) The development and deployment of systems that can engage low-altitude penetrators.
- (2) Expansion of PVO operational responsibility for conventional war missions within an overall Soviet strategy that has emphasized conventional war.

**The Introduction of New Systems.** The systems now entering PVO inventory are capable of engaging the low altitude penetrators that have been the principal threat to the strategic air defense since the 1960s. These systems, the SA-10 (NATO GRUMBLE), the MiG-31 (FOXHOUND), and the Su-27 (FLANKER), represent the final results of efforts by design and research bureaus of Soviet aviation industry and also successful acquisition of Western technology.

The SA-10 began development sometime in the late 1960s or early 1970s. It was first deployed in 1980 and has since been widely deployed within the Soviet Union in two different variants. There is also a navalized version of the system, the SA-N-6, which was developed simultaneously with the land-based variant and equips *Kirov* and *Slava* class cruisers. Even with an extensive development period, the SA-10 was the first of the latest generation systems to be deployed. This "SAM deployment first" is a standard behavior pattern for PVO with the SAM system counter to any particular threat usually deployed before the

equivalent airborne system. This pattern was evident in the response to the high-altitude, high-speed B-70 when the SA-5 was deployed prior to the MiG-25 (FOXBAT). The SA-10 system can engage low-altitude tactical targets against ground clutter as well as high-altitude, high-speed targets. The SA-10 thus combines the capabilities of both the SA-2 and SA-3 strategic SAMs.

The MiG-31 is in some respects an evolutionary development of the MiG-25 (FOXBAT), at least in airframe, but the critical technologies of the MiG-31 are revolutionary. The evolutionary nature is clear in that the M.G-31 remains a pure interceptor. The revolutionary nature of the system is in its weapon systems and propulsion. The MiG-31 has look-down/shoot-down weapon systems together with turbofan engines that give it both an ability to engage low-altitude penetrators and the range performance that could permit it to reach out to cruise missile carriers before they reach their release lines.

The Su-27, initiated in the early 1970s is the most interesting, and most recently deployed of the critical systems. A true air superiority aircraft, the Su-27 can engage bombers, cruise missiles and fighter aircraft. It also has a highly competent look-down/shoot-down radar that may incorporate espionage-acquired details of the F-18's APG-65 radar.<sup>20</sup>

Together, these systems embody technologies that will finally permit PVO to have a high confidence of engaging low-altitude, but not necessarily low RCS, penetrating bombers or cruise missiles. Moreover, the additional requirements for mobility in the SA-10 and air combat capability in the Su-27 have greatly expanded the range of missions such systems may undertake. Such required capabilities reflect the increased role of PVO within the Soviet concept of war.

**PVO Missions in Conventional and Nuclear Conflicts.** While PVO ability to carry out the strategic air defense mission was undermined during the 1970s, the PVO contribution to a conventional campaign became an increasingly important element of Soviet planning during the same

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<sup>20</sup> Soviet Military Power, 1986.

period. In fact, the conventional mission has become a dominant influence in shaping PVO inventory and organization during the current period.

Beginning in the early 1970s, the Soviets began to entertain the idea that a war in Europe might be kept non-nuclear or, at worst, kept from escalating to large-scale nuclear exchanges.<sup>21</sup> This idea was thought through largely out of Western sight. The development culminated in the large exercise *Zapad 81* in which the Western Theater campaign did not feature a nuclear exchange.<sup>22</sup> If such a conventional campaign were to be waged, the requirement for ground forces would dramatically increase beyond those deployed in theater. Such reinforcements could only be provided by the mobilization and deployment of successive echelons from the home military districts. Depending on the mobilization conditions at the outbreak of war, such forces might have to transit the whole of Poland and East Germany while exposed to attack by NATO aircraft. The Soviet perception of NATO and U.S. capabilities against follow-on forces includes holding back attacks directed at second echelon armies at a depth of 80-150 kilometers, second echelon fronts at a depth of 150-350 kilometers, and the second strategic echelon at a depth of 350-800 kilometers.<sup>23</sup>

As shown in Figure 1, the principal lines of communication from the western Soviet Union to the western theater are rail lines that run through Poland and Czechoslovakia to East Germany and western Czechoslovakia. The figure shows the approximate number of divisions that are available in each of the western military districts expected to provide immediate reinforcement to the western theater.<sup>24</sup> The Soviet

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<sup>21</sup>Phillip A. Petersen and John G. Hines, "The Conventional Offensive in Soviet Theater Strategy", *Orbis*, v 27 (1983), pp. 695-739.

