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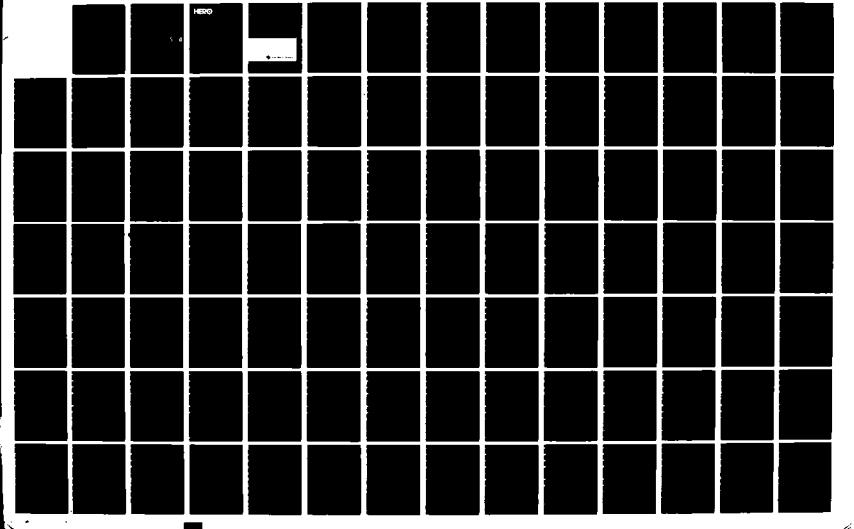

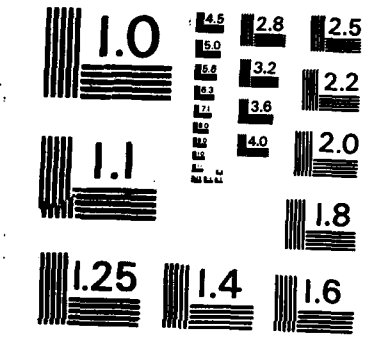

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Historical Evaluation & Research Organization

THE DEVELOPMENT OF SOVIET AIR DEFENSE DOCTRINE AND PRACTICE

Prepared for

Sandia National Laboratories

Contract DE-AC04-76DP00789

July 1981

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The Development of Soviet Air Defense Doctrine and Practice

Historical Evaluation and Research Organization

SAND80-7146/1

THE DEVELOPMENT
OF SOVIET AIR DEFENSE
DOCTRINE AND PRACTICE

A Report Prepared for
Sandia National Laboratories
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Sandia Contact: R. B. Stratton, 5613
April 1981

HISTORICAL EVALUATION AND RESEARCH ORGANIZATION
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ABSTRACT

This report describes the evolution of Soviet air defenses from 1918 through World War II, the war in Vietnam, and the Arab-Israeli wars. It also discusses present-day Soviet air defenses and possible Soviet motivations in structuring such formidable defenses. Chapters IV and V (Secret), bound separately, cover the "Cold War Era" and the Vietnam experience.

THE DEVELOPMENT OF SOVIET AIR DEFENSE DOCTRINE AND PRACTICE

EXECUTIVE SUMMARY

This study is a follow-on to a study prepared for Sandia Laboratories in July 1978, titled Availability of Historical Data Concerning Soviet Air Defense Experience. The objective was to research and analyze data discovered in the course of the earlier effort on the organization and performance of Soviet air defense in World War II and the subsequent development of Soviet doctrine, forces, and materiel in the postwar period.

The study generally lent itself to a chronological breakdown that included the origins of Soviet air defense, Soviet experience in World War II and the immediate postwar period, and the present situation. Because the Soviets were the chief suppliers of air defense materiel to the North Koreans, North Vietnamese, and Arab bloc nations, special emphasis was placed on gaining the available data from these areas, as well as directly on the USSR itself.

A great deal of data has been amassed that tends to indicate that in the past the Soviet Union has devoted, and is presently devoting a large share of its resources toward maintaining a viable air defense system that encompasses not only the protection of the homeland, but also Soviet troop formations. All indications are that the USSR intends to maintain its present level of effort into the foreseeable future, responding to real or perceived threats from the West by employment of the latest technologies available. One reflection of this is the fact that while the West has allowed its air defenses to become obsolescent at best in some areas, the Soviets have continued to upgrade their systems with the obvious aim of ensuring maximum survivability of their means of existence. To this extent, the type and mix of air defense systems currently found in type Soviet military formations can only reaffirm that these formations are offensive in configuration and nature.

While the study is as complete as time would permit, a great deal more needs to be done by way of analysis to determine exactly what effect this present Soviet air defense system would have when applied to certain critical scenarios and what are its vulnerabilities.

THE DEVELOPMENT OF SOVIET AIR DEFENSE DOCTRINE AND PRACTICE

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AA	Antiaircraft
AAA	Antiaircraft Artillery
AAMG	Antiaircraft Machine Gun
AD	Air Defense
ADD	Russian Acronym for Strategic Aviation
CAS	Close Air Support
C & C	Command and Control
CinC	Commander in Chief
Comp	Composite
ECM	Electronic Countermeasures
Front	Soviet term for Army Group
ICBM	Intercontinental Ballistic Missile
Ind	Independent
IOC	In Operational Configuration
MZA	Soviet abbreviation for light antiaircraft artillery
NEADC	National Egyptian Air Defense Command
Point	Soviet designation for an air defense area generally surrounding an important industrial or politico-economic complex.
PKO	Soviet abbreviation for Aerospace Defense
PRO	Soviet abbreviation for Anti-Ballistic Missile Defense
PUAZO	A type of Soviet antiaircraft associated fire direction equipment
PVOIA	Air Defense Fighter Interceptor Aviation Units
PVO Strany	National Air Defense of the Homeland Forces
PVO-SV	New Soviet acronym for Air Defense Forces of the Ground Troops
PVORTV	Air Defense Radio Technical Troops

PVO-Voisk	Old Soviet acronym for Air Defense Forces of the Ground Troops
PVOZA	Air Defense Artillery Units
PVOZRV	Air Defense Antiaircraft Missile Forces
SA/AW	Small Arms/Automatic Weapons
SAM	Surface to Air Missile
SZA	Soviet abbreviation for medium antiaircraft artillery
TVD	Soviet acronym for Theater of Military Operations
VNOS	Soviet abbreviation for Air Defense Air Warning Service

THE DEVELOPMENT OF SOVIET AIR DEFENSE DOCTRINE AND PRACTICE

Introduction

This is a follow-on to a report prepared for Sandia Laboratories in July 1978, entitled Availability of Historical Data Concerning Soviet Air Defense Experience. The objective was to research and analyze data discovered in the course of the earlier effort on the organization and performance of Soviet air defense in World War II and the subsequent development of Soviet air defense doctrine, forces, and materiel. The resultant data was then to be compiled into a comprehensive summary of the findings.

In accomplishing this task a considerable amount of additional data was uncovered that tends to indicate (A) the wealth of source material on the subject and (B) the level of emphasis placed on air defense by the Soviet Union. The data selected for inclusion in this report best illustrates these points and covers material produced in the Soviet Union and supporting documentation collected in this country and abroad.

Data in Soviet sources often is redundant in form and style, and data in US and foreign sources other than Soviet tends to conflict in detail and in interpretation. Whenever possible a fresh analysis of the basic data was performed.

As is the case in all studies of the Soviet Union, this project suffered from lack of data from that source. Such information as actual ammunition expenditures in World War II and parametric data on weapons, which are usually available for the United States and other nations, simply are not made public by the Soviet Union. In some instances it has been necessary to fill gaps in available data by interpolation or extrapolation, based on judgment of individuals at HERO with long experience in analysis of Soviet military matters, or reliable secondary sources.

Although the Soviet Union has not participated overtly in a major war since World War II, its air defense equipment was used by participants in Korea, Vietnam, and the Middle East. Considerable information about equipment and doctrine has been gleaned from experience in those conflicts. Much of the data concerning the Middle East experience has been collected by HERO for other projects.

Sources for charts, maps, and illustrations are identified where appropriate. Most of the statistical charts have been prepared by HERO for this report.

The Chief author of this report was John E. Jessup. Also participating were Trevor N. Dupuy and Grace P. Hayes.

THE DEVELOPMENT OF SOVIET AIR DEFENSE DOCTRINE AND PRACTICE

CHAPTER I

BACKGROUND

To understand the present air defense (AD) system of the Soviet Union better, a study of its evolution is necessary. This does not imply any great innovation on the part of the Soviets but, rather, the problem of application of fundamentals which make Soviet air defense unique. Typically, research into Soviet air defense is beset by the problem of lack of access to basic documentation with the concomitant lack of faith in the data that has been made available or that is found in secondary Soviet sources. In recent years the Soviets have spoken rather candidly about some of the problems encountered in air defense, especially during World War II, and have discussed some of the means used to overcome these problems. Still, the more basic issues, such as the intermediate level decision-making processes and resource allocations, are either totally ignored or are glossed over. Similarly, the statistical data presented in secondary sources is suspiciously the same in form and language and is most often cited without referral to basic documentation. Soviet literature fails, therefore, to present a balanced, credible statistically accurate account of the role of air defense in the war.

A second complication involves the fact that most of the official German Luftwaffe records of the Eastern Front were destroyed near the end of the war. What data does exist, or can be compiled, is sketchy and uneven. Only the memoirs of a number of senior German officers offer any valuable material, and these, of course, must also be taken at face value.

In sum, then, what statistics do exist lack substantial detail and are most often low when dealing with friendly failure and high when dealing with success. The data that does exist, however, illuminates a number of significant areas from which certain inferences may be made and from which certain conclusions may be drawn.

It may be postulated that the Soviets' air defense of today is to a large extent the result of their experience in World War II, where some of the processes of advancement and development were begun. It must also be remembered that, while the fundamentals of air defense have remained basically unchanged over the years, the sophistication of both attacker and defender systems has been modified dramatically, primarily because of technological advancement. Since World War II was the last direct combat experience for the Soviets, there are some important lessons to be learned from that period that will apply to the present. That the Soviets themselves appreciate this may be demonstrated in two ways: their lack of hesitation to reorganize their air defense as they gained experience during the war and their postwar improvements in weaponry, organization and doctrine based on lessons learned, improved technology, and their perception of probable enemy capabilities.

The Prewar Period

Soviet air defense had its beginning in the Civil War period (1918-1920). The general method of air defense at that time combined a system of "spotter" posts (air warning stations) located along the lines of probable attack. These posts were located as far as 100-200 kms. out from the point, usually a city, to be protected. Inside this air warning line the various target attack means were located. Fighter-interceptor aircraft, for instance, assigned to the responsible air defense commander, were usually based just outside the point and were usually maintained on ground alert. These aircraft had the mission of intercepting the intruder in an area between the air warning line and the outer perimeter of the defensive envelop created by the positioning of the assigned antiaircraft artillery (AAA) batteries. Whether the interceptors would pursue into the AAA zone is not clearly stated. Low flying intruders were engaged by small caliber antiaircraft guns and by antiaircraft machine guns (AAMG) located on rooftops in and around the point. Because of a chronic lack of proper communications, which extended into the World War II period, the responsible air defense commander was almost always in the position of having to relinquish control to subordinate commanders, who undertook engagement on an independent, uncoordinated basis. Antiaircraft batteries were positioned,

where feasible, with overlapping fires, but, again, a lack of ability to coordinate the handoff of targets existed because of the lack of adequate communications means.

The two decades preceding the outbreak of World War II did see numerous changes in the Soviet air defense system in all areas - organization, tactics, and equipment. In the main these changes were brought about by the spectacular improvements seen in the airplane itself. As speeds, altitude limits, range, and endurance of aircraft improved as much as 300% in all areas, so did the imperative to improve defenses against them. This requirement was further increased by the knowledge that the newer aircraft being developed by those nations that constituted a threat to the USSR had greater ordnance-carrying capabilities and therefore created an ever-growing menace.

To offset these threats the Soviets set about improving their PVO (Protivovozdushnoi Oborony) or air defense. By the end of the 1920s, the first fundamental study of the subject had been completed in Soviet Russia.[1] In this study, L.N. Borodachev conceived of Air Defense as having three elements - active, passive, and auxiliary - designed to interact in combating the activities of an enemy's air force. This breakdown was not a unique approach for the USSR, nor did the Soviets' assignment of fighter-interceptors and AAA to active, balloons and camouflage to passive, and searchlights, sound detectors, and air warning to auxilliary means constitute any real innovation. Those differences that may have constituted a specific Soviet approach may be found in their appreciation of the size of their country and the fact that most lucrative targets lay close to their western borders, inside the accepted attack ranges of the aircraft of their most likely European adversaries.

This knowledge, coupled with the omnipresent problem of available resources during this critical period in the development of the Soviet state led to the establishment of an air defense program that was characterized by:

- the division of the threatened belt in the western Soviet Union into a number of regions wherein the assigned PVO units would be concentrated around priority areas and,
- the division of these regions into groups of "points" called sectors and,

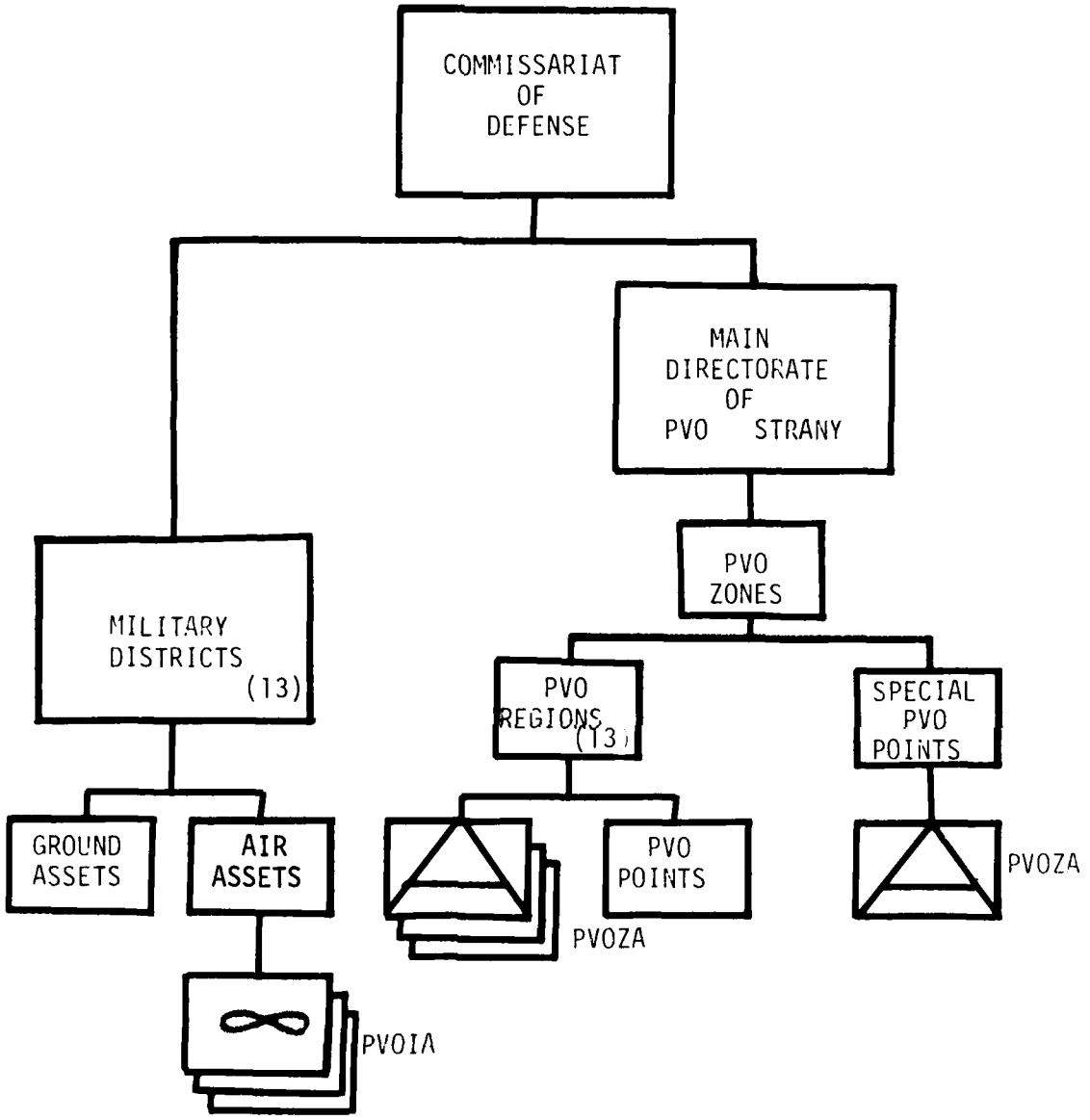
- the selection of the more important "points" as separate areas responding directly to the regional air defense commander.

In this last instance, particularly, the air defense would consist of both air and ground active means. In regions of lesser importance only ground active means would be employed. The regional air defense commander was still responsible, however, for the maintenance of a mobile reserve to be employed on a priority need basis over points not normally covered by air active means. He was also responsible for the assignments of targets to the air and ground active means at his disposal. In essence, this meant he would assign the types of targets to be engaged by each means and the rules of engagement to be followed.

By 1930, some codification of these hitherto rather theoretical points can be seen in the establishment of a Main PVO Directorate within the Headquarters of the Workers and Peasants Red Army. This new directorate added the dimension of national planning to air defense. Even so, a debate of sorts developed between those who saw the necessity for zonal defense systems and those who espoused the Borodachev theory of air defense of points. Others, of course, saw the melding of the two systems as the solution. In this view, the idea of organizing air defense so as to cover the more important politico-economic centers within a particular operational zone was stressed, with aircraft and AAA positioned so as to allow for mutually supporting radii <u>throughout</u> the zone. Thus, in this organization, the intruder was to be engaged early on his entry into the zone and would meet increasingly heavier concentration of air defense means as he approached the more sensitive and important politico-economic centers. This system was eventually selected for employment, and this type of "circular air defense" remained in operation into the war period. Within this system three major politico-economic centers were designated as separate air defense areas: Moscow, Leningrad, and Baku. Approximately 42.5% of all available medium caliber AAA and a high percentage of the available fighter-interceptors were assigned to these three special areas.

From the organizational point of view, these air defense zones formed a belt 500-800 kms. in depth along the western borders and 250-500 kms. deep along the Transcaucasian border. (Moscow was actually outside the western belt, as it lay approximately 1,200 kms. inland.) In 1939, this organization was improved by assigning all AAA units to corps, division,

and brigade formations (PVOZA). Aviation assets of the Air Defenses' Intercept Squadrons (PVOIA) were similarly organized, but, even though the airplane was considered a more efficient antiaircraft weapon, command was retained by the aviation commander of the associated military district. The air defense zones were further divided into air defense regions in which points, including key rail junctions, were designated. These air defense regions generally coincided with the boundaries of the appropriate military district. Almost all the air defense assets of PVO were located within the structure when the war began. The other areas of the Soviet Union, except in the far east, were virtually without air defense protection, but they were also not attacked in the initial period of the war. At best the PVO structure presented an extremely cumbersome organization, which only further diminished its capability. Thirteen such zones existed at the end of June 1941. Figure 1-1 shows the Soviet air defense organization of this period.



SOVIET AIR DEFENSE ORGANIZATION - June 1941

Figure 1-1

CHAPTER I

Notes

[1] N. Borodachev, Taktika Vozdushnoi Oborony (Moscow: 1928). "The Tactics of Air Defense."

CHAPTER II
THE WORLD WAR II PERIOD

Organization

The surprise German attack on the Soviet Union found the air defense system less than adequately prepared to carry out its mission. How much of this was caused by Stalin's total refusal to accept hard intelligence that the attack was coming, and, hence, his virtual stand down orders to all echelons of the armed services, and how much was caused by the numerous deficiencies in the air defense system itself is hard to determine. While Stalin's reaction obviously played a significant role, it constitutes a non-definable element. What can be defined, however, is the Soviet admission that approximately 90% of all of the fighter-interceptors assigned air defense missions were obsolete and that approximately 66% of all medium caliber AAA was due for replacement when the war started. Target acquisition was still limited primarily to visual observation, although a small number of primitive radars (34) were available to PVO. Of this number, only six were capable of doing anything other than identifying the entry of an intruder into their ranging sweep. Still, even if a target could be accurately identified as to numbers, types, direction, altitude, etc. by the extant air warning system, only about 25% of the air warning stations (VNOS) had proper communications to enable rapid alerting of the point or zonal direction center. Thus, the progress from target acquisition to target engagement was in the vast majority of cases hampered by inadequate communications. While some communications means, such as landline telephone, probably were available, they too seem to have failed to perform as required. The obsolete or inadequate equipment, plus the apparent lack of initial alert status at the outbreak, because of Stalin's reluctance to face the realities of the moment, weighed heavily in the initial successes of German airpower over the Russian front.

At the moment of the opening of the Russian campaign, at 0300 hours on 22 June 1941, the German force consisted of 145 divisions of ground troops, along with about 2,000 combat aircraft.[1] The initial successes scored by the Germans in all areas were indeed impressive. Within the first 48 hours the Luftwaffe "had swept nearly all of the Soviet combat aircraft from the skies. By 28 June the High Command of the Luftwaffe announced that 4,000 Russian planes had been destroyed."[2] While the Soviets acknowledge severe losses they have published no confirmation of these cited German figures. Suffice it to say that, regardless of the exact numbers, Soviet air defense was inadequate to ineffective in its overall performance.

The new equipment authorized after the 1939 reorganization was only just beginning to enter the inventory when the war began. What there was of it had also come too late to change the initial outcome. The numbers were too small, and insufficient time was available for essential training of the user personnel and units. Some of the new equipment did see service on 22 June. Some new fighter-interceptors (Yak-1, MiG-3 and LaGG-3) did get airborne, and new AAA weapons, such as 37mm and 85mm guns, were on hand but not in sufficient numbers to affect the outcome. An additional problem was severe personnel shortages. At the beginning of hostilities all units of the PVO were below strength:

Unit Type	% of Troops Available
Aviation Units (PVOIA)	60%
AAA Units (PVOZA)	70-85%
AAMG Units	70%
Searchlight & Balloon Units	50%

One manifestation of the low level of effectiveness that contributed directly to the heavy losses suffered in the initial hours of the German attack is the Soviet statement that the air warning service (VNOS) in the Western Special Military District was "poorly organized," and this was the cause for the losses in tactical aircraft that were caught on the ground at well identified airfields close to the frontier.[3] No more than anyone else the Soviet air defense organization was caught by surprise by the German attack.[4] That the surprise was not universal may be assumed by the

fact that at least some commanders, ignoring the deadly wrath of Stalin, had violated their orders and had gone to advanced readiness conditions. This factor, plus the human phenomenon of untested individuals rising to the occasion, is probably responsible for the disparate levels of effectiveness found among all units of the Red Army.

By August 1941, less than 60 days into the war, the first reorganization of Soviet air defense took place as a part of the overall realignment of the Red Army. Fronts (Army Groups) were established that incorporated all combat, combat support, and combat service support (Rear Services) elements in a particular linear area facing the enemy. The Air Defense Zones, as such, were disbanded. Some AAA assets were assigned directly to the fronts, where they served in the dual capacity of air defense and as direct-fire reinforcement of other antitank units. These AAA units were employed in an antitank role because of the extremely serious situation that existed at that time. German forces had enveloped large numbers of Soviet units around Minsk in the center sector, while at least 15 Soviet divisions had literally disappeared under the German thrust to the northeast across the Dvina River. Salvation rather than textbook utilization must have been the operative factor during these critical days.

The remainder of the air defense assets of the PVO were organized to defend the areas behind the fronts' rear boundaries and, in some cases, certain politico-economic points within the fronts' areas of responsibility. Although these elements were also prepared for antitank missions their principal responsibility rested in their air defense role.

This August 1941 reorganization marked the beginning of the true separation of the PVO into two components -- the PVO Strany, or Air Defense of the Territory of the Country, and the PVO Voisk, or Air Defense of the Troops. The PVO Strany in reality had two missions: air defense of the theater rear and air defense of the zone of interior. The bulk of the total air defense assets apparently went to the PVO Strany.

The PVO Strany during the War Years

The organization of the PVO Strany following the August 1941 reorganization is not clearly delineated, but it is assumed to have remained

essentially unchanged until November 1941, when the second major reorganization of air defense took place. On 9 November 1941, a Deputy Commissar of Defense for Air Defense was designated, who also became the Commander in Chief of the PVO Strany. In effect, he took command of all air defense assets other than those that were placed under the command of the Front Commander by the August reorganization. Statistically, the CinC, PVO Strany, received:

97% of all AAA Regiments
71% of all separate AAA Battalions (Med)
60% of all AAA Battalions (Light)
50% of all AAA Batteries (Med)
40% of all AAA Batteries (Light)
Most of the AAMG units
Most of the VNOS

Logically, it may be assumed that the remainder of each category was spread among the front PVO Voisk. Whether this constituted a major reallocation of the assets as assigned by the August reorganization is not known. One effect of the November reorganization was the codification of the division between the PVO Strany and the PVO Voisk. It did not, however, mark a total separation of the two, as the PVO Strany still had responsibility for point coverage within the front boundaries. Thus, coordination of effort was mandated between the two. A front commander could request air defense coverage of a specific point in his rear area by a PVO Strany element, and, it is assumed, a front could be ordered to reinforce the fires of a PVO Strany element covering a designated point within a front area by fire from PVO Voisk elements.

This overall organization was used throughout the European USSR except at Leningrad, where the unique situation of the city under siege dictated another solution. Here the Leningrad Front commander directed all aspects of air defense from his headquarters.

Elsewhere, Moscow formed the hub of the 250 km. radius, Moscow Corps PVO Region. A total of 13 other, divisional PVO regions were designated in European Russia. The Transcaucasus, Central Asian, Transbaikal and Far East areas were preserved as separate air defense regions because of their distance from the center of activity. In sum, these constituted the major operating elements of PVO Strany and reported either directly to the CinC, PVO Strany, or to two (or four) intermediate headquarters

established for that purpose. Positions of chiefs of specialized units such as Chief of Searchlight Troops, VNOS Troops, Barrage Balloon Troops, Signal Troops, and Rear Service Troops were established to assist the CinC.

Even with this rather sweeping reorganization, which centralized the bulk of ground air defense means under the CinC, PVO Strany, he still had only operational control of his fighter-interceptor aircraft (PVOIA). Although two fighter aviation corps, six fighter aviation divisions (totaling 29 regiments), and 11 separate fighter aviation regiments were assigned air defense missions, the command, administration, and logistic support of these units remained vested in the front or district air force commander. This situation was not corrected until January 1942 when all PVOIA assets were subordinated to the CinC, PVO Strany, along with some 56 airfield support battalions, which were also assigned. The PVOIA, thereafter, became a branch of arms of the PVO Strany. Some analysts perceive the November 1941 reorganization and the January 1942 modification as the establishment of PVO Strany as a separate arm of the Soviet armed forces, with its own assets, missions, and special organs of control.

Subsequent organizational changes took on the character of enlarging upon the already established base. Most of the changes dealt specifically with the improvement of the command and control apparatus. From the beginning of 1942 PVO Strany received increasing amounts of equipment of all types, particularly new fighter-interceptors, better air defense guns and machine guns, more sophisticated radars and other detection, surveillance, and director devices, and large numbers of troops. In April 1942, the Soviet State Defense Committee directed the establishment of the Moscow Air Defense Front and the Leningrad Air Defense Army. Shortly thereafter, a similar Air Defense Army was formed out of the assets of the Baku Air Defense Region. Concurrently, the command and staff organization of the PVO Strany itself underwent a rather extensive reorganization which gave its commander his own Military Council, Main Political Department, a staff structure of 14 sections, and six separate service components. The result was better mission and operational control over the large number of subordinate echelons which incorporated a mix of various arms and services.

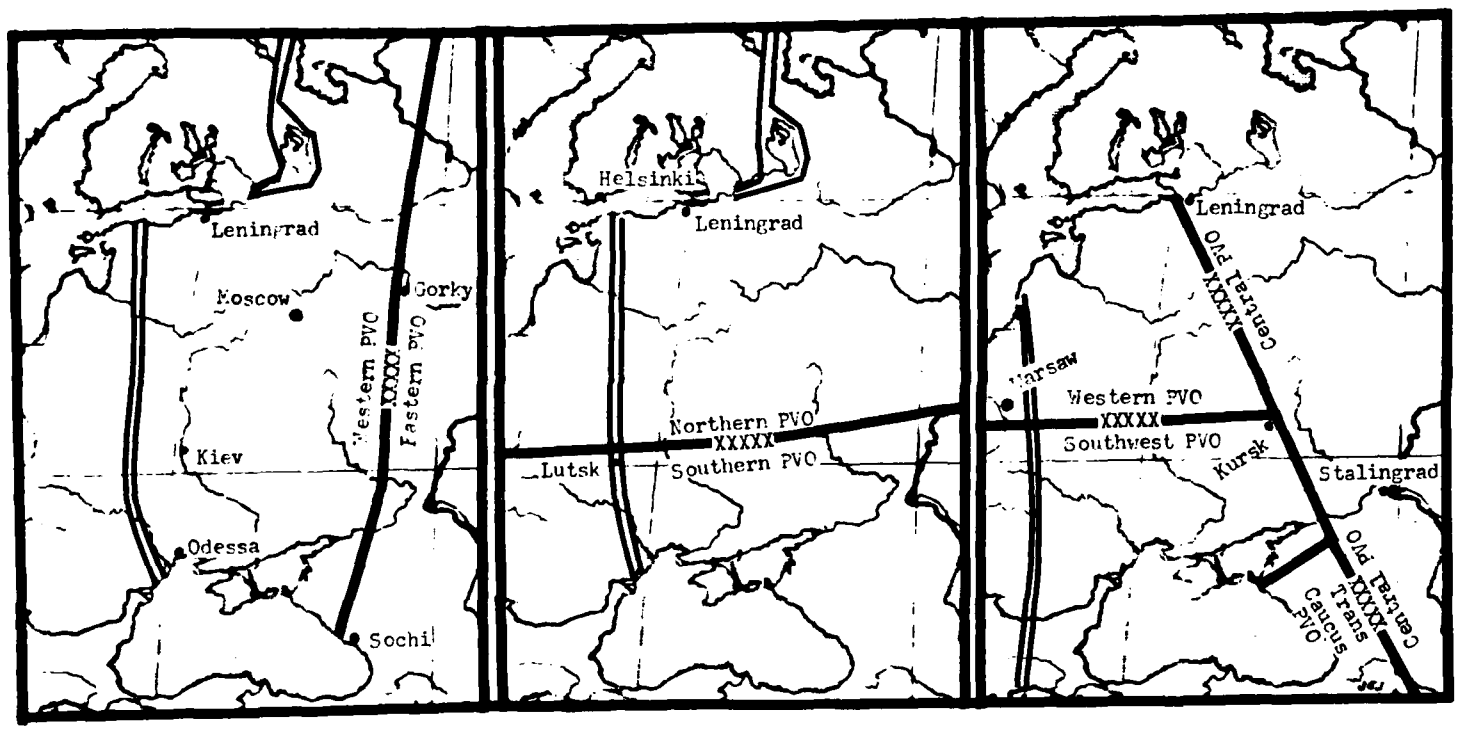
The year 1943 witnessed additional changes in the PVO Strany as the nature and character of the war changed and the Red Army assumed the offensive

in many areas. New corps and divisional air defense regions were formed to cover those areas that had been liberated by the Soviet advances. Additional PVO Strany areas of responsibility were established within the operational areas of the Central, Voronezh, Southwestern, and Southern Fronts to cover important railroad facilities-- points-- as their primary responsibility.

By now the CinC, PVO Strany, was directing more than 25 air defense regions and zones. Such an inordinate extension of the span of control in as complex an area of operations as air defense could not help but cause problems. Of primary concern were a lack of proper oversight of very deep target areas in the USSR and a concomitant failure to supervise the training of air defense troops in those regions.

To overcome these and other noted shortcomings, the State Defense Committee again reorganized PVO Strany in June 1943, this time dividing European Russia into two Air Defense Fronts, the Western and Eastern, separated by a north-south demarcation. (Figure 2-1A) The Moscow Air Defense Front was redesignated the Special Moscow Air Defense Army but was otherwise unchanged, except that all PVOIA assets in the Moscow region were formed into the First Air Army, composed of three aviation corps. In general terms the Western Air Defense Front included Moscow, Murmansk, and Yaroslavsk, while the Eastern Air Defense Front encompassed the northern and southern Urals, middle and lower Volga region, the Caucasus, and Transcaucasia.[5]

The more easterly Transbaikalian, Central Asian, and Far Eastern Air Defense Zones were again made subordinate to their respective military districts. The CinC, PVO Strany, had his Main Directorate and all his organs of control disbanded. Air defense operations were then placed under the direction of the CinC of Artillery, who controlled this additional mission through the CinC of Air Defense Troops in each PVO front. In effect PVO Strany ceased to exist as a separate entity for a time. Command and control of PVO Strany activities, however, were probably simplified by this move, as the two new subordinate front PVO headquarters could be more responsive to their more localized situations. This basic arrangement of high echelon control of air defense remained unchanged until the end of the war.



Until 15 April 1944
A

From 15 April 1944 to 31 December 1944
B

Beginning 1945
C

ORGANIZATION OF THE GROUND FOR AIR DEFENSE
WORLD WAR II

Figure 2-1

Before final victory was achieved, however, two more substantial reorganizations of air defense took place. As the Soviet-German lines continued to shift westward, the zone of responsibility of the Western Air Defense Front grew apace. At the same time, the Eastern Air Defense Front became more and more distant and detached from the seat of war, with only periodic German reconnaissance and bomber flights taking place over its airspace. The bulk of German airpower on the Russian Front was, of course, directed toward the combat zone that stretched roughly from Murmansk in the north to Solchi on the eastern coast of the Black Sea. Because of the fluid situation, the Western Air Defense Front was often called upon to control not only its own airspace but also that of the rear areas of the advancing combat fronts. When the situation was assessed in March and April 1944, it was apparent that additional changes were necessary.

The principal realignment that followed replaced the Western and Eastern Fronts with the Northern and Southern Air Defense Fronts, divided by a boundary running along an east-west axis. (See Figure 2-1B) Moscow fell in the Northern Air Defense Front area. Another change at this time entailed the creation of the Transcaucasian Air Defense Front, which encompassed the old Transcaucasian Air Defense Zone and the Baku Air Defense Army. The Northern and Southern Air Defense Fronts were not oriented perpendicular to the battle front and could, therefore, better utilize the Air Defense resources available to them. Yet this reorganization did not solve all of the problems.

For one thing, as the battle lines continued to move farther to the west and southwest with the advance of the Red Army, control of air defense operations became extremely complicated. Quite often, when air defense front units were shifted westward to maintain density of air defense cover over the most vulnerable operations area, they found themselves located with units of the PVO Voisk of the combat front that had not yet quit the position.

A last reorganization took place in December 1944, when the Northern and Southern Air Defense Fronts were respectively redesignated the Western and Southwestern Air Defense Fronts, and a Central Air Defense Front was

created which basically included the Moscow and Leningrad areas as their regions of primary concern. Assets for this purpose were drawn from the existing area resources and from the Western and Southwestern Air Defense Fronts, which were reduced in size and area of responsibility. In this configuration, Air Defense was organized so that a German aircraft flying eastward along a Berlin - Warsaw - Moscow axis in early 1945 would be first engaged by PVO Voisk elements of the First Belorussian Front, then the PVO Strany of the Western Air Defense Front, followed by the PVO Strany of the Central Front, and, finally, the PVO Strany of the Moscow region. This type organization remained in effect with only minor changes until the end of the war in Europe.[6] (See Figure 2-1C).

Weapons and Equipment

Weapons and Equipment of the PVO Strany

The basic weapons and equipment available to the Soviets for air defense were the same as were available to all combatants in the war on either side: fighter-interceptor aircraft, a variety of antiaircraft artillery weapons of various calibers, and a number of types of machine guns on antiaircraft mounts. Some of the pieces of ground ordnance were self-propelled or at least movable on their own carriages; others were not. The equipment available to support these active systems included all manner of detection devices, mostly sound detectors in the early part of the war, radars of varying degrees of sophistication, barrage balloons, fire directors, and various means of communication to link together all the other weapons and equipment. For the Soviets, possibly more than any other major combatant, their general equipment base was at best obsolescent at the outset.

Aircraft of the PVOIA

When the war began, Soviet air defense was equipped with the I-15, I-16, and I-153 fighter interceptors, all of which were classed as inferior in speed and maneuverability to the principal German bombers, attack-bombers and reconnaisance aircraft they would face. While newer

interceptors were finding their way into the inventory, such as the Yak-1, MiG-3 and LaGG-3, they were too few in number to create any real difference. Those that were on hand were often manned by inexperienced pilots who had not yet received sufficient transitional flying hours in the new machines. The number of new fighter-interceptors available to PVOIA increased dramatically during the first few months of the war, and still newer aircraft continued to enter the inventory up to the end of the fighting. An example of the flow of newer aircraft to the PVOIA is shown in Figure 2-2.

Figure 2-2

Change in Proportion Between Old and New Type Aircraft in Soviet PVOIA
(Expressed in Percentages of all Aircraft Available)

	End of 1941	May 1942	April 1943
Old Type			
I-15 I-16 I-153	59	38	24
New Type			
Yak 1 Yak 7 LaGG-3 MiG-3 La-3	41	62	76

To match these and other later Soviet and Allied aircraft found on the Russo-German front, the Luftwaffe used almost its entire inventory of types of bomber, fighter, fighter-bomber, and reconnaissance aircraft. Practically every type of German military aircraft saw service at some point in the war in the east. A comparison of Soviet and principal German aircraft is shown on Figure 2-3.

Figure 2-3

SOVIET - GERMAN AIRCRAFT
COMPARISON OF CHARACTERISTICS

Soviet Fighter-interceptors Used in PVOIA

Type	IOC	Speed(MPH)	Ceiling, in 1000 ft	Range (miles)	Weapons
I-16	1935	176	29.5	512	2x7.62mm
I-16B	1939	205	29.5	431	2x7.62mm 2x20mm
I-153	1939	143	32.8	434	4x7.62mm
LaGG-3	1940	365	31.5	435	2x7.62mm 1x12.7mm 1x20mm
MiG-3	1940	234	39.4	404	2x7.62mm 1x12.7mm
Yak-3	1940	365	32.8	531	2x7.62mm 1x20mm
Yak-7	1941	348	32.8	519	2x12.7mm 1x20mm
Yak-9	1944	348	32.8	625	2x12.7mm
La-5	1942	372	31.2	475	2x20mm
La-7	1944	405	31.7	616	2-3x20mm
Hurricane	British	330	36+	500+	12x.303 or 4x20mm
Spitfire	British	416	37+	660	Various
P39	US	300+	35	675	4x.50 1x37mm
P40	US	300+	33	610	6x.50

Selection of Typical German Aircraft Found on Russian Front

Type	Speed(MPH)	Ceiling, in 1000 ft	Range (miles)	Ord.Load (lbs)
Do17	224	22.90	990	1760
He 111H6	258	25.50	1760	5510
He 177A5/R2	303	26.25	3400	4964+
Hn 129	199	29.50	428	440
Ju 86K	202	22.30	1240	3204
Ju 86R	155	44.90	645	--
Ju 87B2	232	26.20	370	1540
Ju 88A1	286	30.10	1550	5510
Ju 188	310	31.00	1550	6614
FW 189	221	27.50	430	220
Potez 633	250+	26.20	810	1200

Sources: US, British & German statistics from Jane's,1945; Soviet statistics from Jane's, 1945, & various Soviet sources.

Antiaircraft Artillery (PVOZA)

The second major component of Soviet air defense was artillery designed to engage airborne targets as its primary role. At the beginning of the war the USSR had two medium caliber (Model 1931 and Model 1938 76.2mm and Model 1939 85mm) antiaircraft guns . Efforts were underway to replace the 76.2mm guns, which went out of production in 1940 to be replaced by the newer model 85mm, but this program was only 35% complete when the Germans attacked. By 1943 the changeover had been essentially completed. A total of 2,761 85mm's had been added in 1942, and 3,712 in 1943. Already, however, this model of the 85mm gun was outmoded because of its inadequate range and velocity. As a result, a new 85mm AA cannon (Model KS-1) that had better characteristics than its predecessor was introduced in 1944. In addition, this new model was designed to incorporate data supplied by various new fire control instruments, including a gunlaying radar that had also just entered the system. By 1945, a 100mm AA cannon had been developed, but it entered the inventory too late for combat use and would not be adopted as standard for a considerable period after the war.

The small caliber automatic antiaircraft cannon-type weapons included a Model 1940 25mm and a Model 1939 37mm gun. The latter was the more commonly used of the two. The principal employment of these guns was against low-flying and diving aircraft at altitudes up to 9,850 feet. The 37mm AA gun would remain in the inventory for years after the end of World War II. (Figure 2-4 describes the capabilities of these weapons.)

Antiaircraft Machine Guns

While the small and medium caliber antiaircraft guns were considered artillery weapons, the AAMG was not. The most common AAMG was the 12.7mm, which was originally designed as an antitank/antiaircraft weapon. Its effectiveness as an antitank weapon was quickly overtaken by the appearance of bigger and better armored German tanks. Thereafter, it remained as a moderately effective AAMG used primarily against low-flying aircraft. Some 7.62mm machine guns were also used as antiaircraft weapons.

Fire Control Equipment

Various fire control and direction equipment found its way into the AD inventory as the war progressed. Of major importance was the incorporation

Figure 2-4

Characteristics of Principal Soviet Antiaircraft Weapons in World War II

Gun	Model	Muzzle Velocity Ft/Sec	Maximum Effective Ranges (ft)		Rate of Fire RDS/MIN
			Vertical	Horizontal	
Medium (SZA)					
	1938	2,667	30,183	44,619	15-20
85mm (KS-12)	1939	2,625	34,776	49,212	15-20
85mm (KS-1)	1944	2,903	40,682	56,757	15-20
Small(MZA)					
25mm	1940	2,950	14,760	19,685	240-250
37mm	1939	2,885	19,685	26,246	160-180
Machine Guns(ZPU)					
12.7mm	1938	2,850	3,000	9,900	300-350

of a radical-scan radar that gave constant surveillance of an area within an 80-mile radius.

Air Warning Service (VNOS)

On the eve of war the VNOS was based primarily on visual observation posts established in belts around the covered area. A small number (34) of primitive radars were available, but these were generally ineffective; only six could do more than identify the entrance of an intruder into the surveillance zone. Within six months after the German attack a number of more sophisticated radars had made their appearance and were used primarily in the defense of Moscow and Leningrad.

A new grid system to pinpoint the location of intruder aircraft overcame an initial weakness by eliminating redundant information. A number of sound detectors were also incorporated into the air defense system. In these devices three acoustical resonators were arranged so as to give both direction and height ranging data. Eventually, the Soviets developed a system of early warning radar coupled with visual observation and sound detection and identification that was used thereafter to the end of the war.

Searchlights and Balloons

The types and numbers of barrage balloons and searchlights employed by PVO also increased. At the end of 1943 a new, highly effective, remote controlled searchlight installation was introduced that incorporated a number of advanced principles and allowed a radio-ranging interface with a 20-25 km. target detection range and a precision bearing range of 12-14 kms. Illumination of the target was quite often accomplished on first light-up.

Barrage balloon equipment was also upgraded to improve its aerodynamic qualities. This passive system was used extensively in static situations around targets vulnerable to low level attack.

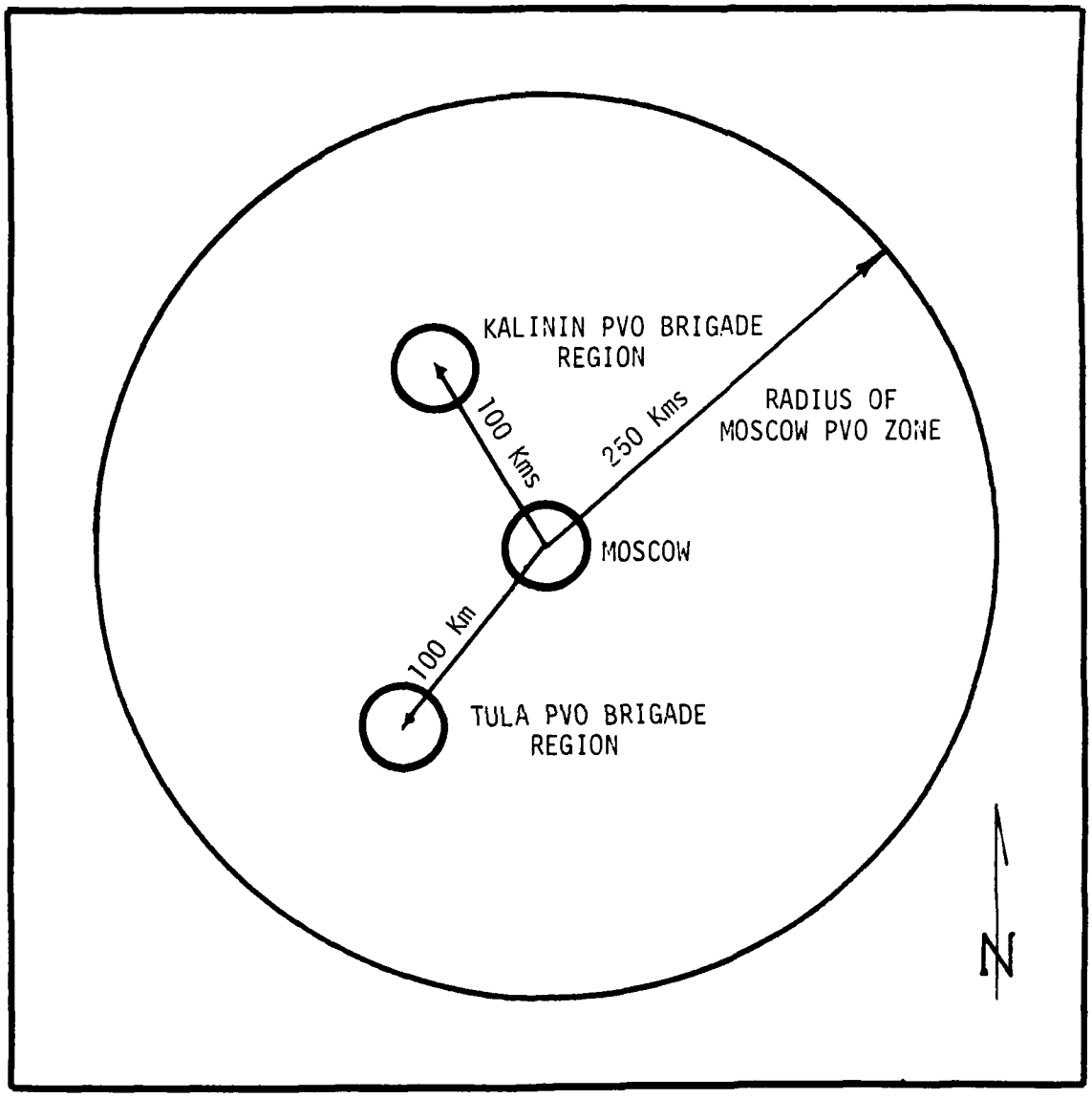
Tactics and Equipment

With the equipment described above, the Red Army conducted its air defense operations. The basic concept of employment was the massing of various mixes of PVO forces to oppose German air operations within the

Soviet air space. The factors of types of targets to be engaged, time, and distance (or space) were used in determining the mix of air defense means. Counter-airdrome operations were carried out by PVOIA units against advanced German Luftwaffe installations, but these missions were almost always against targets in occupied territory and did not entail deep penetration beyond Soviet borders. In fundamental terms, Soviet air defense was organized into two separate yet often integrated elements: the PVO Strany or "Air Defense of the Country" and PVO Voisk or "Air Defense of the Troops." To understand the differences and similarities between the two better, a discussion of the employment of each in two separate engagements is appropriate, as a means of analyzing their tactics and equipment utilization.

PVO Strany - The Air Defense of Moscow

The Moscow Air Defense System on 22 June 1941 was organized as shown on Figures 2-5 through 2-7. The organization of the ground air defense around Moscow itself is shown on Figure 2-5. Although the air defense around Moscow was established in a circular fashion for all-round defense out to a distance of 250 kms., the knowledge that the principal avenues of approach into the city would be from the south and the west called for heavier concentrations of air defense means in those regions. To answer this requirement the Tula and Kalinin PVO Strany Brigade Regions were established. As it worked out, this was the correct decision, as German Ju-87 (Stuka) activity proved to be heaviest over these two areas.[7]



SCHEMATIC OF MOSCOW
AIR DEFENSE ZONE

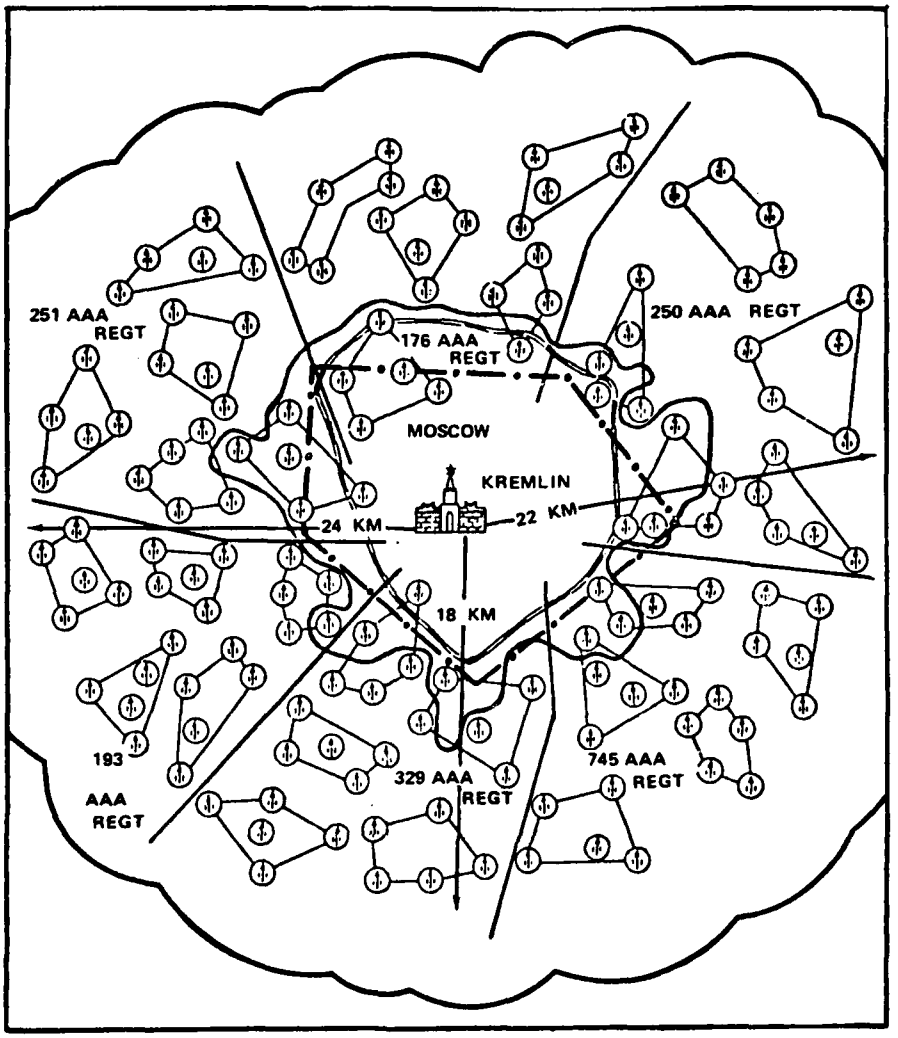
Figure 2-5

Aviation units of PVOIA were positioned around the city inside a radius of 100-200kms. These units were subsequently moved outward to a radius of from 180-360 kms., but, in carrying out this redeployment, those units located to the northeast and east of the city were taken out of effective support range.

After the first air raid on Moscow on 22 July 1941 (there had been some 90 reconnaissance flights over the city since 1 July), the number of fighter-interceptor regiments in the VI Aviation Corps (PVOIA) was increased to 29. By December 1941, only 20% of the aircraft in the VI Aviation Corps were older vintage I-16's and I-153's.

The antiaircraft artillery defense of Moscow proper was organized in six sectors, each with one medium caliber antiaircraft regiment assigned from the I Antiaircraft Artillery Corps (PVOZA) (See Figure 2-6) Some 69% of all guns in these regiments at the outset were Model 1939 85mm. Of the small caliber AAA and AAMG units, about 60% were used to protect the Kremlin, railroad stations, power plants, and other key installations of the city. The remainder of the small caliber AAA and AAMG units were assigned to the defense of PVOIA airfields of the Moscow PVO Zone, and to defense of medium caliber AAA positions, searchlight positions, the locks of the Moscow-Volga Canal, and other key installations outside the city proper. Depending on the size and importance of these installations, one to three batteries of small caliber AAA and one or two platoons of AAMG would be assigned. Within the city and around key installations anywhere in the zone, small caliber AAA and AAMG's were usually positioned on rooftops to maximize their fields of fire. The troop organization of the force involved in the air defense of Moscow was as shown in Figure 2-7.

By June 1942, the number of medium caliber AAA regiments had increased to 13, with an approximate total number of guns around 1,300, 85% of which were Model 1939 85mm's with PUAZO-3 director equipment. Eighteen type SON-2 gun-laying radars were added to the city's defenses during that summer. Even though numerous organizational changes in the Moscow Air Defense Zone and in PVO in general took place during the war, the basic organization of the ground remained the same throughout the war. By war's end, the city was defended by 1,439 medium AA guns, 600 small



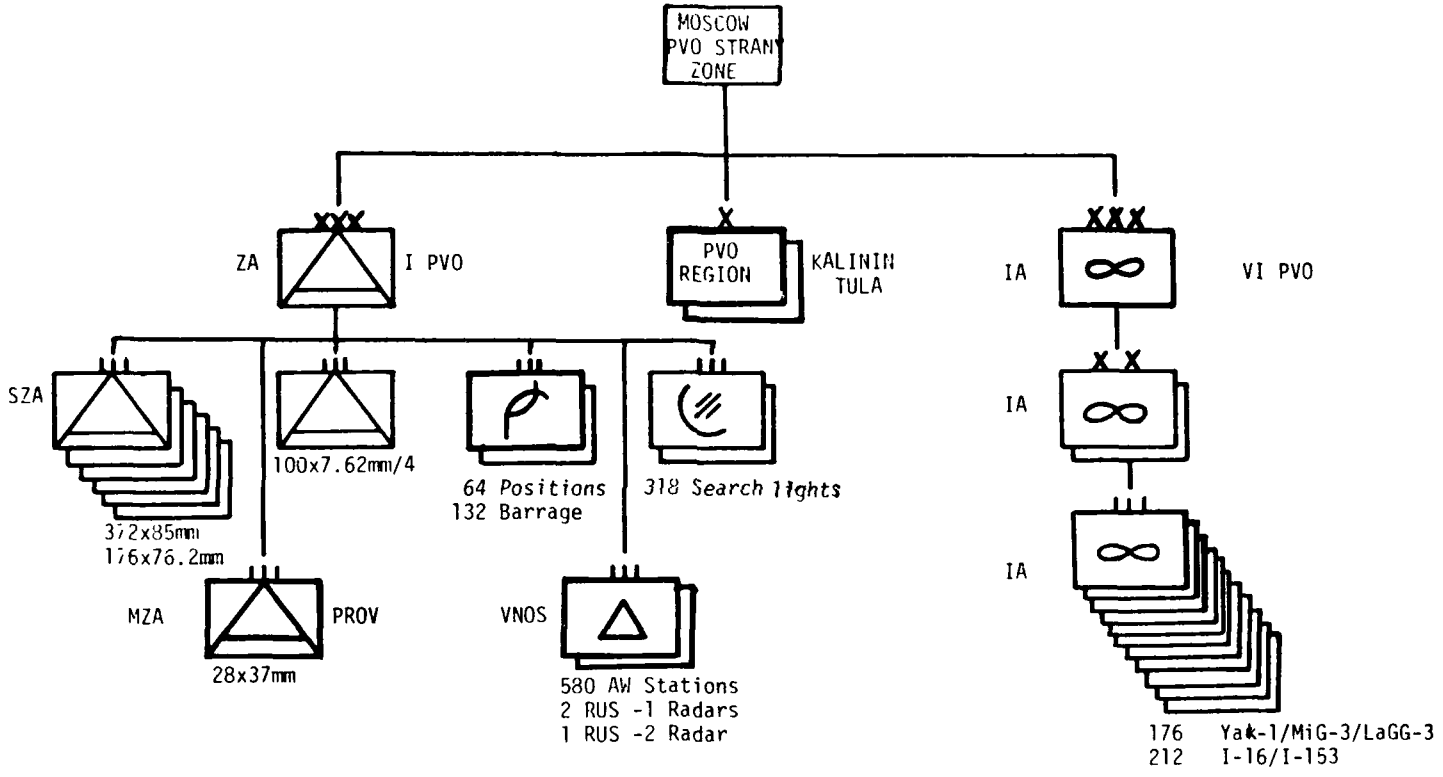
SYMBOLS

- BATTERY FIRING POSITIONS
- BOUNDARIES OF MOSCOW
- DEFENDED AREA
- BOUNDARY OF AAA FIRING ZONE

ORGANIZATION OF MEDIUM CALIBER ANTIAIRCRAFT ARTILLERY
OF PVO MOSCOW ZONE ON 22 JUNE 1941

Figure 2-6

Source: Batitski, Voyska Protivovozdushnoy Obornoy Strany, p. 31.