<sup>22</sup>Arch Shero and Richard Oden, "Exercise Zapad '81", *Review of Soviet Ground Forces*, Defense Intelligence Agency, April 1982, pp. 7-8. See also Edward L. Warner, III, *Soviet Concepts and Capabilities for Limited Nuclear War: What We Know and How We Know It*, N-2769-AF, The RAND Corporation, February 1989.

<sup>23</sup>I. Perov, "The Aggressive Nature of the New Concepts of U.S. and NATO," *Foreign Military Review*, No. 2, 1988, pp. 7-17.

<sup>24</sup>John J. Yurechko, "Soviet Reinforcement and Mobilization Issues," in *NATO-Warsaw Pact Force Mobilization*, Jeffrey Simon ed., National Defense University Press, 1988. *The Military Balance*,

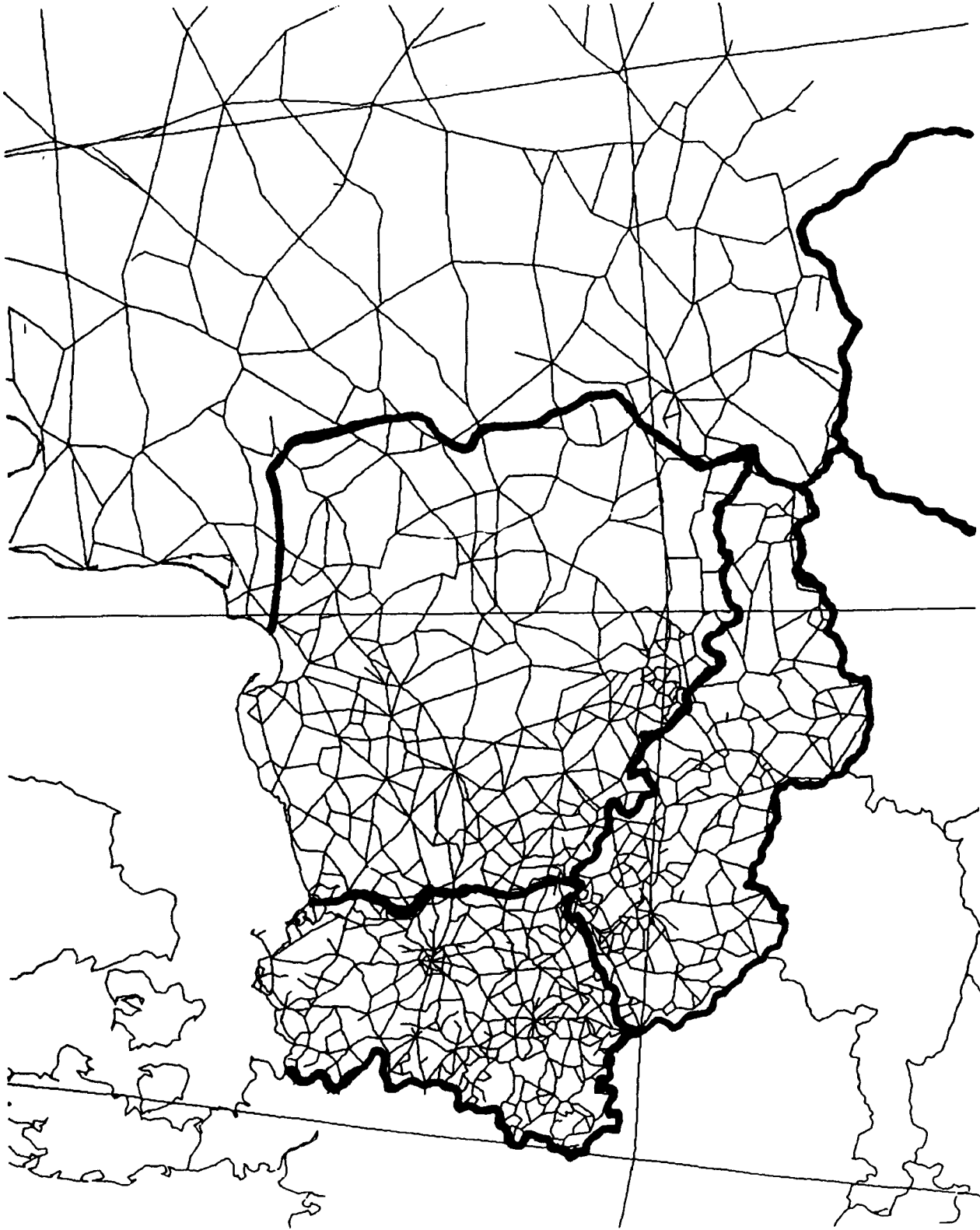


Fig. 1 -- Rail network of Poland, Czechoslovakia and East Germany

Army is dependent on these rail lines not only for the movement of bulk supplies and munitions but also for the transportation of the tanks and other heavy equipment of reinforcing elements. The road net is too sparse and the Soviet Army is not designed to road march the entire way from the home military districts to the inter-German border.

Possible threats to these lines of communication include tactical aircraft, cruise missiles of various sorts, and strategic bombers used in conventional roles. The crucial question for NATO concerns the depth of penetrations required for successful interdiction. Most tactical aircraft cannot be expected to penetrate more than the 150-200 mile width of East Germany if the aircraft are to carry useful payloads. F-111s or Tornados might transit the Baltic to penetrate into parts of Poland. Heavy bombers certainly have the range to carry useful payloads all the way to the Soviet border.<sup>25</sup>

The crucial questions for the Soviet theater commander and the General Staff are how such lines are to be protected and what forces are to be made available for the defense. A full twenty-four-hour area defense of the region is required because the critical rail lines must be defended along their full length and not just at crucial switching yards and rail transfer points. The Polish and Czech national air defense forces, organized along Soviet lines and now obsolescent, are not capable of coping with the full range of threats. Only Soviet forces can augment these national defenses to carry out a full area defense. It seems that sometime during the early 1970s it was decided that PVO would have a role in carrying out this defense. The theater commander was then faced with the sensitive question of where the responsibility of tactical air defense ends and strategic air defense begins.

The defense of lines of communication is a mission that can be carried out successfully without achieving the extremely high probabilities of kill that are necessary to avoid damage in a strategic

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1988-1989, International Institute for Strategic Studies (IISS), 1988, pp. 40-41.

<sup>25</sup>Gen. John T. Chain, Jr., "Strategic Bombers in Conventional Warfare," *Strategic Review*, Spring 1988, pp. 23-32.

nuclear operation. If PVO achieved an attrition of 10 percent while defending rear-area targets, it is doubtful that a conventional bombing campaign could be sustained. Achieving such an attrition rate would thus constitute success for the defense.

While PVO had a tradition of defending lines of communication and a doctrine of maneuvering air defense forces, PVO weapons inventory in the early 1970s was not designed to deal with the tactical strike aircraft that NATO could use for deep interdiction missions. The strategic SAMs were not particularly mobile and Vietnam had demonstrated that they had no great effectiveness against tactical aircraft. Similarly, the interceptor inventory did not include aircraft that had any significant air-to-air combat capability. Beginning in 1975, some PVO interceptor regiments began to reequip with the MiG-23 (FLOGGER) fighter-interceptor that was the mainstay of the tactical fighter force. Aircraft inventory numbers show that the MiG-23s not only replaced older MiG-17 and MiG-19 fighters but also provided a real increase in deployed force. Roughly comparable to the F-4, the MiG-23 was clearly suitable for the air combat role.

While the initial requirement for air-to-air combat capability could be met by acquiring an aircraft that had already been developed for the tactical forces, any new PVO aircraft would need such capabilities. At some point, "no later than the mid-seventies," the Soviets must have initiated the program that led to the Su-27 (FLANKER).<sup>26</sup> PVO requirements for this aircraft clearly imposed a demand for air-to-air combat capability that was much more demanding than that imposed on an interceptor. Similarly, the PVO requirement that led to the SA-10 was issued in the late 1960s. It appears that the initial requirement for a traditional strategic SAM was later augmented with a requirement for a mobile variant of the system.

It was the introduction of the Su-27 and the SA-10, together with the slightly earlier MiG-31 (FOXHOUND), that also gave PVO real capability in its continuing strategic mission. These systems had the

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<sup>26</sup> "Sukhoi FLANKER," *Air International*, v 35 no 2 (August 1988), pp. 69-76.

ability to engage the more maneuverable tactical aircraft as well as strategic systems such as bombers and cruise missiles. How the Soviets have modernized particular components of the strategic defense gives some insight into their conception of PVO strategic air defense mission.

Given current manning and alert capabilities with units alternating on combat alert duty, it is clear that the design point for the air defense forces is not the "bolt-out-of-the-blue" threat and that strategic warning is assumed to generate the forces. Some Soviet analysts have pointed out that strategic nuclear war is likely to spring from a large conventional war in which dual-capable American bombers would operate in theatre and against the Soviet homeland with conventional weapons. The United States would then suddenly execute nuclear strikes with the bombers carrying out the initial strikes and achieve surprise by exploiting Soviet expectations that the aircraft were on conventional missions.<sup>27</sup> Forces that would be generated include the MAINSTAY control aircraft, non-alert interceptors, and mobile SAMs.