PVO - STRANY MOSCOW
AIR DEFENSE ZONE

21 JUNE 1941

Figure 2-7

Sources: Data compiled from numerous Soviet sources.

AA guns, 632 AAMG's, and 35 gun-laying radars. At the time of the first raid (22 July), 124 barrage balloons were in place. By December of that first year of the war that number had been increased to 303, and the number continued to grow until the end of hostilities.

Passive defense measures were also employed in and around Moscow. Strict blackouts were enforced, along with dispersal of essential operations to the tunnels of the Moscow subway system; civilian bomb shelters and camouflage were used extensively; non-essential government and civilian personnel were evacuated from the city by the thousands.

Late in July 1941, the Germans' program of air bombardment of Moscow was in full swing. Air raids were almost a daily occurrence. Most of the raids during this period took place at night. About 1,700 bomber sorties aimed at Moscow took place during July and August alone, although the overall success of this phase of the German operation cannot be accurately gauged. Soviet sources claim that less than 5% of the German aircraft ever reached the outskirts of the city. This would equate to about 85 sorties actually penetrating the city's airspace in these two months, fewer than two per day. Shtemenko commented that "the bombing of Moscow grew in intensity. Alerts were sounded nearly every night. Sometimes bombs fell quite close to the General Staff. The shelter in the basement, though quite unsuitable, now had to be used for work as well." This seems to indicate more than 85 sorties took place. After a time, Shtemenko goes on, the General Staff operated from the Belorusskaya subway station.[8]

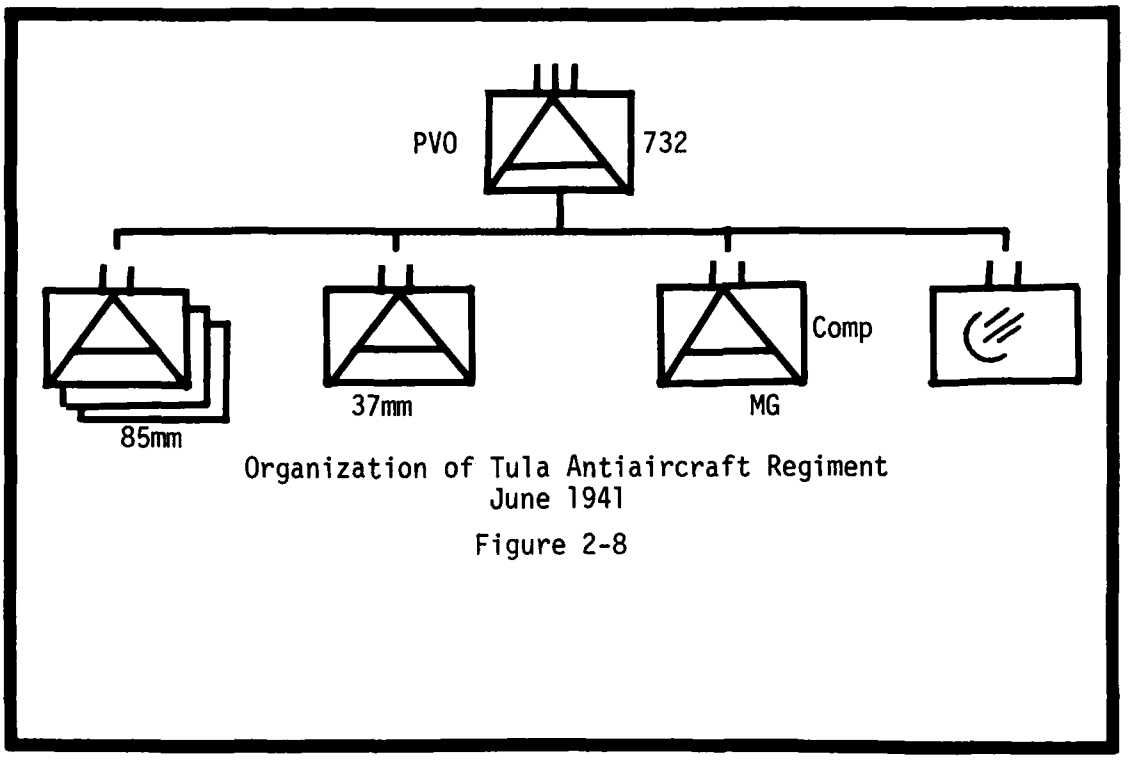
By October, daylight attacks were incorporated into the bombing program as a part of fulfilling Hitler's demand that Moscow be taken before winter set in. In that month alone, 31 raids took place, each of 15-30 aircraft. Each of these raids lasted from 5 to 8 hours. As German columns closed on Moscow, PVO Strany units became more and more involved in direct fire antitank roles as well as in air defense. It is difficult to determine exactly the ratio of employment, that is, numbers of guns or units, proportions of time, rules of engagement, etc., involved in this period. Common sense would dictate that the immediate threat of being overrun by ground elements would demand the first priority for antitank use, but how this affected the air defense role is hard to determine. What can be said is that the number of German air raids against Moscow diminished and

ceased completely, except for occasional reconnaissance flights, after April 1942. Here, of course, one cannot credit the efforts of Moscow PVO Strany alone. German air resources in general were becoming extremely limited during this period, according to Plocher, and necessitated the allocation of most available aircraft to ground support missions rather than carrying out the Moscow bombing program.[9] After April 1942, therefore, the PVOIA of PVO Strany Moscow conducted over 90% of its activities in support of ground operations in the Northwest, Kalinin, Western, and Bryansk Front areas. Still the Soviets claim to have shot down about 300 German aircraft during the year.

Another example of the employment of air defense means in an antitank role may be seen in the operations of the Tula Air Defense Brigade Region of the Moscow PVO Zone. The air defense of Tula was vested in the 732d PVO AA Regiment. This composite regiment was equipped with weapons of various calibers and other mixed equipment. The organization of this regiment is shown in Figure 2-8, while the organization of the ground around Tula is shown in Figure 2-9.

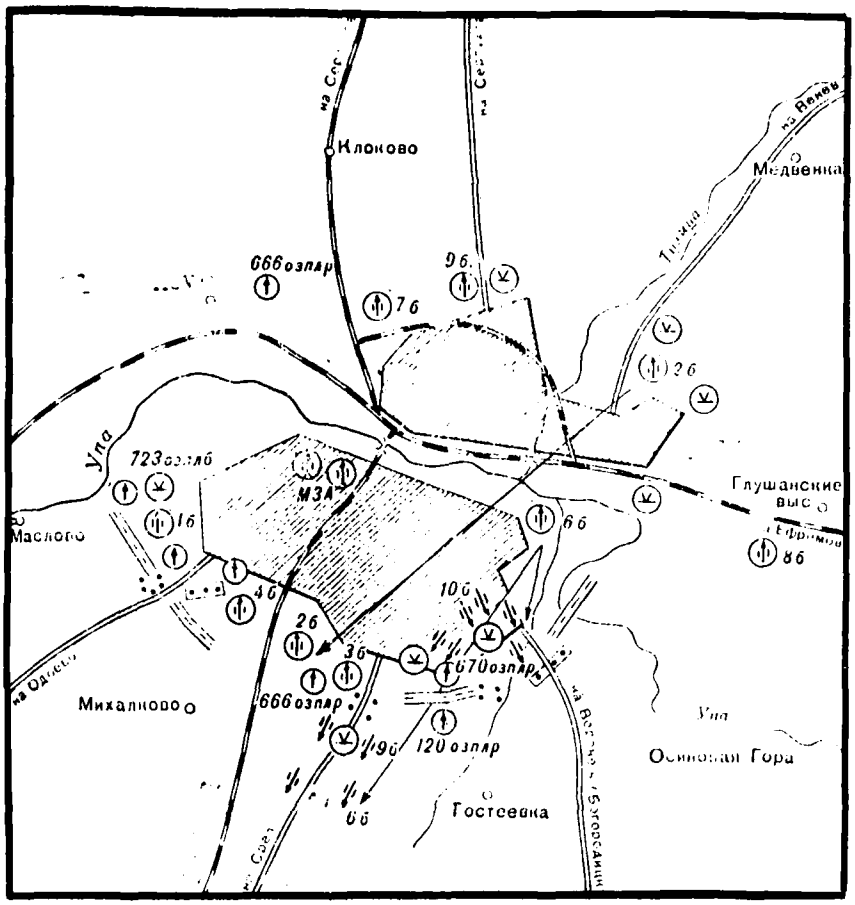
Tula air defense engaged German aircraft on their way to Moscow while, at the same time, covering the important factory complex in its own city. Tula was obviously chosen as a "point," although there is no reference to this selection in the available literature. Tula was noted as an arms manufacturing city before the war. Once the air routes to Moscow used by the Germans were discerned, the Soviets shifted their guns (at night to prevent detection) to attain better coverage. Thereafter, at least in this region, several antiaircraft batteries were designated as "roving" or "hunter batteries," which maneuvered to keep abreast of German air routes.

By 3 October 1941, German ground troops of Army Group Center broke through to Orel, thereby posing a direct threat to the Tula region. The main Soviet combat elements facing the Germans had all but disintegrated. A freshly arrived Red Army force thrown into the gap, the Soviets claim, stopped the German advance for two weeks. The Germans claim, of course, that the hiatus was caused by orders from the High Command. Regardless of this pettifoggery, the respite allowed Tula time to prepare itself



Organization of Tula Antiaircraft Regiment
June 1941

Figure 2-8



RECAP:

Med. AA Posns:	8
Sm. AA Posns:	2
AAMG Posns:	7
Searchlight Posns	8

(Shows no correlation to probable unit or guns breakdown, except if typical understrength condition is acknowledged).

Organization of Antiaircraft and Antitank Defenses of 732d Antiaircraft Regiment - October-November 1941

Figure 2-9

for a ground attack. Positions were strengthened by elements of the Tula PVO Brigade which were given the primary mission of antitank defense. Fighting what amounted to a delaying action, the defenders of Tula held long enough for reinforcements to arrive. Tula held, and the southern approach to Moscow was closed to the Germans by 1 November. On 23 October, the first day of the attack, units employed in the antitank role claimed, according to Soviet sources, 26 of the total of 32 German tanks destroyed. During the action searchlights were used for battlefield illumination at night in what was, for the Soviets at Tula, a great innovation.

This first round of attacks did not mark the end of the action around Tula. By early December the town was literally surrounded. The main road to Moscow was cut, and Guderian, the German commander, announced he would take Tula for his winter quarters. This was not to be, however, and the opening of a Soviet offensive on 8 December 1941 brought a change in the situation. When the offensive began, the artillery commander of the Fiftieth Army, the Soviet ground force unit carrying out the offensive operation around Tula, took operational control of ten batteries of the 732d PVO Antiaircraft Regiment. These batteries were put under the operational control of the various elements of the army. Whether this was done to reinforce organic AA/AT elements within the army or to replace lost AA/AT elements is not known. Nor will the Soviets acknowledge the point. In general terms, the attached air defense elements participated in artillery preparations and in direct fire support against massed German troops, and against point targets such as tanks and other equipment and field fortifications. In the battle the Soviets claim their air defense elements destroyed 49 tanks, 15 artillery and mortar batteries (pieces ?), and 2,000 enemy troops, along with a great deal of other equipment.[10]

Even though German air activity over the Moscow Air Defense Zone virtually ceased after April 1942, the operations of the zone did not. As the air defense picture changed, so did the structure of Moscow's air defense.

A recapitulation of creditable available data on air defense effectiveness regarding the PVO Moscow Strany is as shown in Figure 2-10. This recapitulation tells about as much as can be justified, but even here some difficulties arise. It is not known, for instance, if the numbers include claimed kills in the Tula and Kalinin Air Defense Regions. For purposes of statistical computation it is assumed they do. This data gives only an overall picture of Soviet success and failure in air defense operations in one area. Attempting to correlate data of the entire Russo-German campaign appears nearly hopeless because of the disparate nature of those statistical items that are presented. Some bits of this information do take on significance when applied to specific correlations.

- It should be noted, for example, that German air activity virtually ceased after April 1942. Hence, rather than covering a period of almost four years of activity, the period of high intensity of enemy air activity actually covers about a ten month period.

- As Moscow was the objective of the central German thrust into the USSR under Plan BARBAROSSA and therefore became the target of both ground and air attack in 1941, it is not unexpected that portions of the resources of the Moscow PVO organization should have been employed in non-traditional roles, such as attacks on enemy aerodromes. In many respects, this is a quite important aspect of this study, as it tends to reinforce the notion that the Soviets developed after World War II that attacking the enemy's air assets "on the ground" prevents him from attacking you from the air. During the wartime period the Moscow PVOIA claimed 620 German aircraft destroyed in the air and an additional 60 destroyed on the ground. This accounts for 57.6% of the total of 1,076 aircraft shot down and for 75% of the enemy aircraft destroyed on the ground.

Figure 2-10

PVO Strany Moscow Claims of Enemy Aircraft Destroyed
June 1941 -- 1945
As Against 12,100 Sorties Flown

	PVOIA			PVOZA			VNOS (Air warning)			Barrage Battalions			Total PVO-Strany
	Number	% of Total	% per sortie	Number	% of Total	% per sortie	Number	% of Total	% per sortie	Number	% of Total	% per sortie	
Aircraft Destroyed	1,076	82.4	8.89	216	16.6	1.78	6	0.4	0.049	7	0.5	0.057	1,305
In Zone	738	56.55	6.09	216	16.55	1.78	6	0.4	0.049	7	0.5	0.057	967
By AAA	--	--	--	180	13.79	1.48	--	--	--	--	--	--	180
By AAMG	--	--	--	36	2.75	0.29	--	--	--	--	--	--	36
By small arms	--	--	--	--	--	--	6	0.4	0.049	--	--	--	6
By other means	--	--	--	--	--	--	--	--	--	7	0.5	0.057	7
Outside Zone by PVO-Strany Moscow	567	43.44	--	--	--	--	--	--	--	--	--	--	567
In ground support	483	37.01	--	--	--	--	--	--	--	--	--	--	483
On German airfields	84	6.43	--	--	--	--	--	--	--	--	--	--	84
Air-to-air	992	76.01	--	--	--	--	--	--	--	--	--	--	992

- Of similar interest is the fact that PVOIA claimed the destruction of the following:

1941	1942
311 tanks	100 tanks
3,000 cars and trucks	1,800 cars and trucks
58 armored cars	800 trucks w/cargo
16 oil storage tanks	30 pieces of artillery
650 trucks w/cargo	60 railroad cars
50 artillery batteries (pieces?)	12 ammunition dumps
175 AAMG locations	7 fuel dumps

- One claim made is that up to 90% of all PVOIA Moscow flights were made in support of the Northwestern, Kalinin, Western and Bryansk Fronts, in other words, in ground support rather than air defense roles. Yet, at no time during the initial phases of the war did the Germans lack air superiority.

Another important point is that the highest intensity of German air activity around Moscow came when the Soviets were least prepared for it. In 1941, for instance, the lack of accurate fire direction and target acquisition capability required the PVOZA to engage enemy aircraft with barrage fire. This was especially true at night, when the Germans would simply fly above or around searchlights, and in cloudy weather. Of the 741,000 rounds of medium caliber ammunition fired in 1941, 715,000 were expended in this way. Only 11 enemy aircraft were shot down in this fashion. This equates to 65,000 rounds per kill. During the same period 536 individual targets were engaged with fire directed by PUAZO fire direction equipment. For an expenditure of 25,700 rounds of directed fire of medium caliber antiaircraft artillery, the Soviets claim 82 aircraft destroyed for a shot-kill ratio of 313:1. (An interesting comparison is found in the German claim that the best their antiaircraft could do against Allied bombers was 16,000:1 with the 88mm gun Model 1936 and 8,500:1 with the 88mm gun Model 1941.)[11]

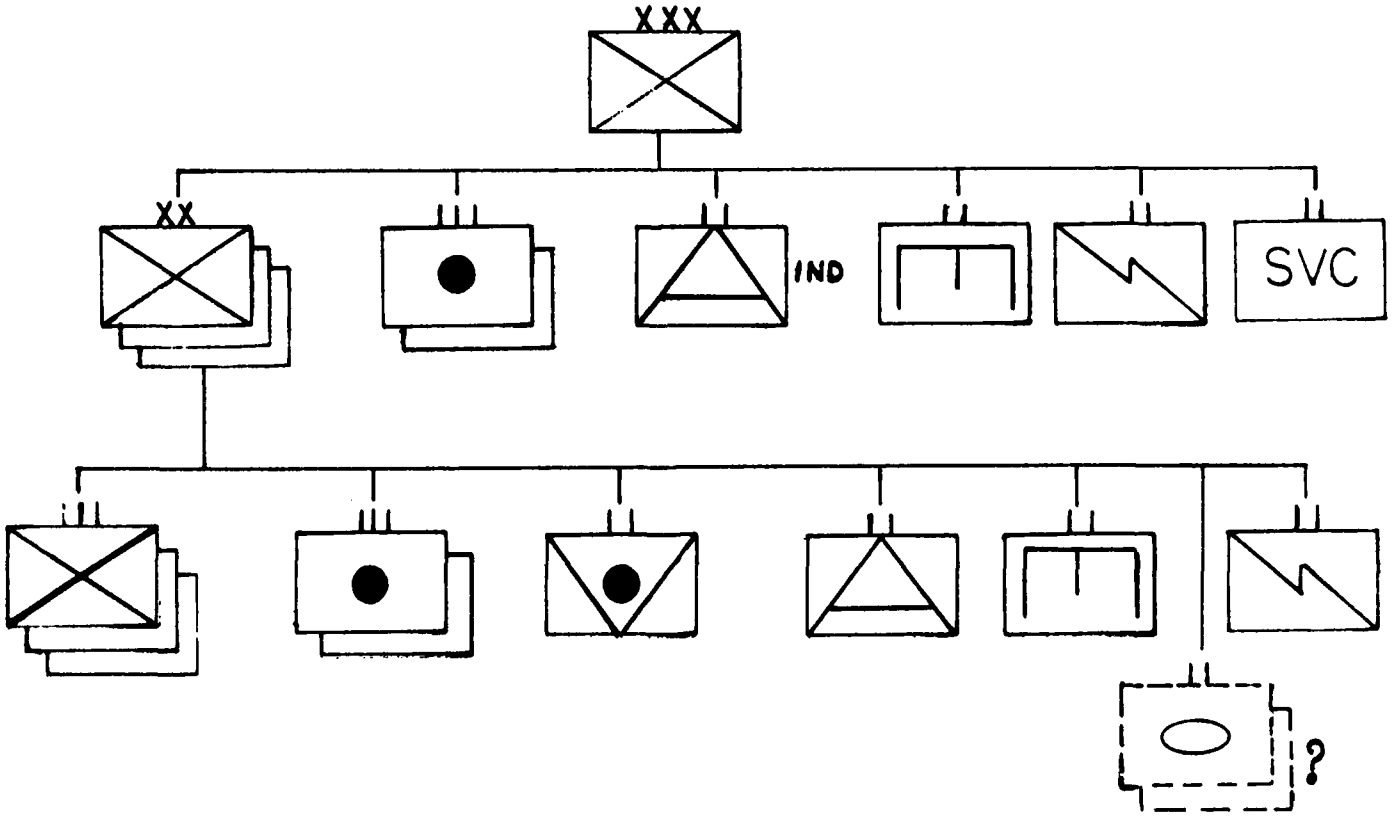
The PVO Voisk

Tracing the history of those air defense units assigned to field formations of the Red Army is somewhat more difficult than with the PVO Strany. Prior to World War II the Soviets were most secretive about their army organizational structure. Some information became available during the war years, but not much. The war with Finland uncovered many weaknesses in the Red Army, and the tasks facing the Soviets at its completion were reorganization, an overhaul of all levels of training, re-equipment of all echelons and types of forces, and redeployment of these newly established forces based on the changed frontiers. In general terms, the reorganization of the Red Army centered on the rifle corps and what would be the reconstituted mechanized corps. These changes presented a type-organizational structure as shown in Figures 2-11 and 2-12: [12]

Figure 2-11

Type Soviet Rifle Corps

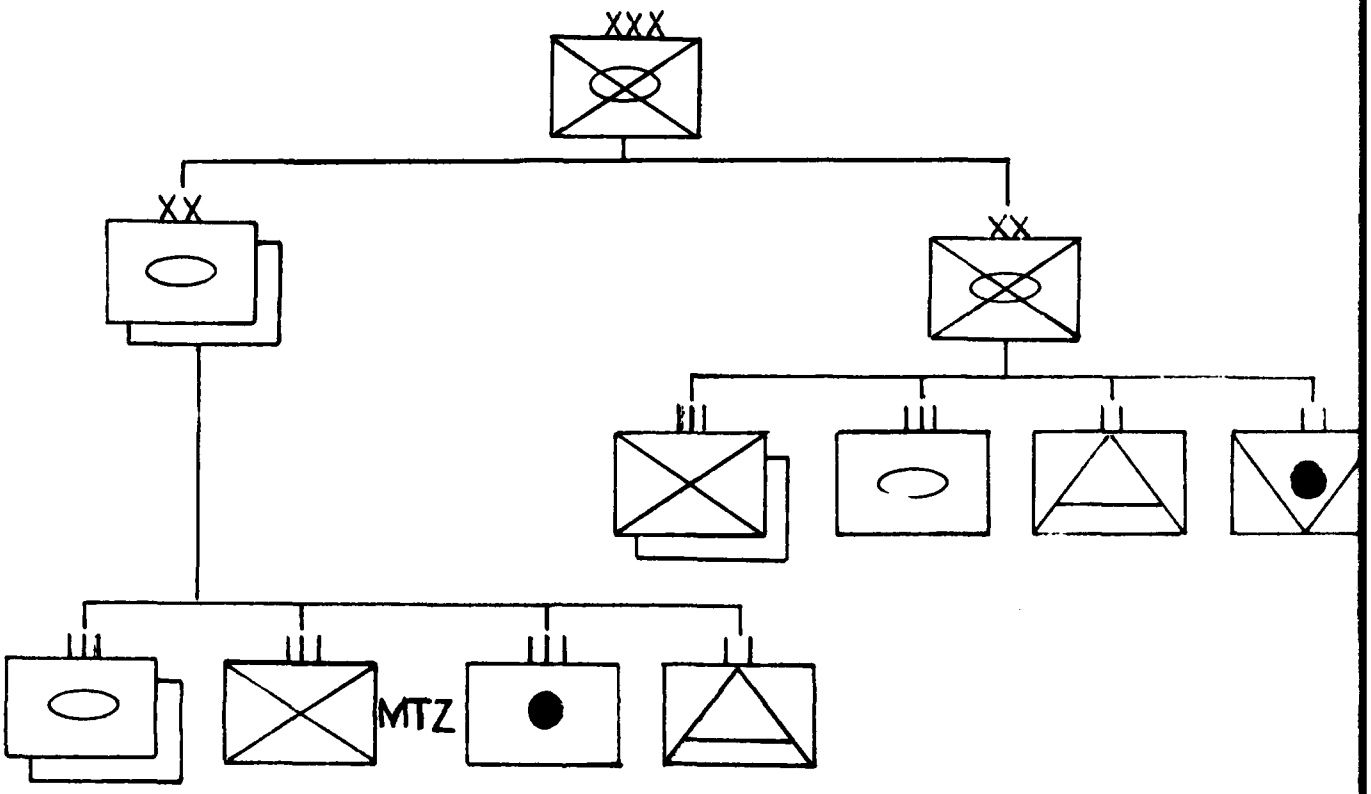
c.1941



All artillery, including AAA was horse-drawn.

Figure 2-12

Type Mechanized Corps
c.1941



N.B. It is presumed that the mechanized corps contained approximately the same combat service support units as were found in the rifle corps.

There were also a small number of tank corps in existence when the war started, which presumably contained some air defense units. These units were completely destroyed in the first phase of the German invasion and did not reappear until the fall of 1942. Soon thereafter the reconstituted tank corps were joined with the mechanized corps (as shown above) and formed into tank armies (later redesignated mechanized armies).

The typical antiaircraft battalion in all formations consisted of eight x 37 mm and four x76.2mm antiaircraft cannon. It is most likely that AAMGs were also found throughout the organizations, but there is no evidence to support this. Neither is there information as to what percentage of the 76.2mm antiaircraft had been replaced with 85mm antiaircraft by the start of the war.

The wartime period saw numerous reorganizations of the Red Army, and it may be presumed that each of these changes also witnessed some reorganization of the air defense means available.

At the time of the Battle of Stalingrad, (July 1942-2 February 1943) for instance, AA divisions and AA regiments were known to exist. In the second phase of that battle, Soviet sources indicate the availability of the following air defense units:[13]

Figure 2-13

AAA Distribution at Stalingrad
c.Nov. 1942

Fronts	AA Divs	AA Regt	Sep AA Med Bns	AA in Units		Nos. of Guns		
				Med Bns	Med Btry	Med	Sm	AAMS
Southwestern	2	12	6	1	10	64	312	505
Don	2	1	5	-	7	50	149	200
Stalingrad	1	7	-	3	14	-	132	202
Totals	5	20	11	4	31	114	593	907

The Southwestern Front was created from elements of the Don Front and the Sixty-third and Twenty-first Armies. The organization was given nine PVO army regiments and two separate medium AA battalions. In addition the Reserve of the Supreme Command had attached two AA divisions (the 1st and 3d), three PVO army regiments, and four separate medium AA battalions.

In the Twenty-first Army air defense was organized in two groups. The first group had two medium AA regiments from the 1st AA Division and two small AA battalions. The second group consisted of two medium AA regiments from the 1st AA Division, four PVO army regiments and two small AA battalions of the Reserve of the Supreme Command. A mobile combined army of one cavalry and one tank corps was covered by two regiments of the 1st AA Division. The regularly assigned AA battalion plus one small AA battery was all that was assigned to the tank corps. The 1st AA division was so split up that the rest of the AA units in the division had no transportation and were therefore wasted in the ensuing battle.[14]

The Fifth Tank Army also participated in the Battle of Stalingrad. This army had an AA Group made up of the 3d AA Division, 5 army PVO regiments, and two separate medium AA battalions. Within the tank army, the air defense means were divided in a similar fashion to that described for the Twenty-first Army above.[15]

While this is far from a complete picture of the organization of air defense means at Stalingrad there are several points that can be made from this data:

- AA divisions had been formed by this time. These divisions contained at least four AA regiments of medium caliber AAA. The division had insufficient organic transportation.
- Each AA regiment was composed of three AA batteries and two AAMG companies.

Soviet sources claim that the Germans carried out 10,000 sorties over the Stalingrad area between 19 November 1942 (the date of the opening of the Soviet counteroffensive) and 2 February 1943 (the day v. Paulus surrendered). Of this number 740 aircraft were shot down - 36.9% or 273 aircraft by AA fire and 63.1% or 467 by PVOIA. The overall sortie kill percentage is 7.4%. There is no information available on ammunition expenditure rates.

By the beginning of the Third Period of the Russo-German Campaign (about the time of the Battle of Kursk) each rifle corps had one AA division. By the 1944-1945 period the PVO Voisk of the First Belorussian Front has 22 AA divisions of the Reserve of the Supreme Command, in addition to 13 organic AA divisions, 29 AA regiments and 8 separate battalions. At the time of the advance to the Oder, 7 PVO Strany regiments, 7 PVO Strany independent AA battalions and one PVO Strany AAMG regiment (a total of 484 AAA & 141 AAMG) were with this front. This constituted a total of about 80 regiments and separate battalions of AAA, of which 29 regiments (36%) were in direct support of the advancing troop units and the remainder in coverage of rear area targets of enemy air attack. There is no data available about PVOIA although there is certain knowledge of its employment.