Figure 2 shows the peacetime main operating bases of the Soviet interceptors. The deployment shows clearly that the interceptor defense is concentrated in European Russia and the Kola Peninsula. Additional deployments include a light barrier defense along the border with China<sup>28</sup> and a small, but locally dense deployment on the Pacific Coast around Vladivostok.

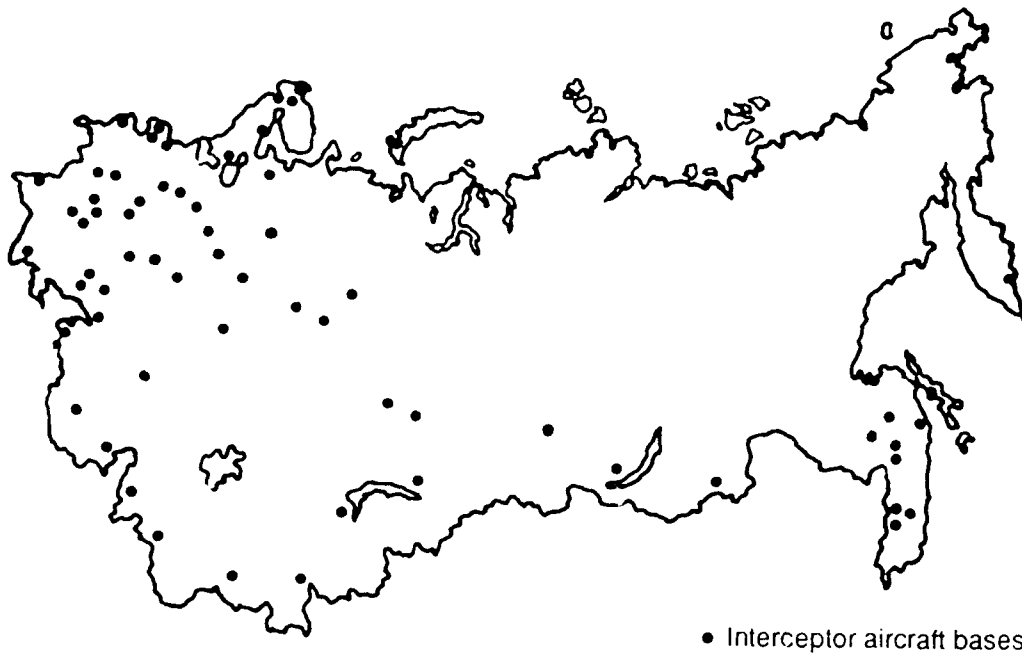
The operational balance between the various components of the air defense is not entirely clear. The usual formula in Air Defense Forces

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<sup>27</sup>Aleksey Arbatov, *Voyenno-strategicheskiy paritet i politika SShA (Military-strategic Parity and U.S. Policy)*, Izdatel'stvo politicheskoy literature, 1984, discussed in Rose E. Gottemoeller, *Land-attack Cruise Missiles*, IISS, Adelphi Paper 226, Winter 1987/8.

<sup>28</sup> The light barrier defense along the Chinese border is particularly intriguing. The Chinese have a missile force of 12 SLBMs, 6 ICBMs, 60 IRBMs and 50 MRBMs and a medium bomber force of only 120 H-6 (the Chinese version of the Soviet Tupolev 16, BADGER). *The Military Balance, 1988-1989*, IISS, 1988, p. 147. Given this small force the Soviets might have a high expectation of carrying out a successful damage limitation strike in the event of war with China. PVO has allocated about 350 interceptors to oppose the 120 medium bombers, with a rough spacing of 500 miles between adjacent interceptor airfields.





SOURCE Soviet Military Power, 1974, 36

Fig. 2--Soviet interceptor aircraft bases

Day addresses has always been to praise the SAM troops as the main firepower of the air defense and to single out interceptor aviation as the most maneuverable component. The interceptor leg has been most extensively modernized in the northern regions of the Arkhangel Air Defense District. This modernization has introduced both MiG-31 and Su-27 aircraft in significant numbers, totaling more than 150 of nearly 270 interceptor aircraft in the district.<sup>29</sup> Both the MiG-31 and Su-27 have increased range and loiter capability, together with large numbers of air-to-air missiles (AAM). With these performance capabilities, the defense might either carry out a linear barrier defense against cruise missiles or move out to attempt intercepts of cruise missile carriers before they reach their release lines ("at the distant approaches").<sup>30</sup>

<sup>29</sup>See Tomas Ries and Johnny Skorge's innovative *Investigating Kola: A Study of Military Bases Using Satellite Photography*, Brassey's Defence Publishers, 1987.

Figure 3 shows the regions that might be involved in such a forward defense attempt. The figure shows radii of 1000, 1500, and 2000 nmi centered on Moscow to long-range cruise missiles. It is clear that the use of Soviet interceptor aircraft in such areas could involve extensive overflight of NATO airspace enroute to the intercept lines. While certainly not insurmountable, the difficulties of such an operation are considerable and the circumstances certainly raise the possibility of fighter-versus-fighter air battles.<sup>31</sup>

A recent article on combat against cruise missiles<sup>32</sup> mentions many possible measures that might be taken, including jamming of TERCOM, attack by SAMs and anti-aircraft barrage fire on the approaches to defended points, and use of aerial-refueled fighter-interceptors at distances of 1500-2000 kilometers from the targets. Only the more exotic idea of using command-detonated mines is given an explicit foreign reference. In addition to jamming of the TERCOM navigation system, electronic combat could include the use of corner reflectors, screens, and aerosols to defeat area correlators. All existing components of PVO, as well as new anti-aircraft artillery components,<sup>33</sup> could participate in such a battle in the immediate vicinity of targets.

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<sup>30</sup>*Soviet Military Power*, 1986, p. 80, uses the expression "well beyond the borders of the USSR."

<sup>31</sup>Such possible Soviet operations were discussed as long ago as 1978. See the testimony of Dr. William Perry, *Hearings on Military Posture and H.R. 10929*, Department of Defense Authorization for Appropriations for FY 1979, Committee on Armed Services, House of Representatives, H.A.S.C No. 95-56, Part 1, pp. 1309-1310.

<sup>32</sup>Lt Col A. Manachinskiy and Lt Col V. Chumak, "Cruise Missiles and Combat Against Them," *Air Defense Herald*, December 1988, pp.78-80, translated in JPRS-UMA-89-005, 22 February 1989. This article is itself a classic example of a once-flourishing species that has fallen on hard times in the current period of *glasnost*. The article is constructed in the surrogate style of "According to foreign military specialists" and even refers to "aggressive circles of imperialism." Nevertheless, both authors are candidates of either military or technical sciences, although apparently not aviators, and they are serious and informed.

<sup>33</sup>Use of anti-aircraft artillery in strategic defense roles would mark a return of weapons that have not been in Soviet strategic defenses since the 1960s.