Soviet Air Defense in the Manchurian Campaign Against the Japanese Kwantung Army

Each front in the Far East was equipped with three PVOIA divisions and varying numbers of PVOZA corps and regiments. Armored trains were fitted out with mounted AA guns. All forward elements had mobile AA, and other air defense units were deployed in the rear to protect against air strikes and possible airborne landings. The lack of any real Japanese air capability limited primary role employment of Soviet air defense, and most of its effort during the campaign was in ground support roles and as fighter-escorts. Little data is therefore available that is of any benefit to this study.

CHAPTER II

Notes

1 Generalleutnant Hermann Plocher, The German Air Force Versus Russia, 1942, USAF Historical Studies: No. 154 (June 1966), p. 12. Plocher indicates 1,917 aircraft operational on 28 June 1941, which was 64.2% of the actual strength as of that date. Soviet sources claim to have shot down 1,200 German aircraft in the first 24 hours of the war. See for instance MG A. I. Dzhordzhadze and C. F. Shesterin, "The Lessons of and Improving Air Defenses," PVO Herald, (Jan. 1972), p. 33.

2 Cf. Plocher, p. 4. Based on OKL, Fuehrungsstab Ic. g. Kdos. Lageberichten Nr. 652-660, June 1941.

3 Preparation for and Unleashing of the War by Imperialist Powers. Vol. 1 of 6 vols. in History of the Great Patriotic War of the Soviet Union, 1941-1945 (Moscow: Military Publishing House, 1960), p. 605. Translated and distributed by DA-OCMH.

4 Comment: It must also be remembered that the Red Army suffered, as did all facets of Soviet society, from the results of the Great Purges of 1937-1938 and the drastic measures taken following the Finnish War of 1939-1940. These events had literally stripped the military of its competent leadership. Those leaders that did remain were either ineffective or as yet untrained in the manifest requirements of high command. In such an environment mistakes and shortcomings were bound to occur. Such ineffectiveness cannot be counted on in the future unless a similar environment is developed in advance.

5 Vestnik Protivovozdushnoi Oborony, No. 3 (1975), 75; No. 1 (1977), 143.

6 Although there were some organizational variations involved in the Air Defense support of the Soviet campaign against the Japanese Kwantung Army in Manchuria, they were predicated more on the distance from the main directorates in Moscow than on any tactical or doctrinal rationales.

7 P.F. Batitski, Voiska Protivovozdushnoi Oborony Strany (Moscow: Military Publishing House, 1968), pp. 103ff.

8 General of the Army S.M. Shtemenko, The Soviet General Staff at War 1941-1945 (Moscow: Progress Publishers, 1975), p. 39. In English translation.

9 Plocher, p. 13.

[10] Reserve Colonel G. Dubinin, "Air Defense Antiaircraft Artillerymen at the Defense of Tula," Vestnik Protivovozdushnoy Oborony, No. 4 (1977), 61-64.

[11] General der Flakartillerie Otto W. von Renz, Deutsche Flugabwehr im 20. Jahrhundert (Frankfurt: 1960), p. 103. Renz states that better kill ratios were developed with larger caliber AAA - 105mm M1939 6K:1; 128mm M1940 3K:1. The "88" Flak had a maximum effective vertical ceiling of 34,770 feet, which compares almost exactly to that of the Soviet 85mm M1939.

[12] John Erickson, The Soviet High Command (London; Macmillan, 1962), pp.568, 571.

[13] Colonel General P. Levchenko, "PVO Sukhoputnykh voisk v nastupatel'hykh Operatatsiyakh vtorogo i tret'ego periodov voiny," Voenno-istoricheskiy Zhurnal, No. 3 (1976), 32-38.

[14] Levchenko, 33-34.

[15] Ibid.

CHAPTER III

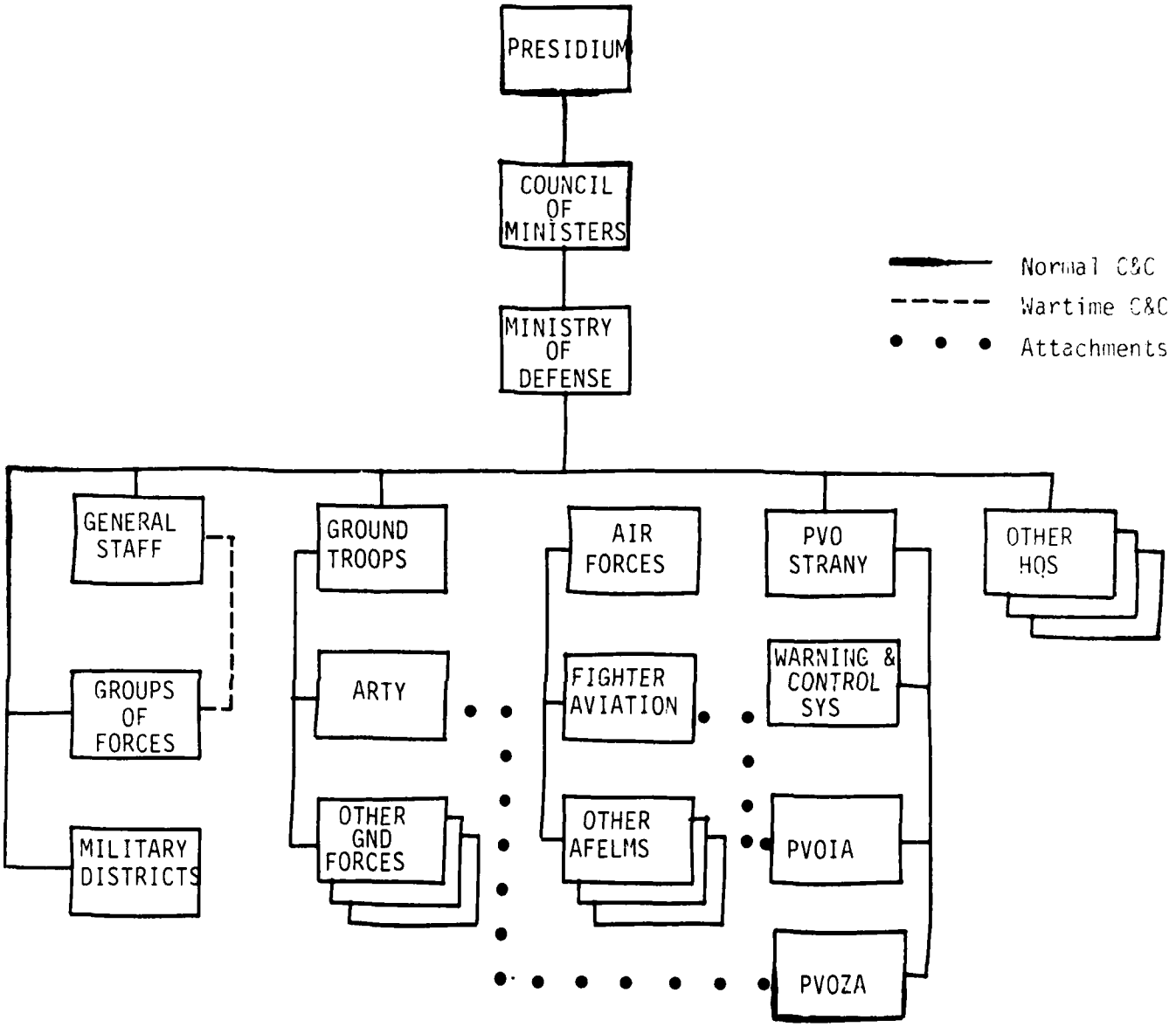
THE IMMEDIATE POST-WORLD WAR II PERIOD

Reorganization and Growth

Following the victory over the Axis Powers in 1945, the Soviet Union perceived what, to them, may have been an even more dangerous threat from the West than the Germans had posed. The economic and political rehabilitation of Europe, led by the United States, and the foundation of NATO, plus the technological advantages in Western hands, constituted, for Stalin, the threat of a surprise attack launched from Europe or the United States. To answer this threat, the USSR began immediate efforts to strengthen even further its already awesome ground offensive capability and to improve its air defenses as means of protecting the homeland. During the 1946-1947 period, the newly designated "Soviet Army" underwent a contraction and reorganization aimed at answering the threat. A new type rifle division made its appearance, and all animal transport was replaced by motorized. The tank corps were redesignated tank divisions, and tank armies became mechanized armies. Mechanized corps were redesignated mechanized divisions. Each of these new organizations and their higher headquarters, the Rifle Army, the Mechanized Army, and the Cavalry Army, had their organic air defense units - the PVO Voisk (now PVOSV).

The PVO Strany also underwent some reorganization in 1948, while still maintaining its mission of defending the air space of the USSR. Besides having its own radar systems, fire control and direction centers, and communications network, PVO Strany had at its disposal AAA furnished by the Ground Forces and fighter-interceptor and other aircraft furnished by the Air Forces. A somewhat simplified organizational diagram of the Soviet High Command is shown in Figure 3-1.

This system required the closest cooperation not only among the various components of the new PVO Strany, but also among the several major branches



Source: Various Soviet and US documents.

Soviet High Command 1948

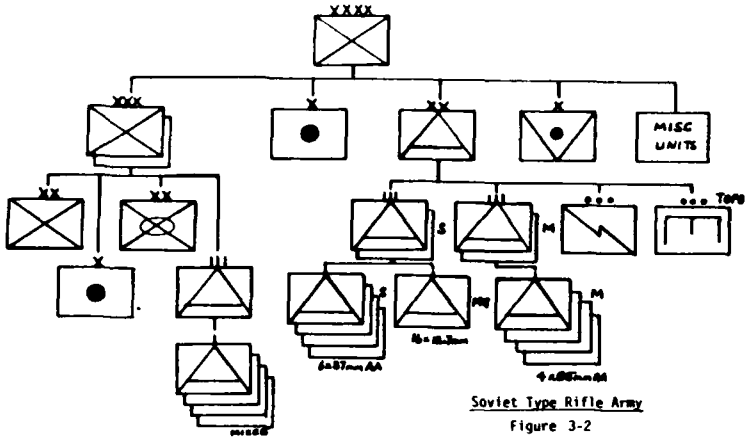
Figure 3-1

of service involved, and between the theater and naval forces. In organizing the ground for air defense, the most important targets were the first covered. Hence Moscow, Leningrad, and one or two other areas had priority of coverage, and air defense units were echeloned along the most dangerous routes of attack. As was the case during the wartime period, intruders could expect to be attacked at any point within the Soviet perimeter, first by fighters and AAA of the various fronts and fleets and, second, by the air defense of the PVO Strany.

Figures 3-2 through 3-5 depict the organization of the various known types of ground organizations with organic air defense means (PVO-SV). Of particular interest here is the fact that, while after World War II there was some reconfiguration of artillery units, including AAA, there was considerably less reduction in numbers than may be found in other arms.

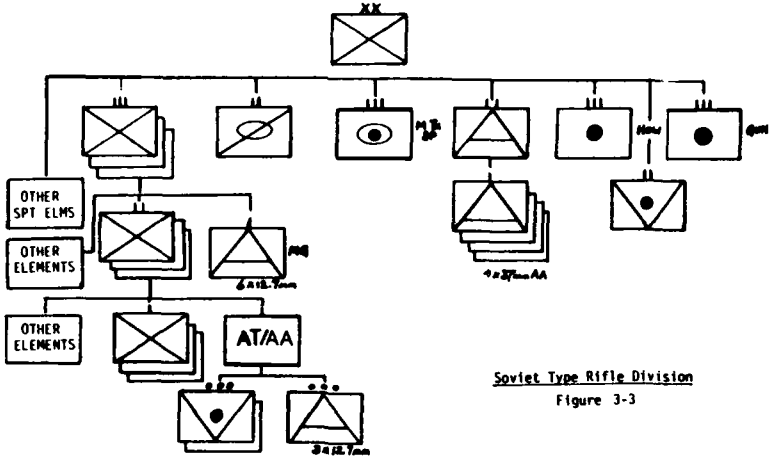
This preeminence of artillery in the Soviet Army is not a new phenomenon. First-rate artillery was a characteristic of the Old Imperial Russian Army back to the late seventeenth century. Peter the Great devoted particular attention to the building of an efficient artillery force, and the tradition of artillery as the "best arm" may be said to have originated in his reign. The Artillery Academy was founded in the early nineteenth century.

During World War II, the Soviet artillery branch made its most dramatic growth, and out of it developed the antiaircraft artillery branch which at the end of the war constituted a considerable investment in both manpower and equipment. In the immediate postwar period the responsibility for air defense artillery was charged to the Artillery Directorate of the Ground Forces Headquarters. In part this department was responsible for the supply of all small arms and artillery material to all other branches of the combat arms, including the PVO Strany and the PVO-SV. It also procured all ammunition for those branches for which it procured arms.



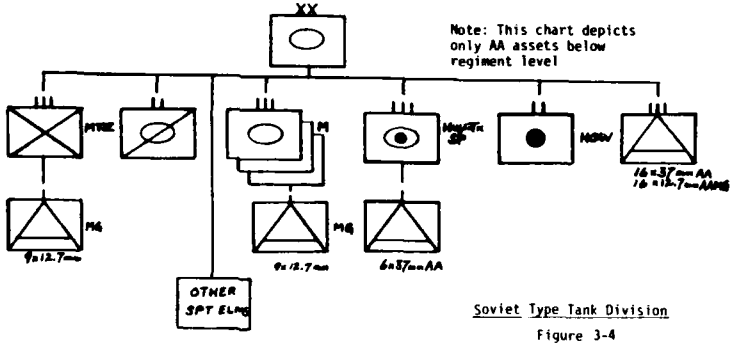
Soviet Type Rifle Army

Figure 3-2



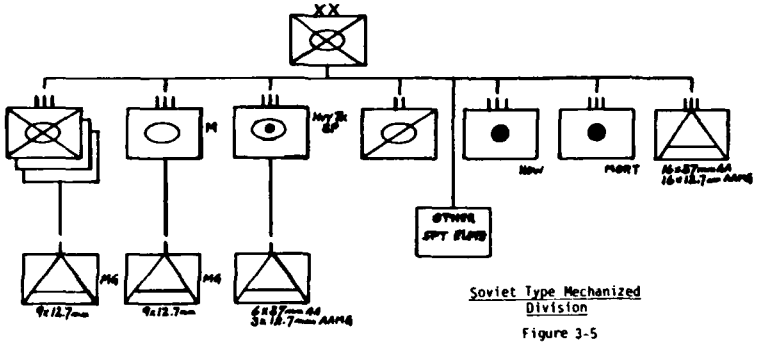
Soviet Type Rifle Division

Figure 3-3



Soviet Type Tank Division

Figure 3-4



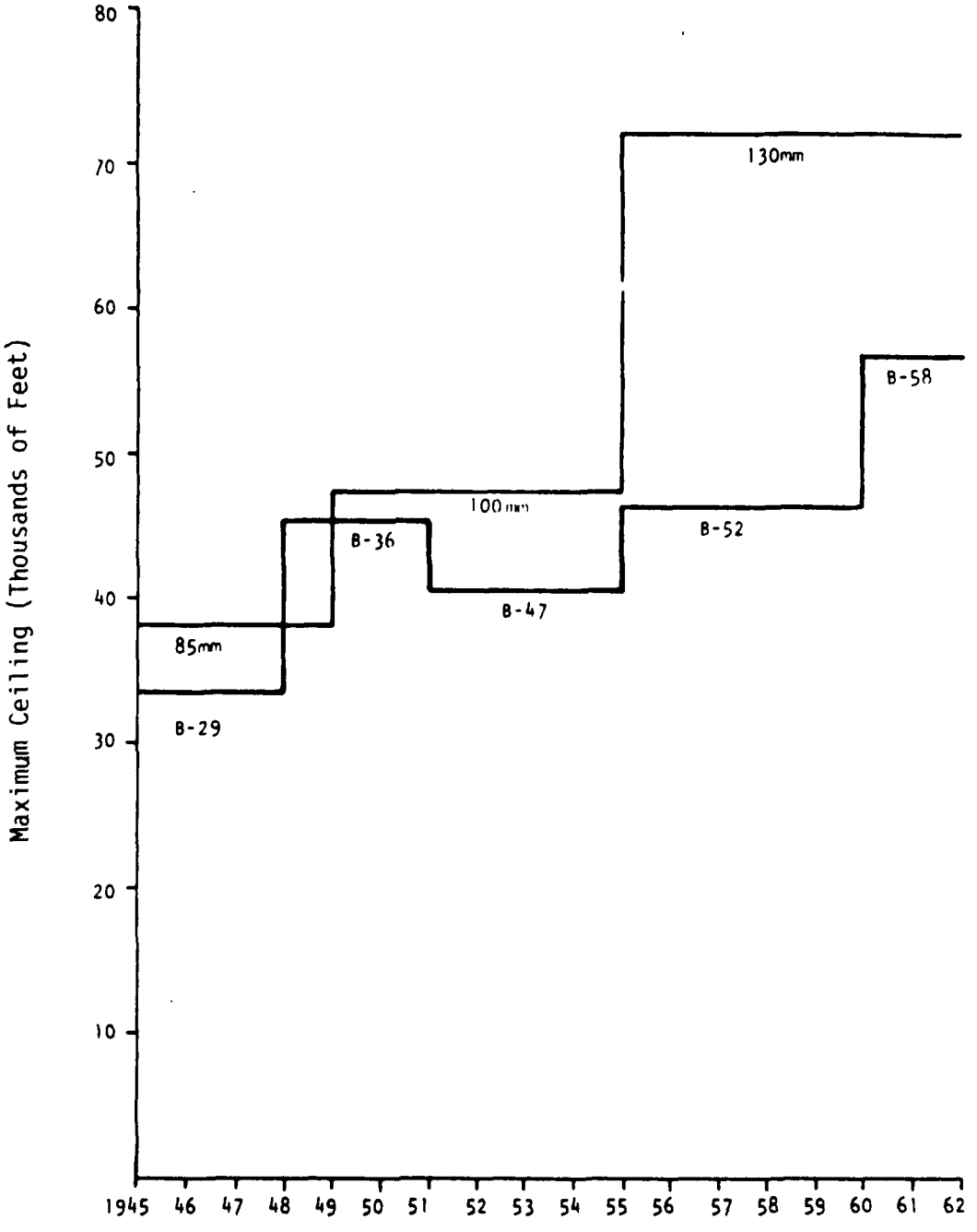
Soviet Type Mechanized Division

Figure 3-5

Also during the immediate postwar period, a debate began in Soviet planning circles about the proper "mix" of air defense means. In its early stages the debate ranged between interceptor aircraft on the one hand and antiaircraft artillery on the other. Before long, however, the third element in the triad was added, the surface-to-air missile. One aspect of this dispute was the simple fact that, regardless of how hard the Soviet Union tried, technological growth was on the side of the United States, and the USSR was always lagging behind. Still, the Soviets did make progress in what may be viewed as a balanced program of development of various modes of air defense. To the Soviets' credit, they were persistent in the introduction of new systems to counter the changing threat they perceived, even if the new system was acknowledged as little more than a stopgap measure. The Soviets were well aware of the West's ability to create new systems which could totally overcome the best the USSR had to offer. Thus, each new western offensive system caused the Soviet Union to react with a new defensive system, thereby avoiding the risk of strategic destabilization even if the new system was destined for obsolescence in the very near future. One application of this phenomenon can be seen in Figure 3-6, which depicts the relationship between US bomber introduction and Soviet AAA development and deployment by comparing their altitude capabilities.

Surface-to-air missiles did not enter the Soviet inventory until the 1950s and, therefore, reliance was placed on antiaircraft artillery, as the ground air defense means, not only into that period but beyond into the period of deployment and expansion of SAM sites. Thus, the 57mm (not shown on the figure) and 100mm AA guns came into the system to fill gaps created by new western systems, and, as a means of further offsetting the technological lag, eight-gun batteries were developed to replace the normal four-gun organization, allowing greater density and effectiveness.

The entire rationale for these actions was the sense of urgency evoked in the minds of Soviet planners who considered the defense of the homeland vital before and during the period in which they developed their own strategic offensive capabilities. That the present day Soviet desire to insure the integrity of the homeland from strategic attack has not changed is manifest in all their literature.



Altitude Capabilities of AAA and Bombers since World War II

Figure 3-6

SOURCE: Various.

The antiaircraft artillery available to the Soviets at the end of the war included guns from 37mm to 85mm. The 37mm AA gun was found in all line divisions. Most of the larger caliber AAA was usually located in separate AA units. Some new items of equipment found their way into the inventory during the fifties. The 57mm AA gun and 14.5mm AAMG were phased into certain units to replace the time-tested 37mm AA and 12.7mm DShK M1938 AAMG. Another new piece of antiaircraft artillery was a 122mm AA gun that showed remarkable external resemblance to the US 120mm AA gun. These changes were in line with international trends in air defense of that period; guns were being developed in larger, longer range calibers, and AAMG were being made in large calibers. But, more important, gun mounts were introduced with two to four AAMGs, firing simultaneously. These changes had all been accomplished by the mid-1950's. In effect, all 12.7mm AAMGs were replaced by the 14.5mm heavy AAMG in either a two-barrel (ZPU-2) or four-barrel (ZPU-4) configuration. The 57mm AA gun M1950 rapidly replaced the 37mm. This new weapon was developed from the 57mm M1943 and had a remote control capability. A twin-barrelled version of this weapon also made an appearance at about this time, first in a ground-mount configuration and then in a self-propelled version in 1957 (ZSU-57-2). The 100mm AA gun M1949, a later version of an untried wartime model, replaced the 85mm AA gun; and the 130mm AA gun M1955 gave the Soviets a new dimension in effective vertical range of 72,000 feet.

With this rather comprehensive improvement in Soviet guns came one more addition, surface-to-air (SAM) missiles. Identified as the SA-1 and nicknamed "Guild" by NATO, this SAM was first seen publicly in November 1960. Intelligence sources identified it as having been deployed as early as 1958 in battery positions, defending a number of the large cities in the USSR, and, in 1959, as being among the systems available to the Commander, Group Soviet Forces Germany. (There was some question at the time whether what was actually observed was a mock-up or an SA-2 "Guideline.")

The decision to deploy the SA-1 was one of those obviously based on expediency. The missile was not very effective, especially in terms of range and altitude coverage. A great deal of difficulty must have preceded

deployment, as the SA-2 overtook the SA-1 in the production cycle, closing the usual inception to operational employment gap of five years to two years. There appears little doubt that work on the deployment of the SA-1 continued, even though Soviet planners appreciated the approach of the SA-2, simply as a stopgap to the perceived western threat. There is some evidence that the SA-1 was never intended to do more than it did, defend Moscow and possibly Leningrad as an interim air defense system. Another bit of evidence in support of this thesis may be found in the promise held out by the SA-2. Simple, flexible, more reliable than the SA-1, the SA-2 had about it the aura of an already accepted, established system when it was deployed. The number of SA-2s deployed only further confirms this idea. Not only was the SA-2 the logical second generation missile to the SA-1, but it also sounded the demise of cannon artillery in the PVO Strany. The SAM was much that the cannon was not in the terms of range and accuracy, something the Soviets desired, but had not previously been able to achieve.

The sum of this development - deployment process may be stated thus:

- The Soviets stressed the early deployment of the first available and effective system to prevent coverage gaps.
- Simplicity and reliability were stressed as a measure of effectiveness rather than the notion held in some western circles that effectiveness is equated with sophistication.
- Incremental system upgrade preceded system replacement.
- Emphasis on continuous research and development of new systems continued apace so that new systems would be ready for deployment when old systems had outlived their usefulness.

Figure 3-7 compares the characteristics of the standard family of Soviet AD weapons, and those designed and developed to update the family.

The improvement in Soviet AAA was matched by improvement of interceptor aircraft for PVOIA. After its debut in December 1947, the MiG-15, codenamed "Fagot," entered the inventory in fairly large numbers. Armed with two 23mm and one 37mm cannon, this jet aircraft constituted a vital element in the emerging strength of the postwar PVO.[1] This aircraft, plus some of the more sophisticated of the new AAA means, gave the Soviet Union a

Comparison of New/Old Soviet Air Defense Means

Figure 3-7

Weapons Type	Old AAMG	New AAMG	Old AAMG	New AAMG	Old AAA	New AAA	Old AAA	New AAA	Old	New AAA	Old	New SAM
Caliber	7.62mm	none	12.7mm	14.5mm	37mm	57mm	85mm	100mm	none	130mm	none	
Model			1939	c.1958	1939	1950	1939	1949		1955		SA-1
Designation			D.Sh.K	ZPU1/2/4	M1939	S60	KS-12	KS-19		M1955		Guild
No.of Barrels	1/2		1	1/2/4	1	1	1	1		1		
Cyclic Rate	600-700rpm		300-350rpm	600rpm	160-180rpm	105-120rpm	15-20 rpm	15 rpm		10-12 rpm		
Practical Rate	250-300rpm		125rpm	150rpm		60rpm						
Muzzle Velocity	800 m/s		860 m/s	1000 m/s	880 m/s	1000 m/s	800-1030 m/s	900 m/s				
Max. Range				7000m								
Eff.Range Vert.			915m	1158m	6000m	8800m	10,500m	15,400m		21,950m		
Eff.Range Horiz			3000m	2000m	8000m	12,000m	15,500m	21,000m				
Armor Penet 0°500m.			20mm	32mm	46mm							
Armor Penet 0°1000m.						96.5mm	102-130mm	172mm				
Missile Speed												Mach 2.5
Max.Eff.Alt.												18-20Kms
Max.Slant Range												30-35Kms

means of defending itself against what must have been considered at the time its most dangerous threat, high altitude bomber attack. After 1948, the Soviet Union viewed with considerable alarm the appearance of aircraft carriers in range of its shores. This led the USSR into at least two divergent, yet mutually-supporting, developmental programs. One was designed to combat the threat at sea, with submarines armed with new weapons capable of attacking and either defeating or scattering carrier task forces before they reached their launch line.[2] The second program was the upgrading of Soviet air defense means. All of this constituted a heavy investment for the Soviets admittedly without the guarantee of total success. Besides those aircraft which might be launched from aircraft carriers, the Soviets had also to contend with attacks by nuclear weapons-carrying bombers. The Soviets, themselves, had perfected nuclear weapons by 1949, but this did not diminish the threat against the Soviet homeland perceived as emanating from the United States and its allies. Through this period, the Soviets showed little interest in precipitating a major war even though most analysts are convinced they envisioned a favorable outcome if war should break out. While they had come to understand the importance of bombing as an offensive tool, they had not lost sight of the simple fact that they themselves could be bombed. Therefore the expenditure of resources, possibly at the cost of other programs on air defense improvement, should have come as no surprise.

Along with this allocation of material resources came the concomitant expenditure of time and effort in other areas associated with air defense. In 1948, PVO was removed from the control of the Directorate of Artillery and made a separate branch of the Soviet Armed Forces, an action that was the logical follow-on to the course taken in wartime reorganizations.[3] But, more far reaching than that, a techno-military revolution was taking place in the Soviet Armed Forces.

Not only were these revolutionary changes pulled along as the USSR developed its postwar national goals and objectives but they were literally pushed forward by the number of technological advances that occurred in that era. Fundamental in air defense was the threat posed by nuclear attack.

A single aircraft with a single nuclear weapon could now do more damage than the combined tonnage of all German bombs dropped in the Soviet Union throughout World War II. Now intercontinental war was possible, where before it had only been conjectured. Not only were nuclear strikes to be considered, but also the other members of the triad of "weapons of annihilation," chemicals and biologicals. Thus, the Soviet Navy was to destroy the enemy's fleets, not only those that were close to Russian shores but also those anywhere on the world's oceans. The Navy was also charged with its own air defense.

Enemy aircraft were to be destroyed by air defense aircraft before they could get close to their targets. Antiaircraft means would also be located so as to prevent the enemy from dropping its weapons on the target. For the Soviets, then, the translations of national objectives and goals into national military objectives and strategies led to the conclusion that the length of a nuclear war would depend upon the Soviet ability to resist the nuclear strikes of the enemy. This had to be delineated into both the protection of Soviet forces carrying out military operations and, also, the protection of the homeland. Two pre-conditions seemed to have developed in this sense. One was a formularization of methods whereby the enemy's nuclear means would be limited and the effectiveness of the means made available to the PVO would be improved. All levels of politico-military strategy had to converge on these two points. For the PVO Strany the basic tools with which to carry out the protective mission were high-performance interceptor aircraft and missiles. These would form the new, active means of air defense. Passive means would include a family of highly sophisticated tools for location, direction and guidance of active air defense means. To this extent, the means available to PVO, from the operational point of view, became an integral part of the overall operations planning of the Soviet High Command, and subordinate commands. Thus, PVO Strany would be noted for its stability, while PVOSV would have its strength in its flexibility to respond to the ever-changing demands posed by combat troops in the field. In either case the closeness of planning between air defense and all of the other aspects of operations became apparent.

Korean Experience for the Soviets

With this doctrinal development process under way, the USSR had the opportunity to look again at some of its older air defense means and at some of its new equipment as well. This opportunity came about through the North Korean attack on the Republic of Korea in 1950. Air-to-air combat began on 27 June 1950 against prop-driven aircraft of the North Korean Air Force (NKA). Antiaircraft action by the NKA was quite limited and consisted primarily in defensive fires by weapons organic to the combat forces. The first US aircraft was thus shot down on 7 July 1950 on a low-level attack mission. The first test of Soviet built AAA came when Chinese air defense units north of the Yalu River in Chinese territory fired on 4 US P-51 Mustangs, downing one, over North Korea, on 15 October 1950. Then, on 1 November 1950, the Soviets, in this case vicariously through the Red Chinese, had the opportunity to test their newest jet aircraft, the MiG-15. Although the MiGs were unsuccessful in their initial engagement, they were more successful on 8 November against a flight of nine B-29's close to the Yalu, where the MiGs badly damaged two of the bombers before being driven off. When the Chinese crossed the river, directly intervening in the ground war as well as the air war, they brought with them AAA. At Pyongyang, the North Korean capitol, for instance, at least 53 heavy AA guns, probably 85mm, and 63 automatic weapons were emplaced. By January 1951, "MiG Alley" had been named and become the scene of numerous air engagements. By May some 252 AA guns and 673 AAMG were in place in North Korea.

One tactic used by the Chinese that found its way into later Soviet air defense doctrine and which may have developed from Soviet WWII experience was the development of "Hunter Groups." Armed with heavy machine guns and other infantry weapons, they attacked low-flying UN aircraft as a means of protecting their supply routes. By the war's end, the Chinese had devised numerous means of deception to entice unwary pilots into flak zones or over dangerous terrain. Another innovation noted was the dispatch of small teams, usually two men with radios, to the tops of mountains to report UN air movements entering North Korean airspace. While this was a primitive system of air warning somewhat reminiscent of Soviet techniques used at the

beginning of the war in 1941, it suited the Chinese purpose particularly well because of the vagaries of landline communications in many areas.

What exactly the Soviets gained from this war is difficult to assess. While they may have learned little of direct concern to their air defense doctrine, tactics,or equipment planning, they did certainly learn what effective air support of ground operations can do to the outcome. The support given by UN air elements to all aspects of the war could have done nothing but intensify Soviet air defense preparations.

Soviet Air Defense Experience in Southeast Asia

The U.S. involvement in Vietnam, Laos, and Cambodia gave the Soviet Union another opportunity to evaluate its air defense equipment. The very nature of the war in Southeast Asia made for excellent testing ground, not only for the Soviets' latest equipment, but also for their most up-to-date doctrinal innovations. Again, the important factor for Soviet appreciation of the importance of Vietnam in this regard was that their client, North Vietnam, was engaged directly with the United States and not a surrogate. Hence, parametric data obtained on their weapons' performance could be applied directly to their thinking and planning processes. A detailed account of the air defense campaign in Southeast Asia is included in Chapter V.

CHAPTER III

Notes

1 William Green, "The Development of Jet Fighters and Fighter-Bombers," in The Soviet Air and Rocket Forces, Asher Lee, ed. (New York: Praeger, 1959), pp. 138-139.

2 See for instance John E. Jessup, "The History of Soviet Submarines," Vol. I in The Navy in the History of the Strategic Arms Competition (Lulejian & Assoc. for the US Navy, 1976).

3 M.V. Zakhurov, ed., 50 Let Vooryzhennykh Sil (Moscow: Military Publishing House, 1968), p. 488.

CHAPTER IV

AIR DEFENSE IN THE COLD WAR ERA

CHAPTER IV is in Annex A

CHAPTER V

THE VIETNAM EXPERIENCE

CHAPTER V is in Annex A

CHAPTER VI

SOVIET AIR DEFENSE EXPERIENCE IN THE MIDDLE EAST

Background

Since the birth of Israel in May 1948, at the expense of the surrounding Arab states, the Middle East has been the scene of an almost constant military confrontation between not only the Arabs and Israelis but, more important, the Eastern and Western blocs. Granting the lack of direct, overt intervention by American or Soviet forces in the military conflict, sufficient late-model equipment and employment techniques have been supplied by both sides to give a fair picture of the relative value of these armaments. This is especially true in the area of air defense.

Soviet entree into the Middle East began in earnest around 1955, two years after the death of Joseph Stalin, and at a significant point in the history of Soviet foreign policy. It was a time when the Soviets considered that a policy of cooperation with non-aligned nations would make these "Third World States" generally more susceptible to their political and military influence. The effort was, as a matter of fact, not a one-sided affair on the part of Moscow's new leadership. Several Arab states found that mutual interests in opposing the territorial aspirations of the nascent and security-conscious state of Israel closely aligned them with the USSR. Furthermore, Israel was becoming more and more heavily involved with the West, which influenced some Arab states to extend Islamic opposition to Israel to the West in general, as the source of all economic exploitation and political interference in the Middle East.

To a large extent, this shift came about because of US concern for Israeli security and suspicion over the motives of one of the most influential leaders of the non-aligned movement, Egypt's President, Gamal Abdul Nasser.

Nasser had only recently been refused US arms aid and economic assistance because of his, and other Arab leaders', strident oratory expressing an absolute requirement for the elimination of Israel as a nation and a state. The American rejection impelled first the Egyptians and then other Arab states to seek out Soviet military aid in consonance with Nasser's strong anti-Israeli bias.

From 1955 onward the Soviets were brought more directly into the affairs of the region diplomatically, politically, economically, and, very strongly, militarily. These ties with the Arab world were strengthened even more in November 1956, when Nasser's nationalization of the Suez Canal brought joint action by Israel, Great Britain, and France. The Soviets purposefully supported the Arab position against Israel and the West and thereafter became the principal source of arms for the militant Arabs.

Following the 1956 war, the United States became more directly involved in the support of Israel, and soon an arms race was in full swing with an estimated 10 billion dollars' worth of arms being supplied to the two sides by the United States and the USSR between 1945 and 1969. Israel and Egypt alone received about 70% of this aid.[1]

Fighter and bomber aircraft, tanks, artillery, both ground and air defense, mechanized and motorized transport, infantry weapons, and even some small naval craft of Soviet and East European origin were furnished Egypt, Syria, Iraq, the Yemens, Algeria, and Morocco in the years following the Suez War of 1956. One interesting point here is that the very heavy Soviet deliveries of equipment to the Arabs during this period may have been for the sole Soviet purpose of clearing out older, western systems from Arab inventories both for purity of operation and to make the client states more totally dependent on the supplier.

This brief introduction is presented to account for the relative importance of these events in the eyes of the Soviet leadership. To a considerable extent they gained access to a region in which the major western European powers had previously held exclusive dominance. An examination of the Soviet commitment in the air defense area alone offers an indication of the importance the Soviets attached to their new-found position.

Soviet Weapons

During 1963, the Soviets delivered about 10 batteries (60 launchers, either single, double or quadri-track) of the SA-2 Guideline SAM, along with its associated radars and guidance gear, plus a modest number of modern 85mm antiaircraft guns to Egypt. The USSR was simply not in a position to pawn off ineffective equipment on the Arabs in a situation where such action might bring an immediate and undesired reaction. This would not have fit the evolving Soviet policy of assisting Third World states against the "common enemy" with military supplies which constituted one-half to three-quarters of all this foreign aid. Here was the perfect place, it would seem, to "exploit her /the Soviet Union's/ more attractive goods -- weapons and advisors -- in the search for influence."[2] Should the Soviets have failed, through an Arab perception of having received unsuitable goods, the USSR could easily have lost its foothold in the region, with the Arabs looking elsewhere for support.

The swift, decisive and calamitous defeat suffered by the Arabs in June 1967 at the hands of the Israelis obviously was not to the Soviets' liking. Among other things it almost certainly pointed out equipment and training failures to the Russians, both on their part in delivering it and on the Arabs' part in utilizing it. There is also some conjecture that the Soviets may have considered their hold on Nasser less than effective.[3] With Soviet prestige at stake, and at Nasser's apparent urging, the Soviets rationalized the situation by increasing aid in the form of more and better equipment and advisors. An immediate, massive program was begun that amounted to a Soviet investment of over 500 million dollars to Egypt alone by the end of 1968. Such a move not only complemented Arab capabilities and Soviet ideological goals, but also improved the Soviet military presence in terms of advisors, naval bases, airfields, and combat troops committed to the Egyptian Air Defense Command. From about 500 Soviet advisors and technicians in Egypt in 1966-1967, the number of personnel increased to over 2,000 by 1969. Then, in 1970, the most dramatic increase took place. Figure 6-1 illustrates this point.

ESTIMATED SOVIET MILITARY STRENGTH IN UAR - 1970

1970	Soviet Mil Personnel			Sov.Manned SAM Sites* (SA-3)	Sov.Manned Aircraft (MiG-21J)	Sov.Controlled Airfields
	Pilots	Msl.Crews (1,000)	Others (1,000)			
1 Jan	0	0	2.5-4	0	0	0
31 Mar	60-80	4	2.5-4	22	0	1(?)
30 Jun	100-150	8	2.5-4	45-55	120	6
30 Sep	150	10-13	2.5-4	70-80	150	6
31 Dec	200	12-15	4	75-85	150	6

*There were also Egyptian-manned SA-2 sites.

Figure 6-1

These increases seem to have come about as a result of President Nasser's visit to Moscow on 22 January 1970. The Soviet Union's very rapid response, if this is the case, is, therefore, of some interest. One might presume that they anticipated the request or that the USSR had a much more flexible capability to respond than otherwise might have been considered.

Before the end of February 1970, along with the already indicated increases, the Soviet Union began supplying equipment previously reserved for Warsaw Pact members. Along with the SA-3 Goa SAM and the MiG-21 Fishbed fighter-interceptor, the Soviets also introduced the ZSU-23-4 antiaircraft gun system, improved SA-2 Guideline SAMs, and, by the year's end, according to some reports, the SA-4 Ganef SAM. To understand these systems in the context of their impact on the Middle East battle area properly it is wise to digress and discuss each in some detail.

The ZSU-23-4 System

The ZSU-23-4 system is a self-contained, four-barrelled, radar-controlled weapon called "Shilka" by the Russians, originally designed as a new system around the ground mounted ZU-23-4 automatic cannon (AZP-23 quadruple 23mm cannon). Work on it began in 1950, using a modified version of the PT-76 chassis. One of the main design features of the Shilka is its on-board, all-weather capable, NATO designated "Gun Dish" J-Band, B-76 radar. The inclusion of this sub-system overcame one of the major deficiencies in the ZSU-57-2 system, whose value is limited to clear weather when its optical sights can be utilized. At the time of this writing, at least eight models of the Shilka have been identified. According to one source, the newest models, sometimes called the ZSU-23-4M, has an on-board digital computer in place of the analogue computer found in earlier models.[5]

This is a most impressive and highly dangerous weapons system. Firing two types of ammunition, an HE round for use against aircraft, and an API round for ground targets, the weapon gives the "firehose" effect when fired, as all rounds have a tracer base. Both types of ammunition have a muzzle velocity of 970 meters per second. One feature of the system, which is designed for short burst fire, is an adjustable rate of fire control, with a 3-5 rounds per barrel or a 5-10 rounds per barrel setting. Although the AZP-23 has a maximum rate of fire capability of about 3,600-4,000 rounds per minute (800-1,000 rds. per barrel), the more practical rate is about 200 pounds per minute per barrel (800 rds. per minute for four barrels) fired in 50 round bursts of about 3 3/4 seconds.[6]

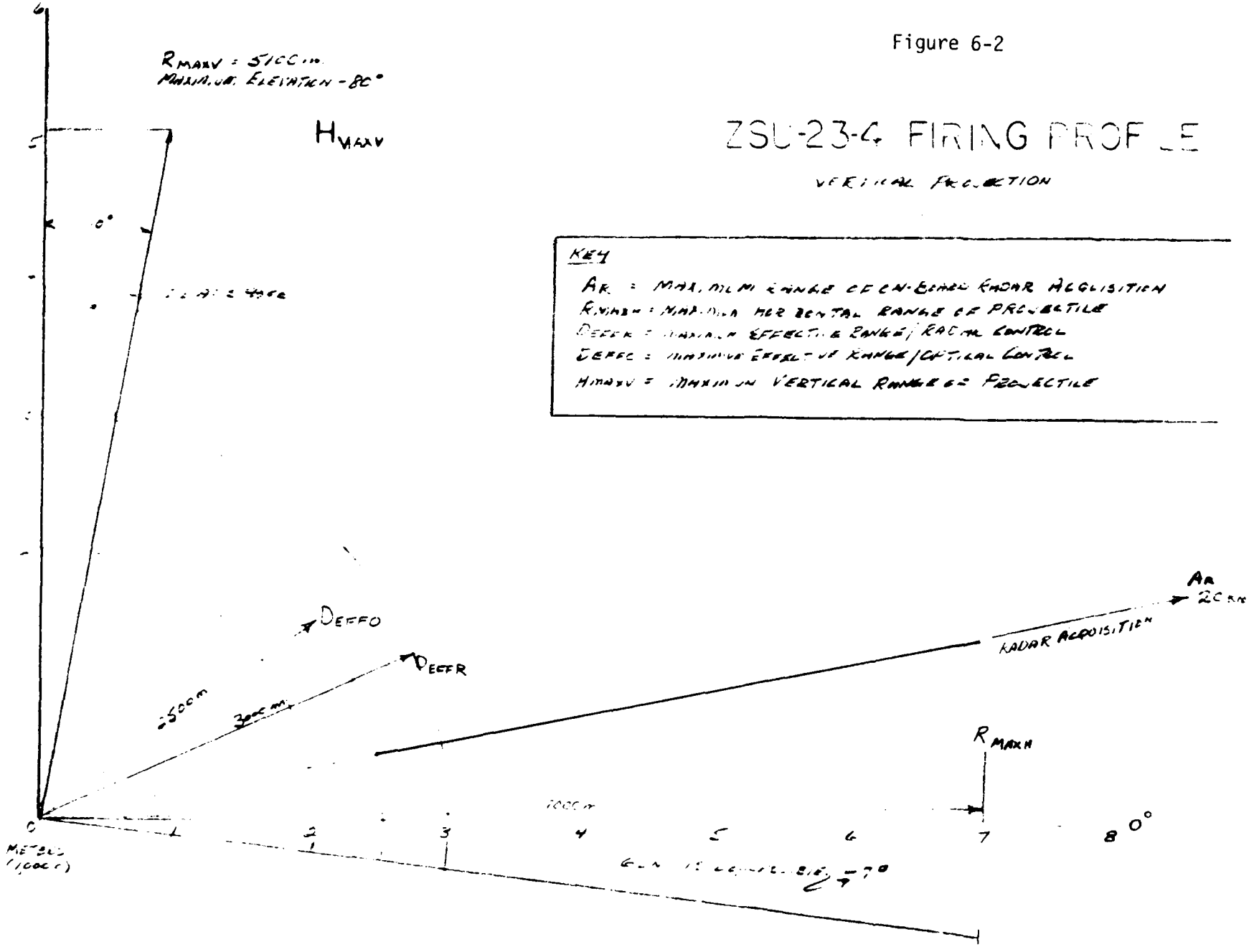
One source states, "In 1973, Israeli pilots learnt from experience that to remain in the sights of Shilka at 2,150-2,750 yds (2,000-2,500m) for 35 seconds is lethal, and shorter exposures at closer ranges provide the same unwelcome result."[7] With this as a base line, certain predictions can be made by incorporating other data. Figure 6-2 shows the vertical firing profile for the ZSU-23-4. Among the more significant data included is:

- Aircraft can be engaged at a greater maximum range as altitude is reduced.
- Aircraft such as helicopters and observation planes are in greater danger than high performance aircraft because of slower flying speeds.

Figure 6-2

ZSU-23-4 FIRING PROFILE

VERTICAL PROJECTION



- Although the rate of fire may remain the same throughout the engagement, accuracy and effectiveness of fire increases as an aircraft approaches the weapons platform. Thus, one might suspect that any counterfire means such as a stand-off missile should be employed in the A_R envelope before reaching the R_{Maxh} fan.

Figure 6-3 displays a horizontal plot of the several fire envelopes involved in the ZSU-23-4 system. To illustrate the various magnitudes of effectiveness, three arbitrary flight paths are also shown.

In Flight Path A the aircraft literally flies over the gun site. Figure 6-4 indicates the various times in each envelope belt and the numbers of rounds which may be expected to be fired. Obviously, the slower flying aircraft are in the greater danger. Also, it is probable that a single hit by the 6 2/3 ounce HE-fragmentation round can do significant damage, if it impacts and detonates in a sensitive area of any aircraft. It must also be remembered that, as the ZSU-23-4 has 360^{o} traverse, all values on Figure 6-4 may have to be doubled. Although specific data on fast traverse (slewing), radar servo-drive reacquisition and target lock-on times is not readily available for the Shilka, it is possible to determine that the fast traverse operates between 20^{o} and 60^{o} per second.*[8] Thus, traverse to recover a retreating target -- that is, slewing 180^{o} -- would take from 3 to 9 seconds. Some attenuation should be taken into consideration in the case of high performance aircraft operating at advanced speeds. An aircraft traveling at 800 km/hr will be in the R_{Maxh} firing envelope from 62 seconds, for example, considering entry at point Z and exit at point V. During that time it may be subjected to both approach and retreating fire, less whatever time is required for the weapon to slew 180^{o}, reacquire target, and reopen fire. This is because the weapon has an 80^{o} elevation limit. As the aircraft is traveling at 222.2 meters/second, it will traverse the deadspace cone of 20^{o} in approximately 2.7 seconds at an altitude of 1,000 meters. If radar-gun reacquisition on the point X - point V track is within 3.5 seconds, then, theoretically, the target will

Figure 6-3

ZSU-23-4 Horizontal Plot Modes of Engagement Ground Level to 1000 meters Altitude

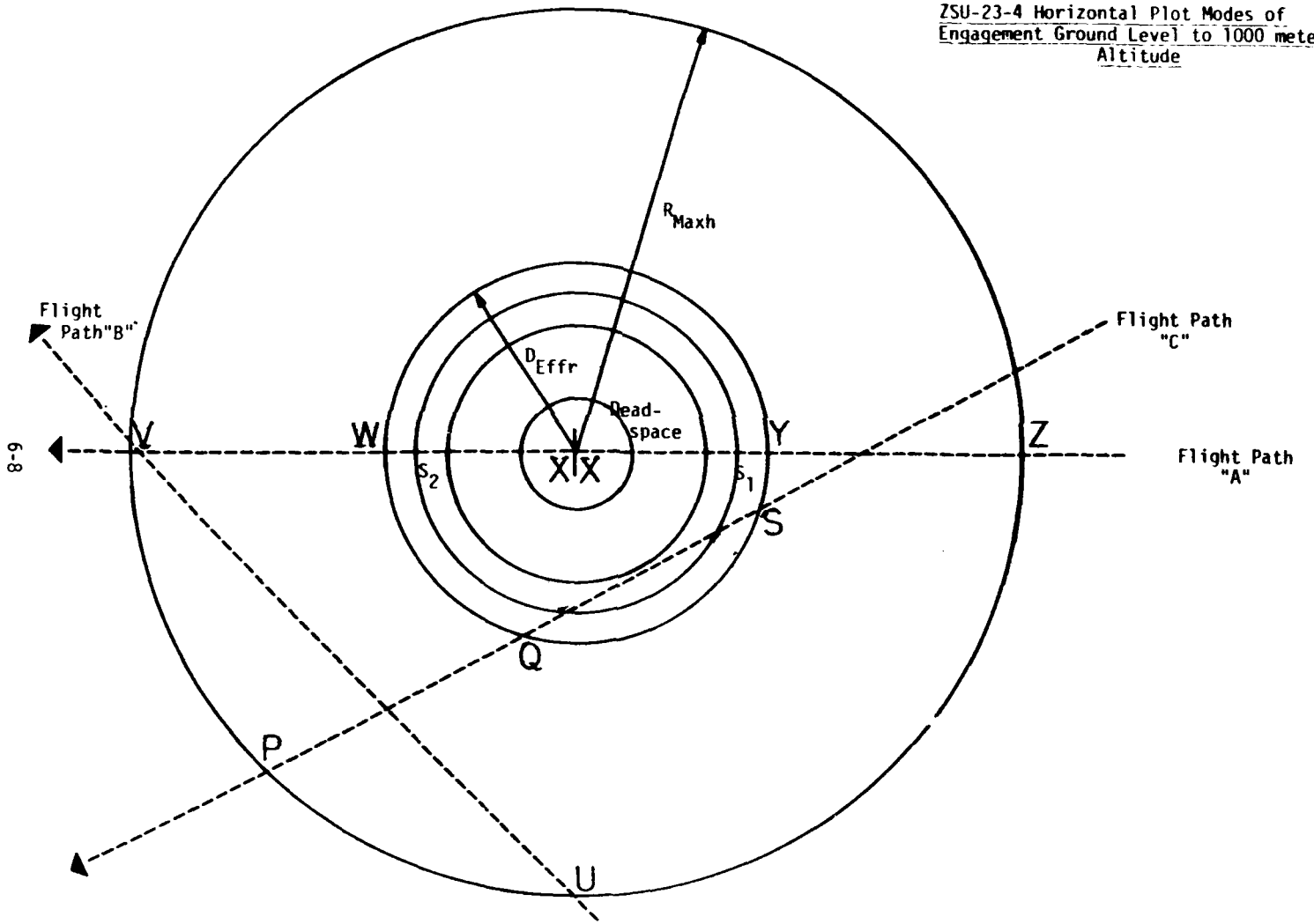


Figure 6-4

Time Elapse and Rounds Prediction ZSU-23-4/Radar Control

Flight Path A -- Head on Engagement Ground Level to 1000 meters

A. Time Elapse (in seconds)

Aircraft speed km/hr m/sec	100 27.8	200 55.6	300 83.4	400 111.1	500 138.9	600 164	700 194.5	800 222.2
$A_R - R_{Maxh}$ (1)	468	234	156	117	93.6	78	66.8	58.5
$R_{Maxh} - D_{Effr}$ (2)	144	72	48	36	28	24	20	18
$A_R - D_{Effr}$ (3)	612	306	204	153	121.6	102	86.8	76.5
Time in D_{Effr} Zone (4	108	54	36	27	22	18	15	13
Total time in range (5)	252	126	84	63	50	40	35	31

B. Rounds Prediction**

Sustained fire- Rounds in Range								
R_{Maxh}	*15,120	7,560	5,040	3,780	3,000	2,520	2,100	1,860
R_{Maxh}	3,360	1,440	1,120	840	667	534	467	414
D_{Effr}	6,480	3,240	2,160	1,620	1,320	1,080	900	780
D_{Effr}	1,440	720	480	360	294	240	200	174
Fired in Bursts***								
D_{Effr} r/sec	108	54	36	27	22	18	15	13
No. of bursts	15	8	5	4	3	3	2	2
No. of rounds	720	400	250	200	150	150	100	100

Formulae

(1) Seconds from radar acquisition to maximum range open fire
a/c spd (km/hr): 3,600 (conv. to secs)::Dist (13 kms): $x = \frac{3,600 \times 13}{spd \times x} = \frac{46,800}{spd} = x$

(2) Seconds from maximum range to radar effective range
a/c spd (km/hr): 3,600 (conv. to secs)::Dist. (4 kms): $x = \frac{3,600 \times 4}{spd \times x} = \frac{14,400}{spd} = x$

(3) Seconds from radar acquisition to radar effective range
$A_R - R_{Maxh} + R_{Maxh} - D_{Effr}$

(4) Seconds aircraft in radar effective range
a/c spd (km/hr): 3,600 (conv. to secs)::Dist.(3 kms): $x = \frac{3,600 \times 3}{spd \times x} = \frac{10,800}{spd} = x$

(5) Time aircraft may be engaged by fire
$R_{Maxh} - D_{Effr} + D_{Effr}$ — Vertical termination (80^0 max.elev.)

*Beyond weapon available ammunition supply, predicated on on-board ammo supply of only 2000 rounds
**This does not take into consideration any HE/API rounds mix.
***3 3/4 sec. burst of 50 rounds with equal pause. Any fraction in favor of first burst.

again be engaged after the aircraft has traversed approximately 1000 meters after reentering the firing zone. In figure 6-5 below, reacquisition, data assembly, and fire command take place at 3.5 seconds after loss of target at elevation terminator. The first round of the burst will intersect the flight path 1.5 seconds later (m.v. 970 m/s); .5 seconds later aircraft will enter the zone of fire. Thus, aircraft will have had approximately 5.5 seconds of respite and 2 seconds since being reacquired by the gun's radar. In less than three seconds, the aircraft will exit the D_{Effr} envelope (point W) but will still be subject to fire until existing R_{Maxh} at point V (as shown in figure 6-3). In such an instance, the relationship between the aircraft speed and the muzzle velocity of the weapon takes on added significance, as the aircraft will exit the D_{Effr} envelope before a seasonal burst will hit it.

In another application of the data available, it has been suggested that an aircraft that remains inside the 2,500 meter fire envelope of the ZSU-23-4 is dead. If this is the case, then the following hypothesis is important: Given a situation where the ZSU-23-4 fires in bursts of 50 rounds in 3.75 seconds inside the 2,500-meter fire fan (corresponds to the D_{Effo} envelope in figure 6-2), with equal length pauses between bursts, then the data in figures 6-6 through 6-8 apply.

The scenario for Flight Path C creates a new set of factors to be considered. In this instance the intruding aircraft penetrates not only the R_{Maxh} fan, but also passes through the radar-controlled effective range envelope (point S to Q). It also traverses what is considered to be the zone of optimum lethality between 2,500 and 2,000 meters range from the gun (point S_1 to S_2). Flight Path C factors out as shown on Figure 6-8.

Of significant importance is the number of bursts the weapon could deliver at slower flying aircraft, such as helicopters, who could take up to seven bursts in this scenario, two of which would be delivered in the optimum zone of lethality.

In both scenarios B and C target lock-on would be continuous; there would be no requirement for reacquisition. In both scenarios the aircraft is in considerable danger, in scenario C the aircraft may well be in lethal danger.