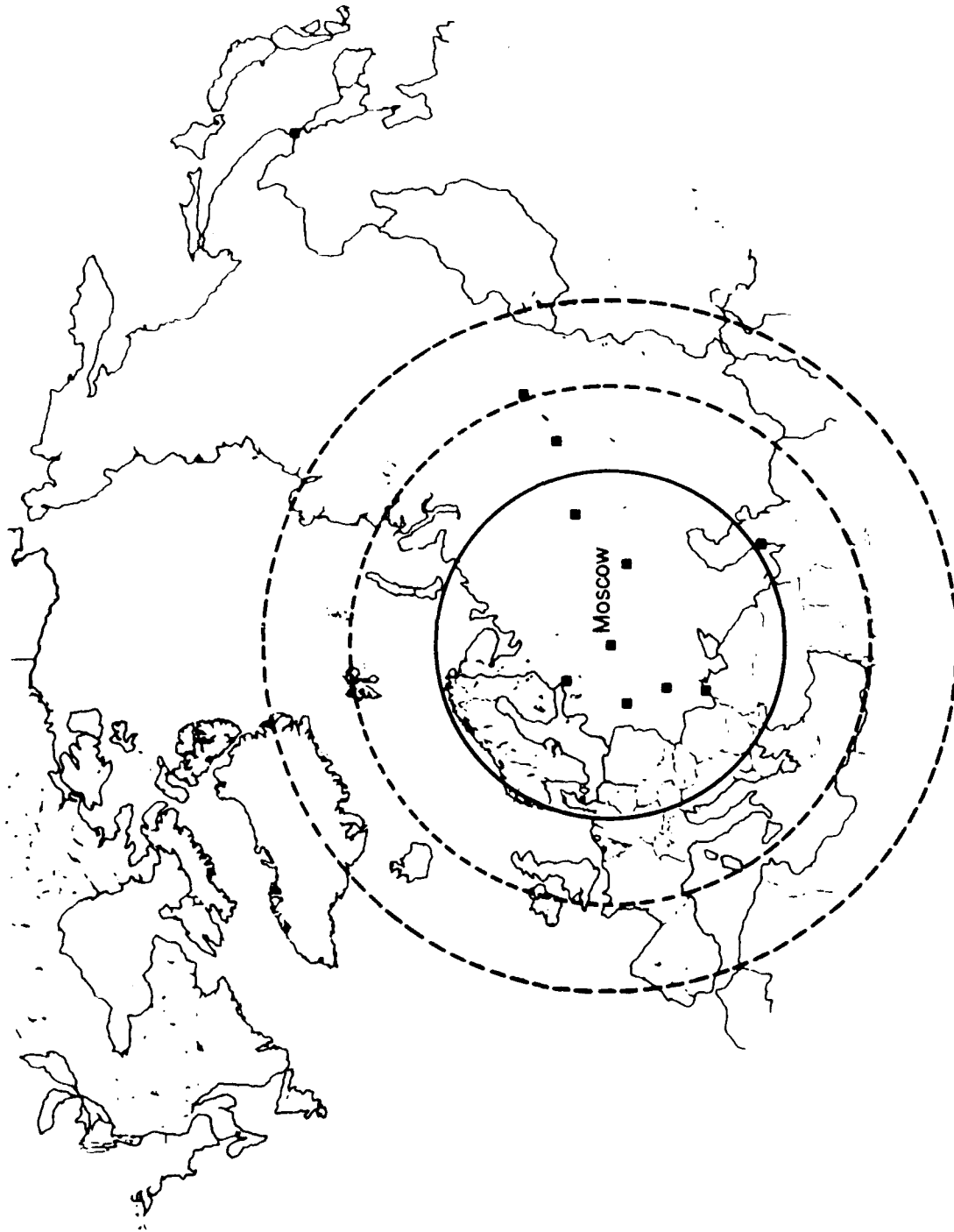


Fig. 3--1000, 1500 and 2000 n mi stand-off circles centered on Moscow

Balancing the level of effort between conventional and strategic missions for PVO forces has led to a period of experimentation with the PVO organization. Late in the 1970s there were signs that elements of PVO were being resubordinated to the air forces of the military districts. Most of the border air defense districts were abolished. PVO Strany continued to survive in the interior districts. At the same time personnel from the ground forces air defense branch, PVO Voysk, were introduced into the reorganized PVO Strany headquarters establishment. The general argument in the West at the time was that the changes represented an attempt to provide combined arms commanders with full command over all air forces necessary to carry out their missions and ensure flexibility in the use of air assets. The changes were centered in those military districts that provide the follow-on echelons to a conventional war in Europe.

Recent evidence suggests that the reorganization of air defense forces carried out in the late 1970s is now being reversed. The latest edition of *Soviet Military Power* dates the change from 1986 and places all the air defense forces again under the direct control of PVO headquarters in Moscow.<sup>34</sup>

The return to the traditional organization may simply represent a General Staff recognition that a portion of the territorial air defense forces sized for the strategic air defense mission cannot be switched from mission to mission and must remain in place after the tactical forces of the military district have departed. If the PVO forces are identified as having a unique mission, distinct from the conventional ground requirements of the military district's wartime operational role, the advantages of a unified air defense system support the traditional organization.

The primacy of the strategic air defense mission need not be the explanation for the reorganization. During a period of major reequipment and retraining, a single-service PVO has the immense advantage of unifying administration of training and establishment of

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<sup>34</sup>*Soviet Military Power: An Assessment of the Threat 1988*, p. 80.

common procedures for operation of new equipment. Moreover, the administrative existence of a separate PVO service need not hinder the assignment of operational command of PVO units to combined arms commanders, as was carried out routinely in the Great Patriotic War.<sup>35</sup>

While the reorganization is interesting from an administrative viewpoint, the operational character of the air defense has had a remarkable continuity. Commanders below the air defense district level clearly remain the operational commanders of the air defense battle.<sup>36</sup> If PVO is to survive as an organization it must be prepared to create sufficient flexibility in its operational commanders that they can support air defense operations in both conventional and strategic nuclear roles. There is no reason why the reorganized PVO cannot provide such capabilities.<sup>37</sup>

#### **THE CHALLENGES TO PVO**

Within the current setting, PVO faces challenges on three major levels:

- (1) Doctrinal commitment to strategic defense
- (2) Allocation of sufficient resources to maintain an adequate force structure
- (3) Development of technical and operational responses to new-generation U.S strategic systems.

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<sup>35</sup>At Stalingrad and Kursk in particular, Von Hardesty, *Red Phoenix: The Rise of Soviet Air Power, 1941-1945*, Smithsonian Institution Press, 1982, p. 113 and p. 153.

<sup>36</sup>See the discussion of the Egyptian Air Defense Force organized on the Soviet model in David R. Jones, "Air Defense Forces," in David R. Jones (ed.), *Soviet Armed Forces Review Annual, 1982*, Academic International Press, 1982. Jim Bussert, "Soviet Air Defense Systems Show Increasing Sophistication," *Defense Electronics*, May 1984, pp. 75-86.

<sup>37</sup>Lepingwell, *op. cit.*, Chapter 7, provides an interesting discussion of the conventional mission and its relation to the 1980-81 PVO reorganization.

Within the doctrinal debate, the air defense forces would be expected to fare well, at least at the doctrinal level. Much of the new Soviet thinking on military doctrine revolves around the nature of a theater war in Europe.<sup>38</sup> An important theme of this thinking has been the concept of the "defensive defense." Within such a concept, the requirement to defend the homeland and its lines of communication to forward forces should be clear; however, the process has become complicated because of the unexpected willingness of NATO to consider air forces within the conventional force reduction talks now underway. The opening NATO position has been to include all "combat aircraft" from the Atlantic to the Urals. Proposed Western definitions for "combat aircraft" would include all combat aircraft and would thus count the vast majority of about 2000 PVO interceptors, together with all the interceptors of the Warsaw Pact countries. Soviet counterproposals have attempted to narrow the definition to "attack aircraft" only, excluding all defensive aircraft. Resolution of this dispute involves a political decision at the highest levels. Should the Soviets accept the Western definition, they would have to directly address the balance between conventional and strategic defenses and, more narrowly, the balance between interceptors and SAMs in an air defense operation.

Until recently, the doctrinal commitment to defend the Soviet Union against possible strategic aerodynamic attacks has been unquestioned. This is still true within the military leadership. However, a new generation of civilian military analysts has begun to examine this critical assumption. A recent paper by Alexei Arbatov, a leader of the new generation of civilian analysts, questions the whole requirement for the strategic defense forces.<sup>39</sup> Arbatov attacks strategic air defense on three grounds:

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<sup>38</sup>An important source on this thinking is Stephen M. Meyer, "The Sources and Prospects of Gorbachev's New Political Thinking on Security," *International Security*, v 13, no 2 (Fall 1988), pp. 124-163.

<sup>39</sup>Alexei Arbatov, "How Much Defence is Sufficient?" *International Affairs* (Moscow), April 1989, pp. 31-44.

- (1) The air defense could not intercept all weapons and intercepting only 80 percent would produce the same effect as intercepting none.
- (2) The installations of air defense would not themselves survive an SLBM precursor strike.
- (3) The ICBM and SLBM attack could destroy virtually all Soviet targets without heavy bombers.

In essence, these are arguments from the American strategic community of the 1960s when the United States abandoned strategic defenses. The Soviet military leadership may now be reaping a bitter harvest from its successful attempt to monopolize military policy during the Brezhnev period: The civilian military analysts now appearing in Gorbachev's inner circle may simply have more familiarity with Western strategic thinking than with the Soviet military's own doctrine.

In many ways the current doctrinal debate is first a struggle to decide who will determine military doctrine. It does not appear likely that there will be a decisive conclusion. Gorbachev's inner circle seems to include many new thinkers genuinely committed to a change in military thinking. At the same time, traditional military thinkers, such as retired Marshal Akhromeyev, are also represented in the inner circle. MSU Akhromeyev's statement to the House Armed Services Committee reaffirmed a commitment to "develop the air defense forces and materiel in the 1990s with due regard to the talks on reducing strategic and conventional forces, development of attack, missile and air force weapon systems of NATO including the USA."<sup>40</sup>

It is possible that with democratization of the Soviet leadership, the United States may finally face a true "mirror image" opponent whose military policy is subject to the same fitful starts, stops, and sudden changes that characterize U.S. military policy. A possible consensus for the near-term Soviet leadership might be to continue a doctrinal

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<sup>40</sup>Statement to the House Armed Services Committee, 21 July 1989.

commitment to defense against bombers and cruise missiles flexibly interpreting "reasonable sufficiency" in deciding on particular programs.

If PVO can avoid outright doctrinal disavowal of the strategic defense mission, the real battle will be fought out in the internal bureaucratic struggle for resource allocations adequate to maintain and modernize the air defense force. As in the West, the two principal resources are hardware and people.

The immediate question on hardware is whether to complete the reequipment program now underway. The aircraft and missiles are now in serial production and presumably commitments to produce at the current rates were made in the last Five Year Plan. Complete reequipment would require production into the period of the next plan.