Figure 6-5

ZSU-23-4 Engagement Profile Retreating Phase X-V Flight Path "A"

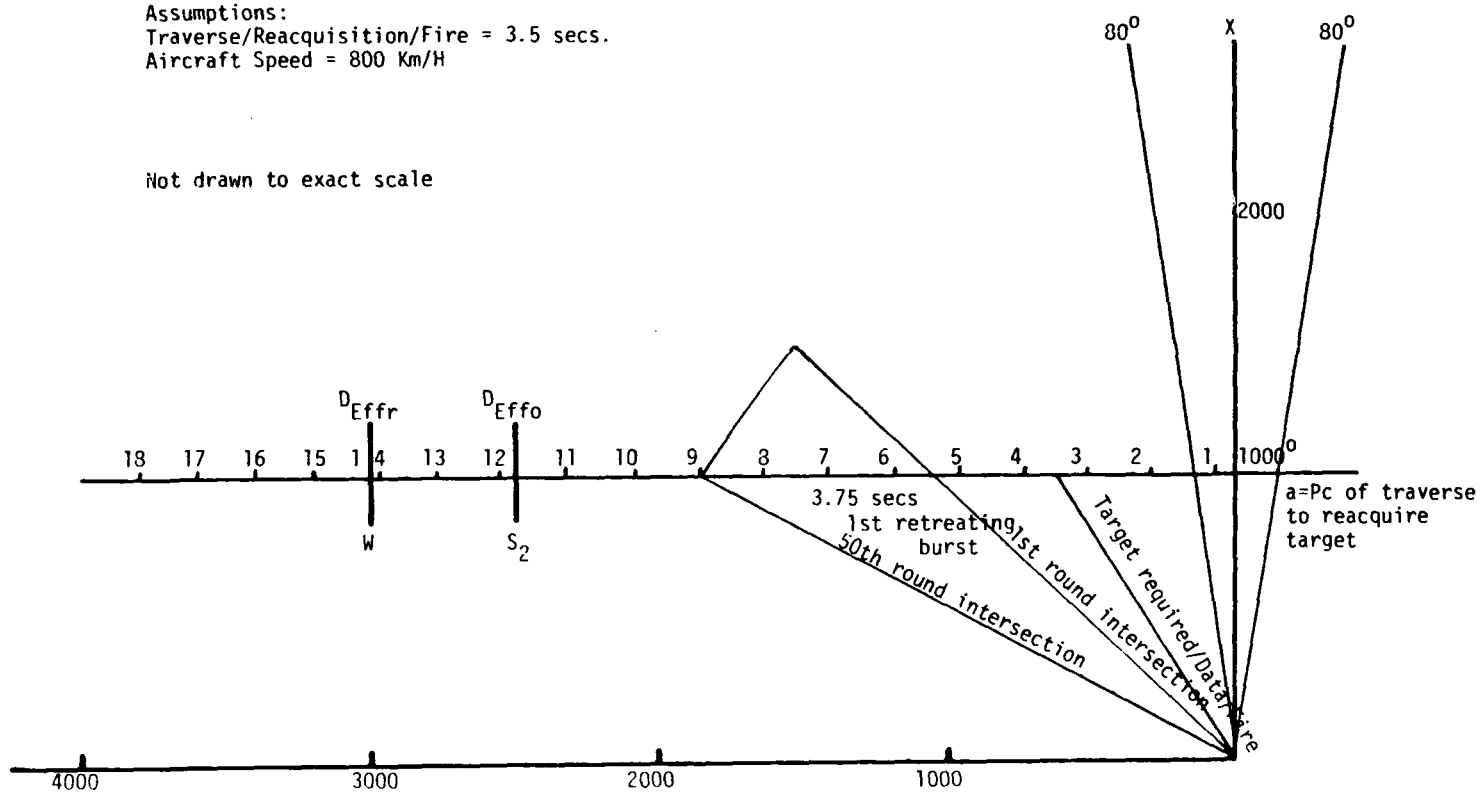


Figure 6-6

Aircraft Lethality Prediction

Flight Path A

Sector S_1 - S_2 Ground Level to 1000 meters

ZSU-23-4

Aircraft Speed	100	200	300	400	500	600	700	800
D_{Effo} R/secs ($S_1 \rightarrow S_2$)	180	90	60	45	36	30	25.7	22.5
No.of bursts	24	12	8	6	5	4	4	3
No.of rounds	1,200	600	400	300	250	200	200	150
Kill Probability	1	1	1	1	1	.8	.8	.6

Notes

Equals 5000 meters without consideration of target loss at elevation termination etc.

Formula $\frac{\text{Time in Range}}{2}$ = Time of Bursts

$\frac{\text{Time of Bursts}}{3.75 \text{ secs}}$ = No. of bursts

No. of bursts x 50 rds = Total rounds

All numbers rounded in favor of guns.

In 35 seconds in lethal stay time in envelope, then all aircraft in this scenario traveling less than 600 km/h must be considered as kills.
Thus, the minimum rate of 5 bursts(250 rds) is lethal.
Thus, any aircraft in the D_{Effo} envelope in any flight profile that takes 5 bursts must be considered lost.
Thus, Time in envelope (s) plus 5 bursts (5B) equals 100% kill probability (1).

S+5B = 1
Thus S+3B = .6 kill probability
S+1B = .2 kill probability

When applied to the table above, the results are as shown in kill probability.

Figure 6-7

Time Elapse and Rounds Prediction Angular Flight Path "B"
ZSU-23-4 Ground Level to 1000 meters

(This scenario assumes aircraft was detected and acquired at A_R range (20kms) Flight path "V" to "U" = 10,000 m.

Aircraft Speed								
Km/h	100	200	300	400	500	600	700	800
m/sec	27.8	55.6	83.4	111.1	138.9	164	194.5	222.2
R_{Maxh} Pts "V" to "U"	360	180	120	90	72	60	51.4	45
Rounds Fired Max.								
R_{Maxh} (3600)	*21,600	10,800	7,200	5,400	4,320	3,600	3,084	2,700
R_{Maxh}(800)	4,800	2,400	1,600	1,200	960	800	685	600
Rd Fired in 50 Rd Burst								
No.ofBursts	48	24	16	12	10	8	7	6
No.ofRounds	*2,400	1,200	900	600	500	400	350	300

*Exceeds Ammo supply of 2,000 rds.

Figure 6-8

Time Elapse and Rounds Prediction ZSU 23-4 Flight
Path "C"

Ground level to 1000 meters

Aircraft Speed Km/h	100	200	300	400	500	600	700	800	
m/sec	10,278	.0558	.0834	.111	.1392	.1668	.195	.222	
Point T - P	486	243	162	121.5	97.2	81	69.4	60.7	13,500 meters
Point S - Q	162	81	54	40.5	32.4	27	23.1	20.2	4,500 meters
Point S_1 - S_2	108	54	36	27.0	21.6	18	15.4	13.5	3,000 meters
R_{Maxh} T - S + Q - P	324	162	108	81	64.8	54	46.3	40.5	9,000 meters
D_{Effr} S - S_1 + S_2 - Q	54	27	18	13.5	10.8	9	7.7	6.7	1,500 meters
Lethal Zone S_1 - S_2	108	54	36	27	21.6	18	15.4	13.5	3,000 meters
Rds.Fired Max. 3600									
R_{Maxh} Zone	*19,440	8,220	6,480	4,110	3,880	3,240	2,778	2,055	
D_{Effr} Zone	3,240	1,620	1,080	810	648	540	462	405	
Lethal Zone	6,480	3,240	2,160	1,620	1,290	1,080	924	810	
800									
R_{Maxh} Zone	4,320	2,160	1,440	1,080	864	720	618	540	
D_{Effr} Zone	720	360	240	180	144	120	103	90	
Lethal Zone	1,440	720	480	360	288	240	206	180	
Bursts - 50 rds (3 3/4 sec burst, 3 3/4 sec pause)									
T - P	(7)350	(4)200	(3)150	(2)100	(2)100	(2)100	(1)50	(1)50	
S - Q	(3)150	(2)100	(1) 50	(1) 50	(1) 50	(1) 50	(1)50	(1)50	
S_1 - S_2	(2)100	(1) 50	(1) 50	(1) 50	(1) 50	(1) 50	(1)50	(1)50	

*Exceeds amount of ammunition carried on vehicle.

In these three scenarios, a rather generalized evaluation of the ZSU-23-4 has been made. In each case only one gun was considered; it is unfortunate, therefore, that such will not normally be the case and Shilkas will normally be encountered in pairs. A normal Shilka battery is composed of three platoons, each with two ZSU-23-4s, along with several command and service vehicles. As a minimum, the Shilkas are used in pairs (one platoon), with the vehicles maintaining 150-200 meter intervals to prevent mutual damage during an attack. In Soviet organization, each tank and mechanized regiment has one Shilka battery. A normal crew is four people: commander, radar search operator, and range operator in the turret, plus a driver in the front left of the hull. The weapon can be fired either manually or by a radar interlock system. In manual fire it would appear that the range operator most likely to operate the optical sights would be the firer. The commander's cupola is to the front left of the "Gun Dish" parabolic antenna which is affixed to the top rear of the turret. The radar appears to have height ranging and azimuth ranging capability, but azimuth ranging appears to be by turret movement only. However, the radar may have to be considered "boresighted" to the guns for azimuth and interlocked to the guns for height by some mechanical system.

Shilka is a very sophisticated system. Among its many features:

- The system has the capability of linking the optical sights (in good visibility) to the angular position-guide of the radar.
- The computer, either analogue in older models or digital in the ZSU-23-4M, provides necessary lead angle data either from the radar or from the optical sights.
- The entire weapons platform is gyro-stabilized to provide constant radar and optical tracking in rough terrain.
- There may be an IFF (Identification Friend or Foe) feature built into the system. Once a target is acquired, either in search or sector-scan, the radar is switched to automatic target tracking, where according to one source, it identifies the target and then gives the necessary lead and height data to the guns. If the target is lost, servo drives automatically readjust the radar to reacquire the target. Once the range, lead, and height angles are confirmed, the guns open fire.[9]

The SA-3 Goa Surface-to-Air System

There were many SA-3s in the mix of air defense weapons the USSR gave to the Arabs. At least 22 SA-3s were in the Egyptian inventory at the beginning of the 1973 war. As a system, this truck-mounted, double-launcher track weapon was designed to fill the low altitude gap created by the ineffectiveness of early model SA-2 at those heights. Although a relative improvement because of its transporter-launcher configuration, it was never very widely used and appears to have been designed as an interim system to be replaced by the SA-6 Gainful SAM for use with the ground forces in forward areas. About 2,000 launchers are still in the inventory of PVO Strany, however, filling the the altitude gaps in the SA-2 system.

The SA-3 incorporates two off-carriage radars: Flat Face (Soviet P-15) acquisition radar with a range capacity of 250 kms., and Low Blow, a fire control radar with the following general characteristics:

Carrier Frequency	-	9,000 - 9,400 MHz.
PRF	-	1,750 - 3,500 pulse/seconds
Range	-	40 - 85 Kms.
Scan width	-	1 - 5 degrees
Fan width	-	12 degrees
Pulse rate	-	.25 - .5 micro-seconds

This is an X-Band System.

The SA-3 is still found in the inventories of most Warsaw Pact nations and in naval weapons systems aboard earlier class ships as the SA-N-1. One disadvantage in the system is the off-carriage radar linkage that is radio controlled. This method is not quite so accurate as either cable linkage or on-carriage component radar.

The SA-4 Ganef Surface-to-Air Missile System

The SA-4 SAM is the longest ranged of the mass produced battlefield systems. Carried on a new-type full tracked transporter-launcher (SAU-152) with a 360^{o} traverse capability, the missile itself is of rather unusual design, having a liquid fuel sustainer engine with four wrap-around solid fuel boosters. There is some indication that the SA-4 may also be capable of surface-to-surface fire. In general configuration it resembles the

British Bloodhound missile. Another unusual feature is that the left missile is mounted 10 inches higher than the right one to allow for nestling the rather large fixed tail fins. In all probability this was designed to allow the overall dimensions of the missile and transport to be within air transportable limits of the AN-22 Antei (NATO-Cock). The vehicle is also known to be amphibious. The weapon utilizes a command/homing guidance system and has semi-active homing radars in each missile. In addition, the system uses the Pat Hand fire control radar. It can also utilize data from the Long Track surveillance radar, in common with the SA-2 and SA-3 systems. A Soviet Combined Arms Army has about nine batteries, each with three launchers. The SA-4 is in Soviet and East German ground units and is thought to have been used to fill in the gaps between SA-6 positions. Although it is believed to have been deployed in Egypt, no engagement reports are available upon which to determine system effectiveness or ECM success or failure.

The SA-6 Gainful Surface-to-Air Missile System

This is a highly sophisticated ramjet rocket-driven missile. It is carried on a modified PT-76GT full-tracked chassis with a triple launcher track system. The system utilizes an off-carriage radar, the Straight Flush, which is mounted on its own PT-76/GT chassis. In principle the system operates through a semi-active homing device in the missile that homes on the RF continuous wave illumination from Straight Hand. The Straight Hand radar is in fact both a target acquisition and a target tracking/target illumination system of very advanced design. It is suspected that it too, along with the ZSU-23-4 system,has an IFF capability. A Soviet Army usually has 10 batteries of SA-6 in its organizational structure.[10]

With this brief resume of the weapons involved, the story of the 1973 Middle East War may now be told.

The Preparation Phase

As pressures mounted toward another conflict in the region in 1969, the Israelis took the hostilities to the Egyptians by attacking Arab air defense installations west of the Suez Canal. The Soviet SAMs delivered to Egypt had originally been sited to protect Cairo and Alexandria. More and more, however, Israel began to note the movement of these sites, or the establishment of new ones, at locations eastward toward the Suez Canal. In the 1969-1970 war of attrition, Israeli air attacks against these installations continued and, on occasion, met and downed Soviet "advisors" flying air cover over these sites. The Egyptians flying MiG-21C and D interceptors and manning SA-2 Guideline launchers were totally ineffective against the Israelis. From 1967 to 1970 they lost about 150 of their small corps of trained pilots. At the same time, Israeli pilots, learning of the low-altitude incapacity of the SA-2, were consistently and successfully attacking the SAM sites themselves.

On 1 August 1970, a ceasefire was arranged which included an in-place standstill within 32 miles of the Canal. In violation of this agreement, the Egyptians, along with their Soviet advisors now entering Egypt in veritable droves, continually pushed their SAM sites forward until, by 1973, they had about 40-50 such sites, comprising 500-600 launchers, in forward areas much closer to the Suez.[11] About 50% of these sites contained the SA-3 Goa manned by Soviet troops. In one respect, this action was a direct consequence of Egypt's failure to contain the Israeli Air Force, which had up to then controlled the air space over the Suez Canal and had had relatively free access into Egyptian home air space as well. One result of this was the already discussed increasingly importune demands of Nasser for a credible counterforce to these Israeli penetrations. Thus, one might conjecture, Soviet prestige became pitted against what Israel viewed as a vital aspect of its national defense, the ability to overfly, maintain surveillance on, and, on occasion, carry out suppressive strikes against targets in foreign territories along its borders. In a matter of months, therefore, the Soviet Union, again opting to stay in the Middle East, began to deliver new weapons and equipment, most of which has already been

discussed, into Arab hands or, at least, into Arab territory. The overall expenditure amounted to about 2,500 million dollars. By 1973, then, Egypt had an inventory of new equipment that included:

SU-7 Fitter ground support aircraft
MiG-21 Fishbed fighter interceptors
MiG-23 Flogger fighter interceptors
Improved model SA-2 Gainful SAMs
SA-3 Goa SAMs
SA-4 Ganef SAMs
SA-6 Gainful SAMs
SA-7 Strela shoulder-fired SAMs

In addition, large numbers of AA guns were delivered, including the already discussed ZSU-23-4. The characteristics of all the weapons are shown in figures 6-9 and 6-10.

At the start of the war in 1973, Egypt had one of the strongest air defense systems in the world, with, quite possibly, the largest concentration of air defense weapons anywhere. The Egyptians could hope to maintain air superiority of sovereign air space and, at the same time, give effective antiaircraft protection to the ground combat forces in forward areas. The Arab air defense inventory at this time is shown in Figures 6-9 and 6-10.

Within less than four months of the start of the buildup the Egyptian Air Defense Command had grown to include some 150,000 troops and numerous SAM sites under their direct control. The Soviets themselves undertook the manning of other sites, flying the more advanced aircraft, and training to improve Egyptian command, control, and communications procedures. Air Defense Regions were established, along Soviet lines, along the Suez Canal and in the Cairo, Alexandria, and Aswan areas. Divisions were formed, with three brigades of six battalions (actually batteries) with from six to eight launchers each. About 70 such batteries, with some 600 launchers, were committed to the Suez Canal Air Defense Region alone. Fully one-third of these sites were within 19 miles of the Canal itself and, given the normal slant range characteristics of the weapons involved, provided the Egyptians with control of the air space to a depth of better than ten miles east of the canal. All associated radars, other fire control systems, and control centers were integrated into the overall air defense system. Most of the sites were located exactly 7 1/2 miles apart to insure overlapping coverage. (See Figure 6-11).

Figure 6-9

Soviet Air Defense Weapons used by Arabs in October 1973 War*

Caliber	Designation	Type	Mount	No. Tubes/ Launchers	Range	Rds/min per tube	Speed (mach)	Max Eff Alt.	Type Target	Arab countries Egypt	Jordan	Syria	Total
14.5mm	ZPU-4	AAMG	Towed	4	1,400	600				250	-	158	408
20mm		Autocannon		1						800	-	-	800
23mm	ZU-23	"		1	2,000 Slt	800-1000				250	-	158	408
23mm	ZSU-23-4	"	SP/ModP76	4xZU-23	2,000 Slt	800-1000				125	-	96	221
37mm	M-39	Gun	Towed	1	v.6,000 h.8,000	160-180				-	-	12	12
40mm		Autocannon	SP	2						-	12	-	12
57mm	S-60	Gun	Towed	1	6,000	120				100	-	72	172
57mm	ZSU-57-2	Autocannon	SP/ModT54	2xS-68	4,000	120				-	-	36	36
85mm	KS-12	Gun	Towed	1	v.10,500mm h.15,500mm	15-20				-	-	72	72
100mm	KS-19	Gun	Towed	1	v.15,400mm h.21,000mm	15				300	-	180	480
130mm	KS-30	Gun	Towed	1	v.21,945mm h.29,260mm	10-12				-	-	84	84
SA-2	Guideline	SAM	Towed	1	Slant 55km/40k' 28km/60k'		3.5	12,000m	High Alt.	800	-	300	1,100
SA-3	Goa	SAM	Trk Mount	2	30km		2-2.5	12,000+m	Low/Med Alt.		-		
SA-6	Gainful	SAM	SP/Pt76	3	High60km		2.8	18,000m	Low Alt.	80	-	60	140
SA-7	Grail	SAM	Shoulder	1	Low 30km 2.9-4km		1.5	45-1000m	Low Alt.	920	-	532	1,452

Source: Correlated from HERO documents
*Does not include Iraq's weapons.

Figure 6-10

Soviet Built Aircraft Used by Arabs in the October 1973 War

Designation	Codename	IOC	Mode	Max Speed est = 9640' altitude	Svc Ceiling	Range/ mi	Egypt	Syria	Iraq	Armament
MiG-19	Farmer	1955	FI	920mi	58,725	H 1367x	60	-		3x30mm, "Atoll" K13A
SU-7	Fitter	1959	All weather Close spt interdiction	1,055mi	49,700'	900x	130	45		2x30mm,various missiles
MiG-21	Fishbed	1958	Limited All weather	1,285mi	59,050'	H 1118x	160	110		2x30mm,"Atoll" K13
MiG-23	Flogger	1971	All weather	1,520mi	55,000'	800x	-	-		1x23mm,Twin various missiles
MiG-15	Fagot	1948	F	668mi	51,000	H 885x	-	-	106	1x37mm, /1x23mm
MiG-17	Frisco	1952	All weather-I	711mi	54,460	H 913x	200	120		1x37mm,2x23mm,8x55mm AAA or various ASM
Tu-16	Badger						18	15		
Il-28	Beagle	1950					30	4		

Source: Correlated from HERO documents

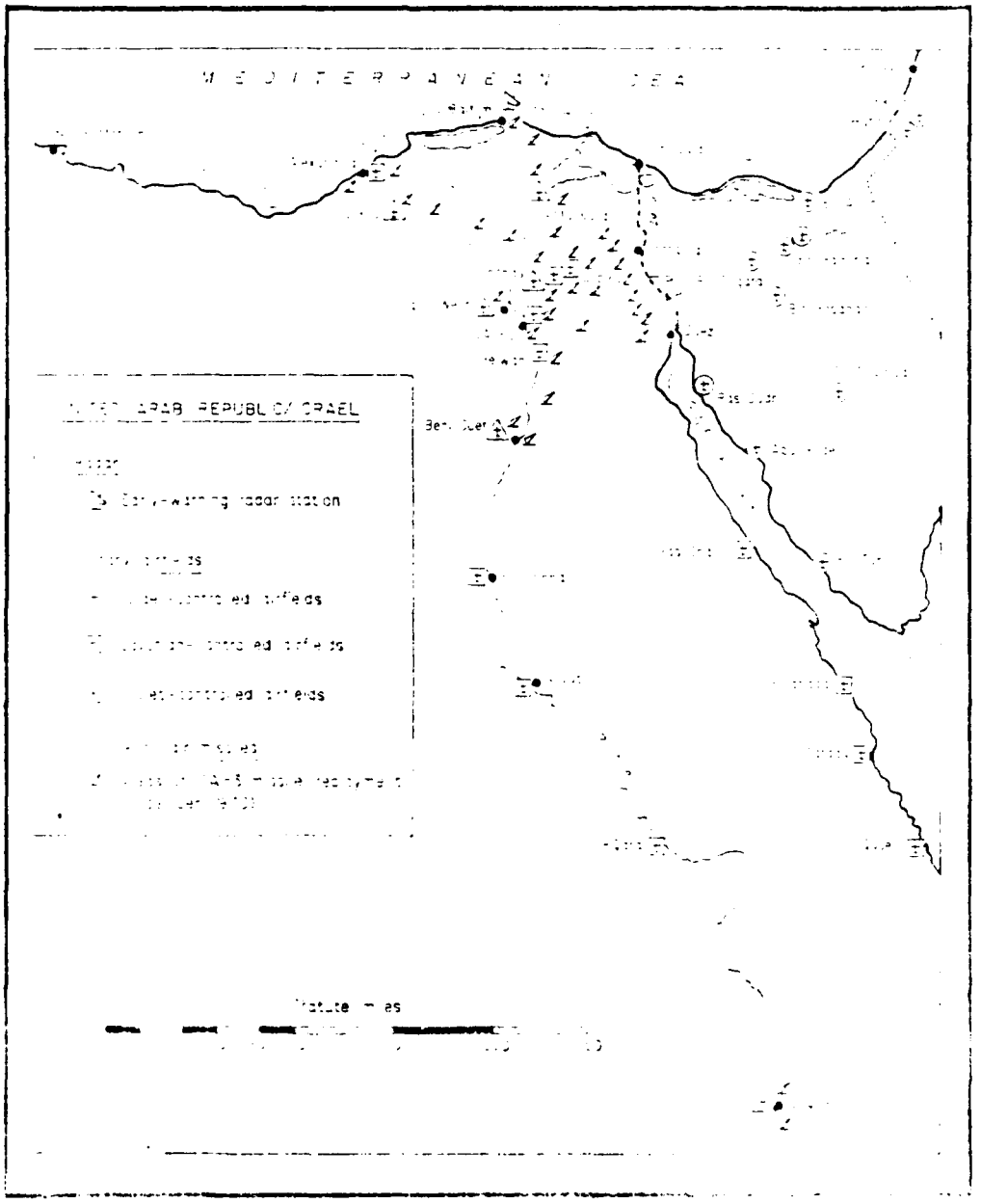


Figure 6-11

Air Defense Dispositions along the Sinai Front before October 1973

Source: Strategic Survey (1970), 49

The war did not begin, however, until several events of importance took place in the three year period following the 1970 ceasefire. Primary among these events was the sudden death of Gamal Abdul Nasser and the assumption of power in Egypt by Anwar Sadat. Immediately on taking the reigns of government, Sadat undertook to put more teeth in the waning and somewhat vapid Arab rhetoric of his predecessor's regime. More importantly, Sadat withdrew from the Pan-Arab ideology espoused by Nasser and moved to place Egypt at the focal center of the dispute with Israel. To this end, a Treaty of Friendship and Cooperation was agreed upon with the Soviet Union in 1971. Sadat then moved to improve the military condition of his nation further by asking for the most sophisticated weapons available. That he received what he wanted is probably best illustrated by the acquisition of the 7SU-23-4 Shilka discussed earlier, and the SA-6 Gainful SAM.

Then in 1972 two momentous events took place. The first was Sadat's startling dismissal of the Soviet advisory contingent in July, for reasons beyond the scope of this study. Suffice it to say that Sadat had become leery of Soviet influence and the possibility of a Communist sponsored *coup d'etat and ordered a significant* reduction in the number of Soviet advisors in Egypt. The second event took place in November 1972, when Sadat apparently decided to go to war once again with Israel. The Egyptians probably fully appreciated the fact that they had not achieved technological parity with Israel but apparently also understood that, unless something happened to break the stalemate, there could be no question of a Middle East settlement.

The Air Defense Campaign

At 1405 hours,6 October 1973, the Arab forces opened the latest in the series of ill-fated wars against the territories under Israeli control. There is no reason to presume that the Soviet Union directly aided in the planning for this event, but the Soviets had certainly abetted the Arabs in establishing the basis for belief that this time they would be more successful. The USSR had advance notice of the planned attack, however, as President Sadat informed the Soviet Ambassador to Cairo, Vladimir Vinogradov, of the plan on October 4, at the very moment that President Assad was informing the Soviet Ambassador to Syria.

> Later that day the chief of the reduced Soviet military mission in Egypt asked to see General Ismail, who at once received the Russian officer. The mission chief told Ismail that he had been informed by the ambassador of the pending attack. He said that he and his technicians had already assumed that the operation would begin soon, but had not been certain of the date. The Soviet government had, of course, been informed, and requested permission to send aircraft to Cairo to fly out all civilians, including the families of the handful of Russian officers remaining in Egypt. Ismail at once approved this request without comment. The Russian wished the Egyptian general good luck, then departed. The air lift began late that night, and continued through the 5th.[12]

The war lasted exactly 19 days, during which time the West was treated to a preview of the near-future battlefield. The conflict also presented an opportunity to study Soviet air defense weapons in a combat environment. As one might expect, Israel, Egypt, and Egypt's cohorts have been less than totally candid about a number of things that would be of direct interest to this study. Data on ammunition supply rates (ASR) and rounds fired per weapon, for instance, have not been made available in any detail to the west. Without this data, only educated assumptions may be made about certain key ratios. Nor have official sortie and loss rates been published. The statistical data used in this report has been checked unofficially by knowledgeable people on both sides and is considered accurate within reasonable limits.

An interesting facet of this war is that the Israelis utilized almost all US and other Free World air defense systems, while the Arab bloc used Soviet equipment almost exclusively. Certain comparisons are, therefore, possible of the relative effectiveness of like systems, although the resultant analysis may not be a true measure of systems as they would function in a U.S. versus U.S.S.R. scenario. This is in no way a denigration of the skill shown by the Israelis in this latest chapter of their internecine struggle with the forces of Islam. Greater credit, more than ever before, justified, must be given to the Arab forces for the conduct of such complex operations as those carried out in 1973. This is especially true in the Arabs' acquisition and employment of the most sophisticated air defense means available to them at that juncture.

The Egyptian commander of air defense forces barely credits the Soviets with any substantial role in the development of the National Egyptian Air Defense Command (NEADC) other than that of arms supplier. The draft text of a history of the NEADC in fact makes only two brief references to the Soviets, in one case dealing with a 1965 visit to Moscow, and in another declaring that the Soviet "suppliers" accomplished their task.[13]

The brilliantly planned and well executed opening of the October 1973 war with Israel by the Arabs permits some cogent observations on the effectiveness of the Soviet sponsored, Egyptian manned air defense command. The removal of Soviet advisors in July 1972 reinforces the statement of General Fahmy that it was an Egyptian operation secondarily supported by the Soviets.

Basically, the Egyptians and Syrians followed Soviet air defense doctrine on the organization and employment of air defense systems and deviated only slightly on the deployment of organic weapons. This air defense system accounted for nearly all the Israeli aircraft destroyed, and denied air superiority over the forward battle area to the much-vaunted Israeli Air Force. Above all, it greatly deflated the myth that advanced, supersonic airborne weapons platforms or aircraft had made conventional antiaircraft means obsolete. In doing this, it forced the United States and NATO to turn their attention once more to the tactical battlefield, where lessons learned in the Middle East needed to be applied.

Analysis and Results

Figure 6-12 gives a basic comparison of Arab sorties/losses versus Israeli sorties/losses. This basic formulation indicates that the Arabs had a sortie/loss ratio of 15:1 or a loss of 0.07 aircraft per sortie. For the Israelis the sortie/loss ratio was 103:1 or a loss of 0.0097 aircraft per sortie. A further comparison of losses is shown on the graph at Figure 6-13.