Near-term personnel decisions will have a great deal of influence on the long-term prospects of PVO.<sup>41</sup> The recent reduction of PVO by 50,000 men as part of the unilateral reduction of the Soviet military produced some unhappy comments from PVO leaders but still leaves a large force. The recent force of 520,000 needs large numbers of personnel suited for technical training and, therefore, proficient in the Russian language. At the same time, the conventional ground and air forces also have greater needs for the Slavic conscripts, both because of their greater trainability and because of their political reliability in the current troubled times. PVO is in direct competition not only with the other military services but with the civilian sector. Conscript service removes technically skilled candidates from the labor force for two years. Officers who make a career in the military are lost to the civilian labor force for virtually their entire working lives.

The final challenge to PVO is the U.S. deployment of the Advanced Cruise Missile and the prospect of deployment of the B-2 bomber. The ACM is an evolutionary development of the cruise missiles already deployed. As discussed earlier, Soviet counters to the cruise missile already in train might be evolved to deal with the deployment of the

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<sup>41</sup>Personnel and training problems are described in the companion piece *Soviet Strategic Air Defense: The Struggle for Competence*.



ACM. Tentative agreements on portions of the START agreement have already guaranteed that the cruise missile threat will never rise to the 8000 level that the Soviets are alleged to have thought possible.<sup>42</sup> Current Soviet offers include mutual abandonment of nuclear-armed, sea-launched cruise missiles. Any agreement to count cruise missiles on cruise-missile carriers towards START limits without discounting would further constrain the maximum size of the cruise missile component of the offensive forces. If the threat is constrained to only 100 cruise missile carriers based on a small number of bases, then special-purpose solutions that preferentially attack and barrage cruise-missile carrier fly-out corridors, together with operations designed to reach cruise-missile carriers before they arrive at their release lines, can become attractive operational counters. In addition, capping the total number of cruise missiles and thinning out the force before it reaches its release lines remove simple saturation as a plausible penetration tactic and enhance the prospects of terminal defenses.

The B-2 bomber is a more serious challenge. Not only does it represent the latest generation in stealth technology, its man-in-the-loop guarantees responsive maneuvering to real-time threat indications and allows the possibility of real-time lethal suppression of defenses. In the U.S. view, the prospects for a Soviet solution to low observable penetrators are not promising. Even the design specification of the threat cannot be completely known by the Soviets at this point in the B-2 program. It is known that the B-2 is intended to provide more than a point design threat. The redesign of the wing has guaranteed that the B-2 can be introduced first as a high-altitude penetrator and then shifted to the low-altitude role if the Soviets successfully develop a counter to the B-2 at high altitude.

From the Soviet viewpoint, there is no immediate cause for panic. It is possible that the Soviets might make a political decision to abandon strategic defense and assert that the bomber will always get through; political decisions masquerading as technical judgments are not

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<sup>42</sup>Strobe Talbott, *The Master of the Game: Paul Nitze and the Nuclear Peace*, Knopf, 1988, p. 275.

unknown in the West. But in such a situation it would be more probable to assert that any bomber would get through, not just a B-2, and deny stealth technology a unique role. On the other hand, it is possible that the B-2 program will find budget-constrained Capitol Hill a more lethal environment than PVO is capable of producing at the moment. Even if the program is funded, there is no particular reason to take the Americans at their word that there is no counter to the low observable bomber. The commitments that the Soviet leadership make now are research programs rather than development programs. While the opportunity costs of assigning particularly talented engineers and scientist might be large viewed from a more global perspective, the immediate budgetary impacts of the programs are not likely to be daunting. The cost of such research is probably now within the discretionary budgets of design bureaus or research institutes that already have the required engineers and scientists on their staffs.<sup>43</sup> The cost of such a research program need not be as high as equivalent U.S. research into stealth technology which must have included extensive research into the exotic manufacturing technologies associated with stealth aircraft. The Soviet program need not make a heavy investment until it reaches the stage of development of weapons and deployments. Until the United States actually deploys the B-2 in numbers, the Soviets need not undertake the most expensive portion of any program of counters. As demonstrated by the Soviets' thirty-year response to the low-altitude penetrator with stand-off weapons, the pace of any such Soviet program need not be hectic.

Assuming PVO can avoid entanglement in conventional force reductions or major doctrinal revolutions, the least surprising future for PVO is continued existence as a separate service with completion of the current reequipment program, although it may shrink in response to current budgetary limitations and demographics. It is very likely that the Soviets have already initiated a deliberate, long-range research

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<sup>43</sup>Arthur J. Alexander, *Decision-Making in Soviet Weapons Procurement*, International Institute for Strategic Studies, Adelphi Papers 147 and 148, 1978, p. 32.

program into counters to U.S. low-observable threats. The research need not bear fruit immediately--if PVO survives the immediate future, it can take the long view.