As far as the Arab side of the war was concerned, the air defense doctrine of the Soviet Union, especially as espoused by A.A. Sidorenko in a volume called Nastuplenie (The Offensive) published in Moscow in 1970, was employed with only minor modification.[14] The war saw the deployment of about 10,000 SAMs and AA guns of all varieties, many of them of new design. In particular, the combination of the SA-6 Gainful SAM system

AD-A166 753 THE DEVELOPMENT OF SOVIET AIR DEFENSE DOCTRINE AND 2/2
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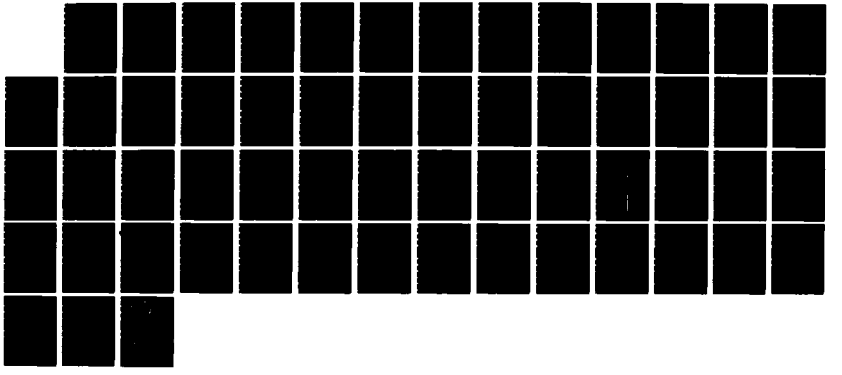


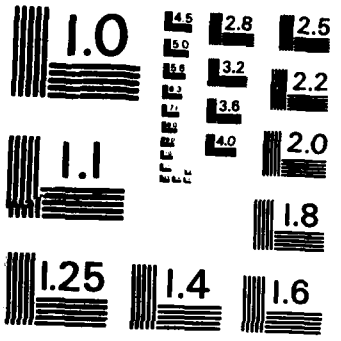


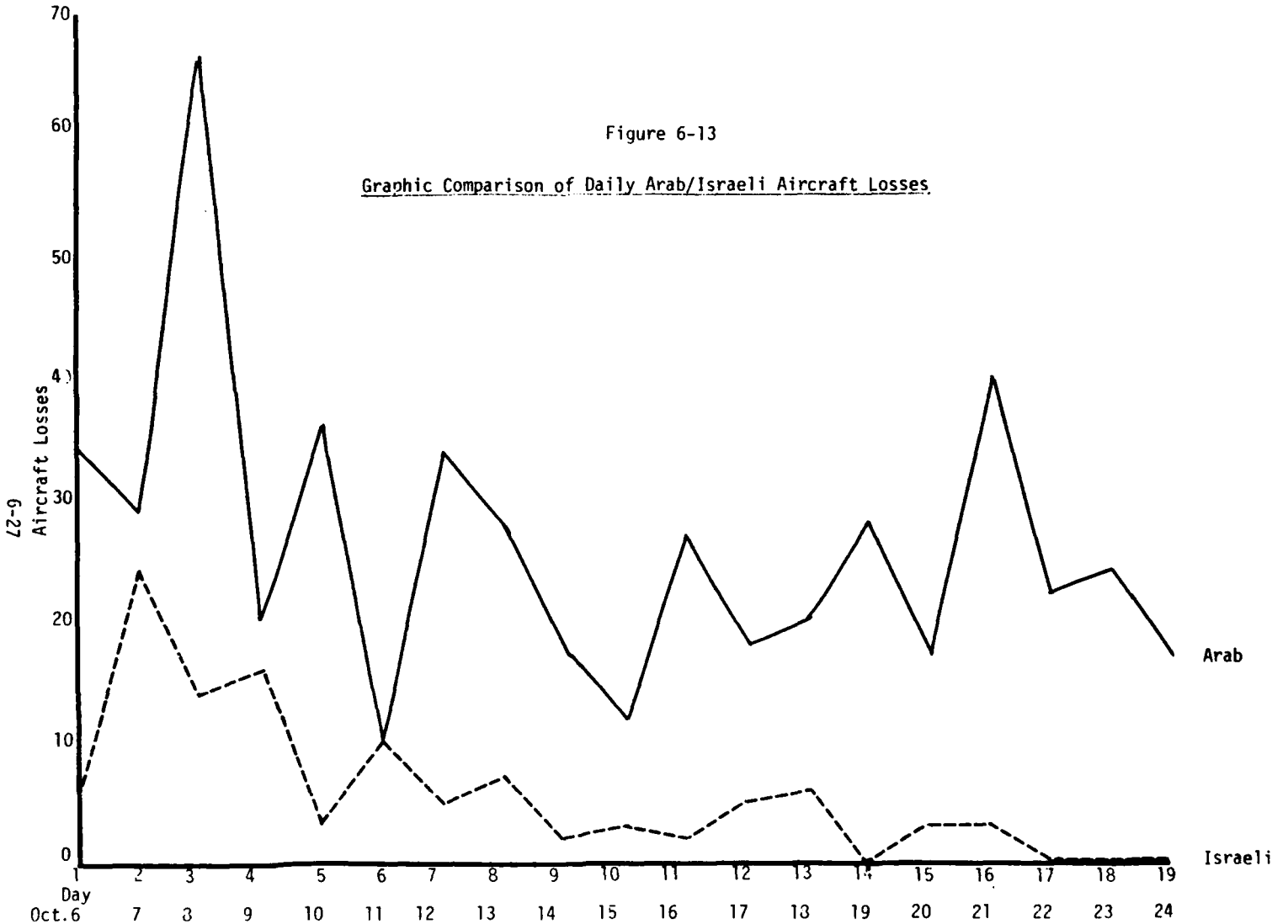
Figure 6-12

Sorties and Aircraft Losses
Arab - Israeli War 1973

Date	Day of Week	Day of War	Total Arab Sorties	Arab losses Egypt/Syria	Total Arab losses	Total Israeli Sorties	Israeli Sinai/ Golan	Total Israeli losses
Oct. 6	S	1	1,080	11/23	34	405	4/2	6
7	S	2	840	6/23	29	635	10/14	24
8	M	3	780	48/19	67	877	10/4	14
9	T	4	540	11/9	20	807	10/6	16
10	W	5	480	7/29	36	746	0/3	3
11	Th	6	120	3/7	10	648	2/8	10
12	F	7	180	2/32	34	599	0/5	5
13	S	8	240	6/22	28	444	2/5	7
14	S	9	240	9/9	18	527	2/0	2
15	M	10	120	5/7	12	514	1/2	3
16	T	11	450	15/12	27	546	2/0	2
17	W	12	150	9/9	18	445	1/4	5
18	Th	13	180	20/0	20	461	6/0	6
19	F	14	270	28/0	28	557	0/0	0
20	S	15	180	17/0	17	575	3/0	3
21	S	16	780	25/15	40	608	1/2	3
22	M	17	300	13/9	22	796	0/0	0
23	T	18	210	13/11	24	604	0/0	0
24	W	19	180	17/0	17	439	0/0	0
Total			7,320	265/236	501	11,233	54/55	109

Figure 6-13

Graphic Comparison of Daily Arab/Israeli Aircraft Losses



with the ZSU-23-4 Shilka accounted for the largest proportion of the destroyed Israeli aircraft. According to one source, the ZSU-23-4 destroyed so many Israeli A-4s attempting to attack Egyptian air bases that the Israelis stopped the attacks for three days while they reevaluated their tactics.[15] Most sources credit the Shilka with 1/3 to 1/2 of the aircraft destroyed by all means.

The Israeli Air Force began its operations less than 30 minutes after the Egyptians opened their attack at 1405 hours on 6 October 1973. Israeli air strikes in force did not begin, however, until about 1600 hours. These air strikes were most effectively countered by the Egyptian air defense envelope covering the west bank and by mobile AAA and SAMs moving with the assault units. Not only were the already mentioned SA-6s and ZSU-23-4s used, but the SA-7 Grail covered rifle companies in the very forefront of the advancing Egyptian forces. At least six Israeli aircraft were lost to this shoulder-fired weapon which approximates the U.S. Redeye surface-to-air missile. The SA-7, or Strella as it is called by the Soviets, failed to perform as well as it should, however, against the Israeli A-4 and F-4 aircraft. The extremely light explosive charge in the Strella round, even if it detonated in the tailpipe of an aircraft, was simply not powerful enough to insure disablement or destruction.

The Strella launcher is probably found in pairs in each motorized rifle company, and probably in each tank company as well, in the normal Soviet organization. (There is some debate in western intelligence units on this point.) This has to do as much with employment as with numbers, as the Soviets consider the proper employment of this weapon is firing in pairs against a single target. The SA-7 gunners or missiliers ride in the company commander's vehicle and presumably stay close to him when he is afoot. It is estimated that at least 5,000 rounds of SA-7 were fired in the 1973 War.[16] As this is an infrared guided heat-seeking missile, many of the techniques developed in Vietnam to counter its effectiveness were used by the Israelis, including the use of decoy flares and placement of deflectors on helicopter exhausts.

As the war progressed, the Israelis realized that something had to be done about the Arab air defense system. This was as true on the Golan Heights front as it was in the Sinai. By Day 3, 8 October, the Israelis had begun a systematic air defense suppression campaign aimed at knocking out the SAM systems on both fronts. The graph in Figure 6-13 illustrates the Israeli success in this campaign. Although the number of Israeli losses is not particularly high in comparison to Arab aircraft losses, the graph does illustrate a number of interesting points.

The Israelis lost only six aircraft the first day(October 6th). It must be remembered, however, that they did not mount their air strikes in any numbers until 1600 and that the war itself did not start until 1405. Hence, in ten hours the Israelis lost six aircraft, which would translate to fourteen plus aircraft for a 24 hour period at that intensity. Day 2 (October 7th) marked the high point in Israeli losses from all sources, with 24 aircraft destroyed. This is accounted for by the initial Israeli surprise in running into the intensive air defense fires of the Arabs. Thereafter there was a steady diminution of losses throughout the remainder of the war. To carry out the suppression campaign required diversion of aircraft from close support missions with Israeli ground forces.[17]

The Israeli suppression campaign brought two points to the fore. Electronic countermeasures (ECM) worked rather well against the SA-2 Guideline and the SA-3 Goa; they did not work, however, against the SA-6 Gainful, with its off-carriage Straight Flush radar and the semi-active homing capability of the missile,which utilizes the RF energy reflection to home on the target. For attacking the SA-6 special tactics had to be developed. A first attempt to overcome the missile's effectiveness took the form of spotting the puff of smoke given off at ignition. The aircraft would then begin special evasive maneuvers to avoid the mach 2.8 speed missile. Because the smoke puff had to be identified almost instantaneously, helicopter spotters were assigned to accompany the attack aircraft. So many helicopters were destroyed by SAMs or by the ZSU-23-4, however, that this experiment was quickly abandoned. A more successful tactic was a high altitude penetration of the SA-6 envelope to a point directly over the launch site. Taking advantage of the rather flat launch trajectory of the

missile, the aircraft would then dive directly on the launcher. Another innovation was the employment of chaff to confuse the radar. As the Israelis did not possess chaff pods, they jury-rigged a system by filling the dive brake wells of the attack aircraft (usually F-4Es) with chaff, which was then scattered simply by opening the brakes. This system had only marginal effectiveness, since neither could sufficient chaff be dispersed nor was it dispersed always in a sufficiently dense pattern to confuse the radar. The Israelis went to great pains to identify safe corridors through the air defense areas, but, to a large extent, this effort was overcome by the suspected IFF capability of both the ZSU-23-4 and the SA-6. In general terms, then, it may be said that the Israelis were only partially successful in overcoming the Arab air defense system. Only a rather tedious and expensive program of attriting the sites paid off in the long run.

In the meantime, air support of the ground effort suffered. The Israelis were, understandably, loath to sacrifice precious aircraft and crews and adopted the safest means of employment of their air resources. Operating at much higher altitudes to allow more evasive maneuver time against oncoming missiles and to avoid the Shilka, the air support also became less effective. In one sense, this accomplished one aspect of the Soviet air defense doctrine. If you cannot destroy the enemy's aircraft, force him to give up at least part of his capability.[18]

Detailed Analysis of Israeli Losses

Figure 6-14 displays the daily breakdown of Israeli aircraft destroyed in the October 1973 War and the numbers of attack sorties. While the available data identifies attack sorties flown into the Sinai and into the Golan fronts it does not differentiate air defense missions in these two categories. Thus, loss statistics indicate the number of aircraft lost on a particular day as opposed to a known number of attack sorties and an unknown portion of the day's air defense sorties.

Figure 6-14

Israeli Aircraft Sorties and Losses
1973 October War

Day of Week	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	Totals
Date (Oct. '73)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Day of War	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Attack sorties Sinai	182	242	446	413	270	55	138	83	231	242	292	231	275	347	380	314	550	347	292	5,330
Attack sorties Golan	22	270	187	171	242	363	209	149	55	72	33	22	-	2	6	55	22	50	3	1,933
Total attack sorties	204	512	633	584	512	418	347	232	286	314	325	253	275	349	386	369	572	397	295	7,263
Total Air Defense sorties	202	123	244	223	234	230	252	212	241	200	221	192	186	208	189	239	224	207	144	3,970
Total Sorties	405	635	877	807	746	648	599	444	527	514	546	445	461	557	575	608	796	604	439	11,233
Losses Sinai	4	10	10	10	0	2	0	2	2	1	2	1	0	0	3	1	0	0	0	54
Losses Golan	2	14	4	6	3	8	5	5	0	2	0	4	0	0	0	2	0	0	0	55
Losses Total	6	24	14	16	3	10	5	7	2	3	2	5	6	0	3	3	0	0	0	109
% of A/C lost	1.48	3.78	1.59	1.98	0.4	1.54	0.83	1.57	0.39	0.58	0.37	1.12	1.3	-	0.52	0.49	-	-	-	0.97

Using these numbers as a basis, the following relationships of aircraft lost to particular weapon types may be shown:

Total Israeli sorties flown		11,233 (7,263 atk/3,970 AD Sorties)[19]
Total Israeli aircraft lost		109
Aircraft lost to:		
Air-to-Air		15
SAM (SA-2/3/6)		40
SA-7		6
AAA		31
Other/Unknown		17
	Total	109

Number of aircraft destroyed per sortie flown 0.01

Number of sorties flown per aircraft destroyed 103.00

Israeli Aircraft Lost in Air-to-Air Combat
(Data is not available as to whether these aircraft were lost to AAM or cannon.)

Aircraft lost	15
Aircraft lost per attack sortie	0.002

Israeli Aircraft Lost to SAMs

Number of SAM launchers in Arab inventory

	SA-2/3	SA-6	(Total)	SA-7	Total
Egypt	800	80	(880)	920	1,800
Syria	300	60	(360)	532	892
	1,100	140	(1,240)	1,452	2,692

Israeli attack sorties	7,263
Israeli losses to SAMs	40

Based on Arab emphasis on ground air defenses and on the fact that the SA-6 was deployed well forward in the battle area, in conjunction with the ZSU-23-4, the following assumptions are made:

Each missile launcher fired 2 missiles;

The SA-6 accounted for ½ of the total kills because of its location and radar;

The SA-2/3 ratio is 2:1; hence there were 733 SA-2s and 367 SA-3s;

The SA-2s are all considered to be single track launchers;

The SA-3s are 2 track launchers;

The SA-6s are triple-track launchers; therefore:

Israeli Losses to SAMs by Type

SA 2/3	20
SA-6	20
Total	40
SA-7	6
	46

Number of Missiles Fired

SA-2	733 launchers x 2	1,466
SA-3	367 two-track launchers x 2	1,468
SA-6	140 three-track launchers x 2	840
	Total missiles fired	3,774
	SAMs fired per aircraft killed (40)	94.35
	Aircraft killed per SAM fired (40)	0.01
	Aircraft killed per attack sortie (40)	0.006

Israeli Aircraft Losses to the SA-2

Israeli attack sorties	7,263
Number of SA-2 launchers in Arab hands	733
Number of SA-2 missiles fired	1,466
Assumed SA-2 kills of total 40 SA-2/3 kills	14
SA-2s fired per aircraft killed	104.7
Aircraft killed per SA-2 fired	0.009
Aircraft killed by SA-2 per attack sortie	0.002

Israeli Aircraft Losses to the SA-3

Israeli attack sorties	7,263
Number of SA-3 launchers in Arab hands	367
Number of SA-3 missiles fired	1,468
Assumed SA-3 kills of total 40 SA-2/3 kills	6
SA-3s fired per aircraft killed	244.6
Aircraft killed per SA-3 fired	0.004
Aircraft killed by SA-3 per attack sortie	0.001

Israeli Aircraft Losses to the SA-6

Israeli attack sorties	7,263
Number of SA-6 launchers in Arab hands	140
Number of SA-6 missiles fired	840
Assumed SA-6 kills of total 40 SAM kills	20
SA-6s fired per aircraft killed	42
Aircraft killed per SA-6 fired	0.023
Aircraft killed by SA-6 per attack sortie	0.0028

Israeli Aircraft Losses to the SA-7

Israeli attack sorties	7,263
Number of SA-7s in Arab hands	1,452
Suspected number of firings	5,000
Number of firings per launcher available	3.42 or 3
Probable number of SA-7 fired	4,356
Israeli aircraft killed by SA-7	6
Prob. no. of rounds fired to kill these 6	12 (One round each from two launchers)
Total missiles fired per kill	726
Aircraft killed per missile fired	0.0014
Aircraft killed per attack sortie	0.001

Total All-Type SAM/Israeli Analysis

Israeli attack sorties	7,263
Total Israeli losses to SAMs	46
Total missiles fired	8,130
SAMs fired per aircraft killed	177.9
Aircraft killed per SAM fired	0.0057
Aircraft killed by SAM per attack sortie	0.0063

Israeli Losses to AAA & AAMG Fire

Recapitulation of Types of AAA & AAMG Available to the Arabs [20]

Weapon	Egypt	Syria	Jordan	Iraq	Total
ZPU-14.5mm	250	158		?	408
Cannon 20mm	800			?	800
ZU-23 23mm	250	158		?	408
ZSU-23-4 23mm	125	96		?	221
M39 37mm		12		?	12
Cannon 40mm			12	?	12
S-60 57mm	100	72		?	172
ZSU-57-2 57mm		36		?	36
KS-12 85mm		72		?	72
KS-19 100mm	300	180		?	480
KS-30 130mm		84			84
Total	1,825	868	12	?	2,705

Israeli attack sorties	7,263	
Israeli losses to AAA & AAMG	31	
Aircraft killed per gun/MG	0.011	
Aircraft killed by AAA/AAMG per attack sortie	0.004	
Relationship of ZSU-23-4 to other AAA/AAMG	8.89:1	(Other AAA: ZSU-23-4)
If ZSU-23-4 killed 50% of AAA/AAMG kills	16	
Aircraft killed per ZSU-23-4	0.07	
Aircraft killed by ZSU-23-4 per attack sortie	0.002	

The ZSU-23-4 - SA-6 Complex

Israeli attack sorties	7,263	
Israeli losses to ZSU-23-4 & SA-6	36	
Aircraft killed per ZSU-23-4/SA-6 launcher	0.149	
If 5 bursts of 50 rds. ea. of ZSU-23-4 kills, then:		
16 kills represent 4000 rds. Kills per rd.	0.004	
If average no. of bursts is 3, then each gun		
fired 150 rds. x 221	33,150 rds.	expended.
If 3 burst is average, then:		
Aircraft killed per no. of bursts	0.024	
Aircraft killed per no. of rds. (33,150)	0.0005	
Rounds fired per aircraft killed	6,216	
Aircraft killed by ZSU-23-4/SA-6 per attack sortie	0.005	

Israeli Aircraft Inventory

Fighter Interceptor/Fighter Bomber		352
Mirage	50	
F-4 Phantom	140	
A-4 Skyhawk	150	
Super Mystere	12	
Total number Israeli aircraft killed		109
Ratio of aircraft to killed		30.9:1
Aircraft killed per attack sortie		0.048

Figure 6-15 shows comparable sortie/loss data on Arab forces. Analysis of that data shows the following relationships:

Total Arab sorties		7,320
Total Arab aircraft lost		501
Arab aircraft lost to:		
Air-to-air		334
SAM (Hawk)		25
AAA		72
Destroyed on ground		22
Friendly fire		48
	Total	501
	Lost to Israelis	453 (all calculations are based on this figure.)
Number of aircraft destroyed per sortie flown		0.06
Number of sorties flown per aircraft destroyed		16

Arab Aircraft Lost in Air-to-Air Combat

(Data is not available as to whether kill was made by cannon or missile)

Aircraft lost	334
Aircraft lost per sortie	0.046

Arab Aircraft Lost to SAMs

Number of Israeli launchers (Hawk)		75 (Each Hawk launcher holds 3 missiles)
Arab sorties	7,320	
Arab losses to SAM	25	
Assume each launcher fired once; therefore:		75 missiles fired
Aircraft killed per Hawks fired		0.333
Hawks fired per aircraft killed		3
Aircraft killed by Hawk per sortie flown		0.003
Aircraft killed by Hawk per attack sortie flown		0.01

Figure 6-15

Arab Aircraft Losses: 1973 October War - Estimated

Day of Week	S	S	M	T	W	Th	F	S	S	M	T	W	Th	F	S	S	M	T	W	
Date(Oct '73)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Day of War	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Egyptian attack sorties	260	100	200	0	20	16	16	50	40	20	90	20	60	90	60	160	80	40	60	1,382
Syrian attack sorties	100	180	60	180	140	24	44	30	40	20	60	30	0	0	0	100	20	30	0	1,058
Total attack sorties	360	280	260	180	160	40	60	80	80	40	150	50	60	60	60	260	100	70	60	2,440
Total Arab AD sorties	720	560	520	360	320	80	120	160	160	80	300	100	120	120	120	520	200	140	120	4,880
Total sorties	1,080	840	780	540	480	120	180	240	240	120	450	150	180	180	180	780	300	210	180	7,320
Egyptian Losses	11	6	48	11	7	3	2	6	9	5	15	9	20	17	17	25	13	13	17	265
Syrian Losses	23	23	19	9	29	7	32	22	9	7	12	9	0	0	0	15	9	11	0	236
Total Arab Losses	34	29	67	20	36	10	34	28	18	12	27	18	20	17	17	40	22	24	17	501

Arab Aircraft Lost to AAA		
Arab sorties		7,320
Arab attack sorties		2,440
Arab AAA lost to AAA		72
Number of AA guns available to Israelis		982
20mm	770	
40mm	212	
Arab aircraft killed per gun		0.073
Arab aircraft killed per sortie		0.0098
Arab aircraft killed per attack sortie		0.01

Arab Losses to Ground Fire (Hawks and AAA)	
Attack	97
Sorties per aircraft killed	25
Aircraft killed per attack sortie	0.039

Even the most cursory glance at the recapitulations in Figures 6-16 & 6-17 indicates that the Israelis fared better than the Arabs in the area of aircraft lost through opposing air defense operations. As with all such data, some of the statistics are estimates based on intimate knowledge and are not hard numbers confirmed by the participants. What refinement of these numbers has been accomplished, however, has done little to change the general evaluation. As it stands, then, the Israelis, with their reliance on airborne air defense (interceptor aircraft) did better than the Arabs with their concept of the primacy of ground means of air defense.

Obviously, such a simplistic evaluation fails to appreciate a number of significant points. First of all, it fails to identify properly the tremendous increase in the air defense effectiveness of the Arabs over earlier Israeli encounters. Second, it fails to appreciate that, while the Israelis' air defense system was not greatly changed, the Arabs were utilizing equipment much of which they had had no combat experience with. This in no way is meant to designate "good guys" or "bad guys." Rather, it tends to note that, in such an environment as the last Arab-Israeli War, pure statistics do not in and of themselves tell the whole story. Criticism could certainly be heaped on both sides. The Israelis apparently failed to appreciate the seriousness of the improved Arab air defense until after

Figure 6-16

Aircraft Loss Comparison 1973 Arab-Israli War

Force	Total No. Sorties	Total No. Attack Sorties	No. of A/C Lost to Enemy	Lost per Sortie		Lost Air-to-air		Tot.Lost Ground-to air		To SAMs		To AAA		To Air-to-Ground	To Friendly		Other/Unk.	
				Tot	Atk	No.	per tot sortie	No.	per atk sortie	No.	per atk sortie	No.	per atk sortie		No.	per tot sortie	No.	per tot sortie
Arabs	7,320	2,440	453	.06	.19	334	.05	97	.04	25	.01	72	.03	22	48	.01	-	-
Israelis	11,233	7,263	109	.01	.015	15	.001	77	.01	46	.006	31	.004	Unk	Unk	?	17	.002

Figure 6-17

Aircraft Loss to SAMs Comparison 1973 Arab-Israeli War

Missile	No.of Attack Sorties	No.of Aircraft Lost	A/C Lost per attack Sortie	Atk Sortie / A/C Downed	Number of Launchers	Number of msls. fired	No. of msls. fired per kill	No. of A/C killed per msls. fired
Hawks vs. Arab Aircraft	2,440	25	.01	97.6	75	75	3	.33
Arab SAM vs. Israelis Aircraft	7,263	46	.006	158	2,692	8,130	178	.006
SA-2	do	14	.002	519	733	1,466	105	.009
SA-3	do	6	.001	1,210	367	1,468	245	.004
SA-6	do	20	.003	363	140	840	42	.023
SA-7	do	6	.001	1,210	1,452	4,356	726	.0014

the war had begun, for one thing, while the Arabs seem to have failed to capitalize on the means they had available to them, probably because of lack of sufficient training. The comment has been made that the Arabs received roughly the same amount of training as was given Soviet troops. If this is the case, training methods and content failed to appreciate the variance in background and relative sophistication between Arab and Russian.

Still, what has been learned is important, especially as a tool for further evaluation of U.S. versus Soviet potentials.

CHAPTER VI

Notes

1 Laurence Martin, Arms and Strategy: The World Power Structure Today (New York: David McKay, 1973), p. 188.

2 Strategic Survey, (London: International Institute of Strategic Studies, 1977), pp. 65, 67.

3 See for instance Martin, p. 189. For a good account of the air defense campaign in the 1967 Arab-Israeli War see unpublished MSS. LTG. Mohamed Fahmy, The Fourth Service, pp. 40-46.84.

4 Adapted from Strategic Survey, 1970, p. 47.

5 Steven J. Zaloga, Modern Soviet Armour (London: Arms and Armour Press, 1979), p. 79.

6 Jane's Weapons, 1979-1980. Most of the above data is taken from this source, although additional information was collected from numerous other source documents.

7 Zaloga, p. 81.

8 W. Schafer, "NVA Troop Antiaircraft Defense, "Militartechnik No. 9 (1967), 422-423. In translation FTD-HT-23-499-68, p. 1.

9 This data is compiled from a number of sources, including: Zaloga, P.81; FM 30-40, HQDA, 30 June 1975; Benedetto Pafi, L'armata Rossa dal 1946 al 1974 (Milan: Intergest, 1974); Daniel K. Malone, "Air Defense in the Soviet Ground Forces," Soviet Aerospace Almanac in Air Force Magazine (March, 1978), 82; Jane's Weapons: 1979-1980.

10 The data on these missiles was developed from a number of sources: see mainly Malone, 79, 82; Zaloga, pp. 85-86; Wm. F. Scott, "Troops of the National Air Defense," Soviet Aerospace Almanac in Air Force Magazine (March, 1978), 56; Bill Sweetman and Bill Gunston, Soviet Air Power (London: Salamander Books, Ltd., 1978)pp. 32-97. Parametric data on all systems is shown elsewhere in this report.

11 It should be noted that the Israelis were also violating the agreement.

12 HERO report, The Middle East War of October 1973 in Historical Perspective, February 1976, p. 40.

13 Fahmy, op. cit.

14 This work is found in translation in the Soviet Military Thought series published under the auspices of the United States Air Force.

15 Malone, 81-82.

16 Ibid., 82.

17 The majority of this section of the report is taken from data found in HERO's report, The Middle East War in Historical Perspective.

18 Gatsolayev, p. 6.

19 For purposes of this study, and based on the available data, it is assumed that all 109 aircraft lost by the Israelis were lost on attack sorties and not on air defense missions -- usually MiGCAP over Israeli territory or MiGCAP overwatching deep penetration bombing missions into Arab territory.

20 Data extracted from HERO, Combat Data Subscription Service Vol. II, No. 2 (Spring 1977) Data on Iraq is not available.

CHAPTER VII

PRESENT DAY SOVIET AIR DEFENSE

In the recently updated version of Weapons Technology the following statement may be found:

> As late as the Korean war of 1950-53, the United Nations tactical air forces were able to dominate the battlefield, denying movement to the enemy by day. At that time, anti-aircraft cannon were effective only in defence of point targets at the very low and low levels (ground level to 2,000 feet). The introduction of air defence guided weapons in the 1950s and 1960s, and their use by the Arabs in the October 1973 war, brought about a profound change in the tactical use of air power. The success of the enterprising and operationally experienced Israeli air force in out-flanking and, to an extent, breaching the strategic air defences of Egypt and Syria should not lead to the conclusion that, by the end of the campaign, tactical air power had once more proved to be supreme. The fact is that neither the Egyptians nor the Syrian ground forces were destroyed: each retained an integrity which owed much to the success of SA-6 and SA-7 in combination with conventional air-defence cannon, including the radar-directed ZSU-23-4, in denying the Israelis the free-ranging air-to-ground attack operations of earlier wars. Since that event, the British Rapier and Blowpipe, the Franco/German Roland, the United States infra-red homing Redeye and the German Geopard armoured anti-aircraft multiple cannon have all come into service as matching -- in many instances as superior -- systems. But the USSR has not fallen behind: SA-8 and SA-9 have been added to the inventory of the Warsaw Pact to comprise, with the weaponry previously in service, a formidable capability to resist air attack upon their armies. It must be expected that a new family of weapons and equipment is in course of development to maintain and enhance this capability.[1]

This excerpt from this prestigious publication tells the story of the present period in Soviet air defense rather well. The author does seem to err in his description of Red Eye, which was operational as early as 1964. and probably preceded the SA-7 Grail by a few years. But, otherwise, this semi-official British view is quite accurate. Certainly the Soviets learned much from the experience in the Middle East and Vietnam. There are those who

say they may, in fact, have learned more than the West. One expression of this concern may be seen in the following chart that shows the relative posture of the United States and the Soviet Union for the five year period 1973-1977:

Figure 7-1

Comparison of US/USSR Air Defense Means[2]

Year	Manned Aircraft		Strategic SAMs		ABM Missile Launchers		Personnel	
	USSR	US	USSR	US	USSR	US	USSR	US
1973	2,900	585	10,000	481	64	-	500,000	34,109
1974	2,650	532	9,800	261	64	-	500,000	33,438
1975	2,550	374	12,000	-	64	-	500,000	30,500
1976	2,650	331	10,000	-	64	-	550,000	29,350
1977	2,650	331	12,000	-	64	-	550,000	24,595

The comparison is obvious and therefore does not warrant discussion. What is more important is how the Soviet Union utilizes this manpower and equipment and how it has organized not only its strategic air defenses but also its tactical air defense capabilities.

Soviet Strategic Air Defense in the 1970s

The Modern PVO-Strany

A general reorganization of the PVO Strany began under Khrushchev's overall revamping of the Soviet armed forces. Intercept aircraft numbers were reduced, missile development programs undertaken, and, as SAMs became available, antiaircraft guns were removed from the inventory. Khrushchev most likely achieved the goals he desired in this regard, and Soviet air defense appears to have benefited, as the removal of obsolescent equipment could not help but raise system effectiveness. During this period numerous SAM sites equipped with the SA-2 Guideline were deployed throughout the Soviet Union. The rate of deployment was so high, in fact, that it "astounded Western military planners."[3]

The Brezhnev period in strategic air defense is best characterized as a time of conservatism and inconsistency. Certainly, the conservatism may be judged as a normal reaction to the preceding Khrushchnevian period marked by gross change and modification. The matter of inconsistency is something else altogether and relates particularly to the Soviet Union's seeming lack of proper perception of its strategic air defense needs. During a time when the United States has steadily decreased its strategic bomber capability, for instance, the Soviet Union has steadfastly retained over 10,000 SA-2 and SA-3 SAMs within the PVO Strany inventory. One German source, quoting US figures, put it another way; in 1960 the ratio between US strategic bombers and Soviet intercept aircraft was 1:2.9. In 1977, this ratio was 1:6.3.[4]

This might be nothing more than the manifestation of the Soviets' obsession with the defense and security of their territory. Regardless of the rationale that drives the Soviet mind, the fact remains that there is have a well-integrated extensive air defense shield over the Soviet Union. One depiction of this shield is shown in Figure 7-2. Care should be taken to note that an ICBM and ADD overlay are also a part of the sketch. An initial impression of the air defense belts developed in this 1976 sketch is that the Soviet Union is prepared for an attack from both west and east, the east obviously being equated with the People's Republic of China. There is no question but that this is an accurate appraisal, for voluminous literature deals with these perceived threats. It would be erroneous to assume that all PVO Strany air defense means are collected in these two belts, however, as each military district throughout the Soviet Union has its own air defense resources, possibly including antiaircraft cannon in the more remote areas. These PVO districts are most likely established on a priority basis that provides a sequence for deploying new equipment and other resource allocation. (See Figure 7- 2 and 7-3.)[5]

To carry out this overall program of strategic air defense occupies some 500,000 Soviet troops, plus satellite forces. Since 1971, the air defense forces within the Warsaw Pact have been nominally under the control of the Commander in Chief of the Soviet PVO Strany.[6] In effect, this

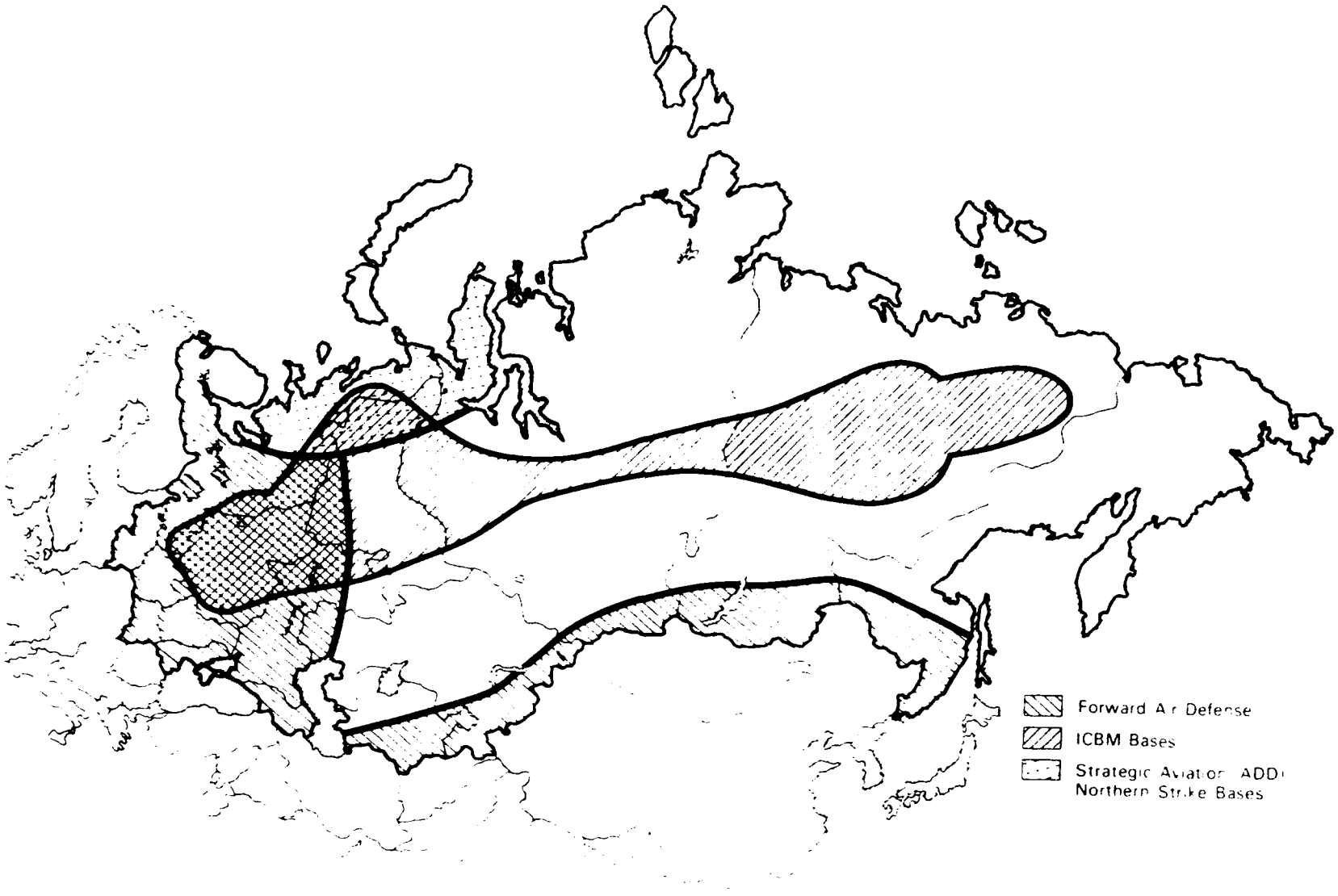


Figure 7-2

PVO-STRANY
Air Defense Zones In USSR

Figure 7-3

Military Districts in USSR

extends the Soviet air defense area to the very borders of West Germany and the NATO shield. Deployment of heavy concentrations of air defense ground means such as the SA-4 Ganef into forward areas could put the Soviet Union in the position of threatening the western air space over the Federal Republic of Germany.

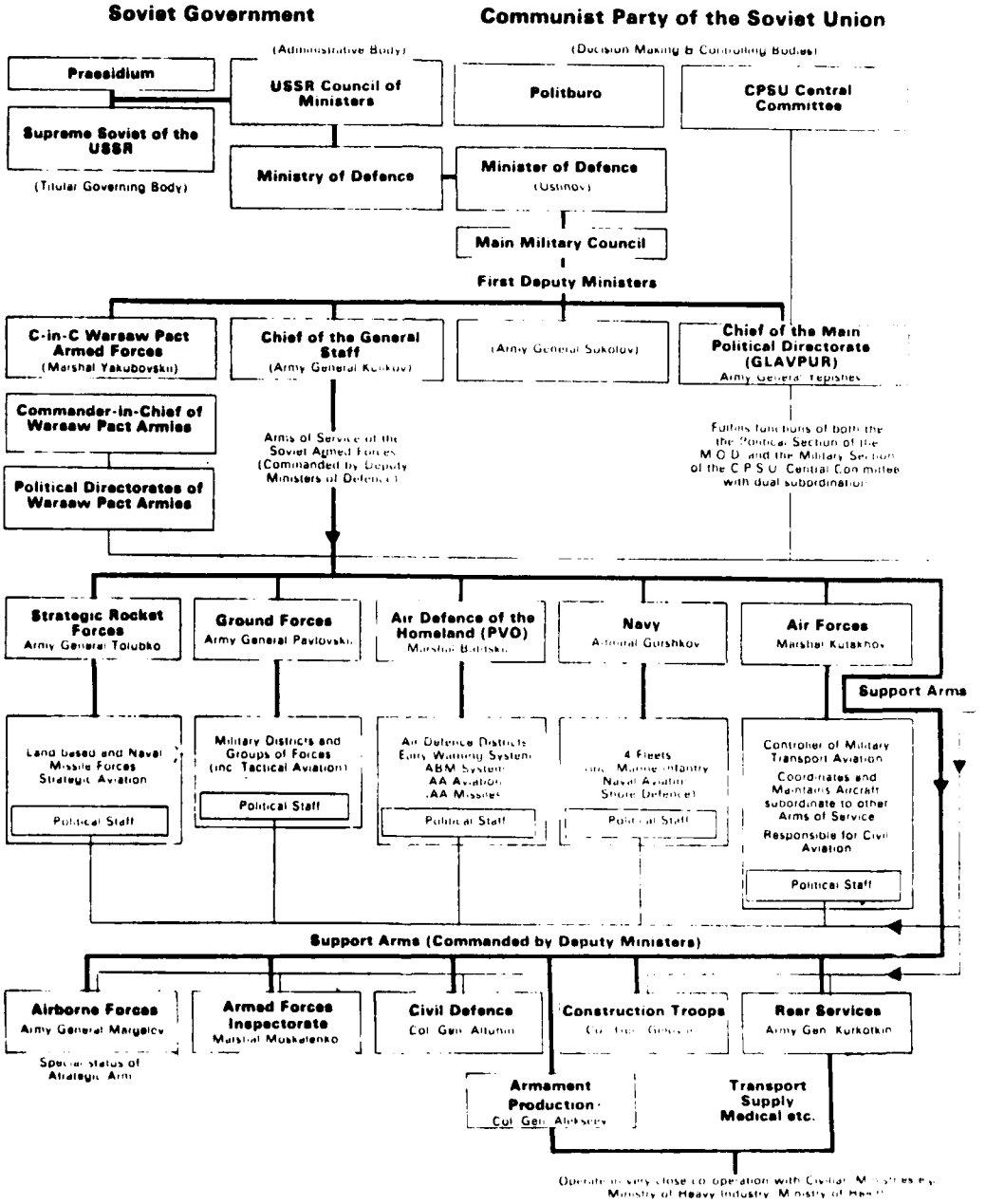
At present the PVO Strany, under the command of MSU P.F. Batitskii, who is also a Deputy Minister of Defense, as are all of the five major component commanders, is comprised of the manned fighter incerceptor force, the Fighter Aviation of the Air Force (Istrebitel'naya aviatsiya PVO) or PVOIA, the Anti-Aircraft Missile Troops (Zenitno-Raketnye Voiska) or PVOZRV, and the Radio Technical Troops (Radioteknicheskie Voiska) or PVORTV. There are two other elements associated with the overall PVO Strany mission and structure; these are the PKO or Protivokozmicheskaya Oborona, the Aerospace Defense Forces and the PRO or Protivoraketnaya Oborona, the Anti-Ballistic Missile Forces. In the case of the former, the PKO, very little is said of this force since the signing of the treaty banning the use of space for military purposes in 1965. The PRO, on the other hand, enjoys a unique position as the only ABM force anywhere in the world. While the PKO deals in technologies well beyond the scope of this paper, the PRO uses equipment which fits into the more prosaic pattern surrounding PVOZR operations.

Although a definite slowdown in activities associated with the PRO program can be traced back to 1968, the organization still mans four complexes, each with 16 launchers. Whether this system will eventually phase out remains to be seen. At present, at least two missiles are associated with the PRO, the Galosh ABM with a range of up to 400 miles and a warhead capability of one to two megatons, and the SA-5 Gammon, an advanced surface-to-air missile with a slant range approaching 100 miles at 95,000 feet. Two other ABM missiles are thought to be in the production cycle.[7]

The command organization of the military and political infrastructure of the Soviet Union is shown in Figure 7-4, while the organization of PVO Strany is shown in Figure 7-5.

Figure 7-4

Military and Political Infrastructure of the Soviet Union



Chaired by the Minister of Defence the Military Council directs the work of the USSR Ministry of Defence. Members of the Military Council include all First Deputy and Deputy Ministers of Defence and most senior officers of an Arm or Service such as Commanders of Military Districts or Fleets senior political officers and members of the Central Committee and senior civilians from relevant positions e.g. those responsible for industrial production.

A Military Council meeting called by the Minister of Defence may involve only the First Deputy Ministers plus a few other members e.g. heads of organisations involved in matters on the agenda of the meeting.

A senior commander such as the Chief of an Arm of Service directs his organisation through his own Military Council composed of his deputy commanders and senior subordinates. At all levels the Military Council includes at least one member of the Political Administration who is directly subordinate to his superior in the GLAVPUR organisation as well as to the senior military commander.

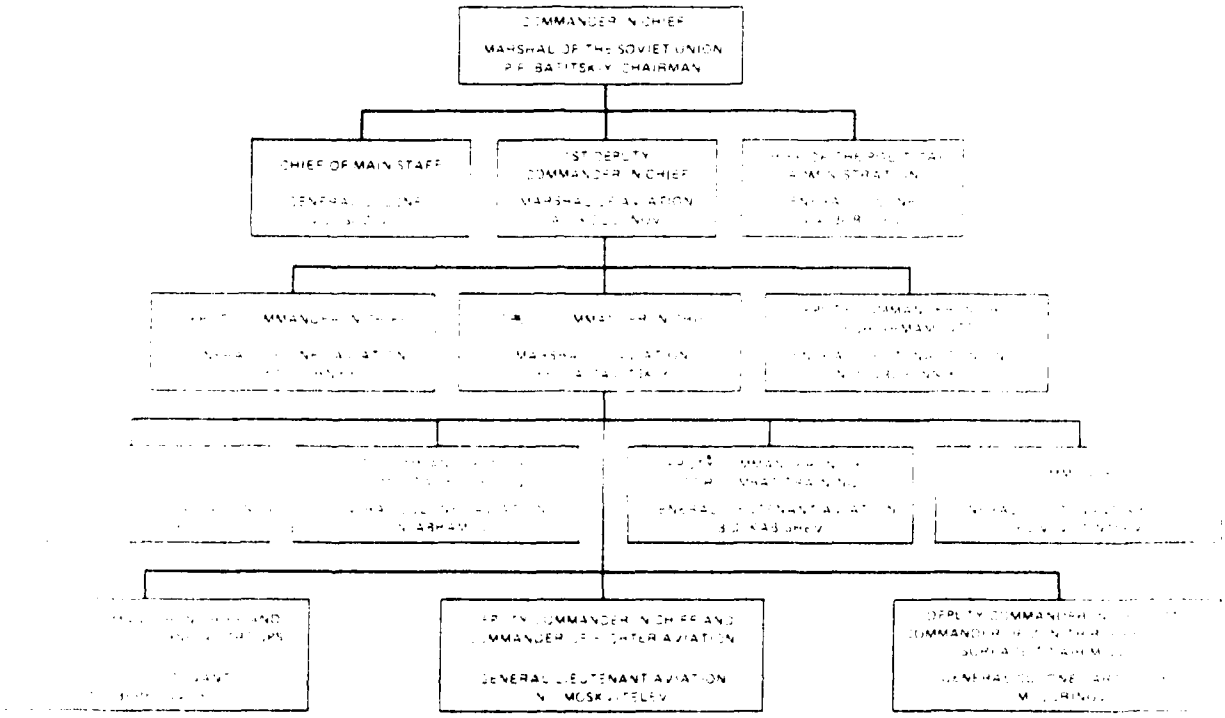


Figure 7-5

Members of the Military Council
of Troops of National Air Defense
July 1978

The wartime operation of the PVO Strany is a point of conjecture. Moreover analysts feel that coordination of all air defense efforts under the joint system presently in being will be extremely difficult. If past procedure is followed, two things may be expected. PVO Strany will be modified as required without too much hesitation. And representatives of STAVKA, the Soviet Supreme High Command, will appear in areas where coordination problems occur. With their command authority, they would be able to override the most senior officers on either or both sides of the problem.

For the present and into the future PVO Strany holds a secure position within the Soviet military establishment. This is demonstrated not only in the resource allocations it receives but also in its specialized educational system, consisting of about 14 service schools dedicated to air defense specialties. There are even special schools for pilots assigned to the PVOIA. This procedure tends to separate pilots from those assigned to other parts of military aviation such as Frontal Aviation and the Long Range Bomber Command. Common specialties such as logistics and administration are taught at schools under the direction of the Ministry of Defense and are not part of the PVO Strany educational system.

Soviet Tactical Air Defense in the 1970s

As the RUSI article pointed out, the USSR has already added a number of new surface-to-air missile systems to its inventory. In each case the new system seems to follow normal Soviet doctrinal logic in that the new addition has been designed to fulfill a specific role.

The SA-8 "Gecko", seen in the field for the first time in 1976, appears to be the Soviet answer to the Franco-German Roland. (The Roland II won the NATO SHORADS (Short Range Air Defense System) competition in 1975.

The missile system first developed by the French Aerospatiale Industrie and the German firm of Messerschmitt-Bölkow-Blohm in 1965. This is one of the few European engineered and designed weapons ever accepted by the United States. Initial procurement of the system began in 1979 with sales also being made to Norway, France, and Germany.)

The SA-9 Gaskin is another Soviet air defense system fielded in 1975. It is a highly mobile intermediate weapon that takes its place between the ZSU-23-4 and the SA-6 Gainful. Basically, the SA-9 is an upgraded SA-7 with a larger engine and warhead. The latter would seem to overcome the lack of destructive power of the SA-7, while the former provides additional throw-weight for the heavier warhead and greater range. The system includes a four launcher mount placed on a BRDM-2 vehicle especially modified for the purpose. The system is air transportable and amphibious. A comparison of the SA-9 and SA-7 is shown in Figure 7-6.

Figure 7-6

Comparison of SA-9 and SA-7 Characteristics

	SA-9	SA-7
Msl Length	1.35 meters	1.35 meters
Fueled Wt.	10 Kgs	10 Kgs
Max Eff Alt	1,500 meters	~5,000 meters
Max Slant Rg	3,600 meters	~5,000 meters

Numerous reports in recent months indicate the addition of an SA-10 to the Soviet air defense system. While little is known about this weapon, it appears to be a single stage ultra-high speed missile that accelerates at 100g to mach 6. With a range estimated to be about 50 kilometers at 16,500 ft. (5,000 plus meters), this missile constitutes an entirely new type of threat. If this new system meets these characteristics, it would appear to constitute a direct threat to the cruise missile currently under development in this country.

There are several naval air defense missiles in the current Soviet inventory which are relevant to this study, although their employment is in a somewhat different mode. The SA-N-3, called "Goblet" in NATO, is thought to be the naval counterpart of the SA-6. This missile is found fitted aboard a number of classes of surface combatants in the Soviet fleet, including the carrier/cruiser Kiev-class, helicopter cruiser Moskva-class, and Kresta and Kara class cruisers. This missile has effectively replaced the SA-N-1. Another naval

missile is the SA-N-4 not yet nicknamed by NATO. There is little data on this short range SAM although it is known to be installed on at least eight classes of surface combatants. Some theorize it is the naval counterpart of the SA-8 Gecko.

Following the logic stated by RUSI, one would suspect that there are new antiaircraft cannon in the production cycle, but there is no data readily available on this. As the new family of missiles unfold their potentialities it may be determined that the bulk of the cannon-type antiaircraft weapons in the Soviet inventory are now short-lived and that missiles will prevail in the future. The one exception that can be expected from this is the highly effective ZSU-23-4, whose characteristics proved themselves in the Middle East (and possibly Vietnam as well). As has been previously stated and demonstrated this is a very dangerous weapon within its parameters and can be expected to remain in the inventory for some time to come. As for the other cannon-type weapons, it might be postulated that they will become items for the Soviet foreign military sales program on a much broader scale than heretofore witnessed.

The closest western counterpart, the M-163 Vulcan Air Defense System, mounts an AVADS (Autotrack Vulcan Air Defense System) turret (General Electric M-168 six barreled 20mm cannon with associated equipment) on an M-113 armored personnel carrier. The weapon has selectable cyclic rates of fire between 1000 and 3000 rounds per minute, an M61 gyro lead-computing gunsight and a range-only radar. The effective range of the Vulcan is 5,100 meters. Cursory comparison indicates the ZSU-23-4 is superior in many ways.

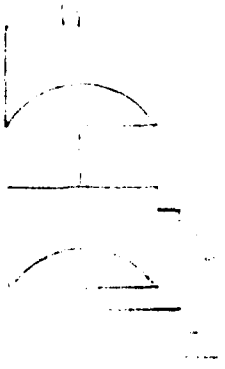
Current Soviet organization places antiaircraft defense means at all levels throughout the field army structure. Figures 7-7 and 7-8 show the current organization of the units that constitute the ground combat elements of the Soviet army.

The number of antiaircraft weapons and personnel found in the two, basic type divisions of the Soviet ground forces is shown in Figure 7-9, while Figure 7-10 compares Soviet and US air defense means in similar divisions.

By way of comparison, the Soviet numbers are compared to numbers of weapons found in similar U.S. organizations in Figure 7-10.

Figure 7-7

Type Antiaircraft Artillery Regiment Found in Soviet Motorized Rifle and Tank Division Artillery Organization



4xSA-6
OR
4xSA-8

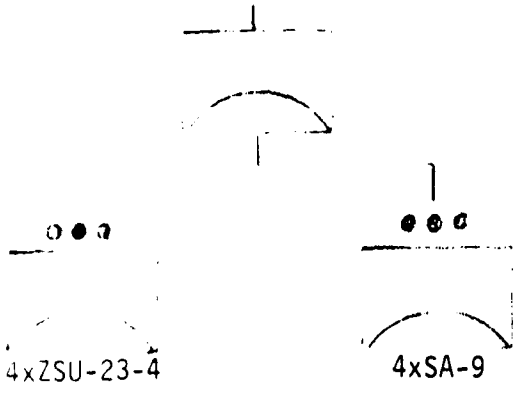
(These batteries are called battalions by the Soviets)

This appears to be the most current organizational data on this unit. Other sources indicate this regiment is in fact equipped with 6 batteries of 6xZSU-23-4 which may have been an interim organization between the older 4 battery 6xS-60 57mm AA gun and this one.

This unit provides point air defense to the divisional elements such as the division command post, Frog battalion, and others as directed. The unit may displace by echelon to insure continuous coverage on the move.

Figure 7-8

Type Air Defense Battery Found in Soviet Motorized Rifle and Tank Regiments



4xZSU-23-4

4xSA-9

(These batteries are called battalions by the Soviets)

Source: IAG-13-U-78, 1978 USAITAC

Figure 7-9

Recapitulation of AA Weapons
Soviet MTZ and TK Divisions

Air Defense Item	Division		Regiment		Battalion	
	MTZ	TK	MTZ	TK	MTZ	TK
* 57mm S-60	24	24	4	4		
ZSU-23-4	16	16				
** SA 6/8	20	20				
SA-7	116	36	36		9	
SA-9	16	16	4	4		
***Pers off/men	26/302		5/59			

* Being phased out and replaced with SA 6/8
** Either SA-6 or SA-8 will be found
***Does not include personnel assigned as SA-7 missiliers

Figure 7-10

Comparison of Similar USSR/US Systems
in Type-Divisions

	Soviet Division		US Division	
	MTZ	TK	Mech	Arm
ZSU-23-4 Shilka	16	16		
M-163 Vulcan			24	24
SA-6/8 SAM	20	20		
M-730 Chaparral			24	24

Employment of PVO-SV in Combat Operations

The first encounter that should be expected at the onset of East-West hostilities is the meeting of two units. This is a movement by design by one force taking offensive action against another, the defender. As opposed to a meeting engagement where the two opponents may decide to seek out the enemy simultaneously, a march or movement to contact usually takes place when one force seeks to penetrate the enemy's position at its weakest point, or, having penetrated the enemy's lines intends to pursue the withdrawing enemy forces. If, for instance, a large Soviet force intended to attack NATO forces in Western Europe by penetrating the defensive line at the weakest point (exploitation) its combat elements would move forward on parallel axes until contact was made and then it would shift its reserve weight to the area of weakest enemy resistance, with the final objective of seizing key politico-economic centers or critical terrain features deep in the NATO rear. The west bank of the Rhine River would be an example of the latter, while Paris might be an example of the former.

In this Theater of Military Operations (TVD) there will be one or more fronts (army groups) supported by Long Range Aviation and, possibly, Strategic Rocket Forces. While the forces involved have the seizure of the final objective as their paramount mission, they will also seek the concurrent destruction of the military forces defending it and, at the same time, seek to prevent their own destruction. It is in this last mission that the Air Defense Forces of The Ground Forces (PVOSV) has its primary role.

Soviet theory, doctrine, and weapons deployment are pivotal to the Soviets' comprehension of offensive operations where mass and shock action seem to dominate. The same is true in the organization of air defense means. In a normal TVD with two fronts, for example, each front would have three or more armies, most likely with four divisions each. These divisions would be a mix of both motorized rifle and tank organizations. Within each of these organizations, army, division, regiment, battalion, and company, organic air defense means are found in abundance. While there is little confirmed information on the command and control structure of the PVOSV within an Army formation, centralized control of the resources appears mandatory as a normal Soviet method of operation.[9]

Within the Army's area of operations, air defense units are organized in belts or sectors roughly parallel to the forward edge of the battle area (FEBA). Each rifle and tank company has its complement of SA-7 Strela missiliers. The two usually assigned will be found close to the company commanders' location and are expected to ride with him in his BMP Infantry Fighting Vehicle. The SA-7 operates under a free fire concept for the most part. Any aircraft intruding within the range of the Strela will be engaged as a target of opportunity. A major difficulty here is the need for positive identification of the aircraft as friend or foe. This is one reason for what may be assumed to be the natural reluctance of the company commander to allow the missiliers to get beyond his physical presence and control. SA-7s are believed to be widely dispersed throughout the Army area of operations. If the experience of the 1973 Middle East conflict is a true indication of Soviet doctrine and organization, SA-7s will also be found at SA-2/3/6 sites for close-in defense in the envelope where those missiles are ineffective. This would be less than 5,000 meters for the SA-2/3 and 1,500 meters for the SA-6. The SA-7's effective range of about 2.25 miles at an elevation of 50 meters to an altitude of about 1,500 meters makes it ideal for this purpose, its capability being flawed by the lack of destructive power of the warhead. SA-7 missiliers are evidently instructed to aim at the rear of the aircraft to allow the infrared homing guidance in the missile to have the optimum acquisition capability on the jet exhaust. Under most conditions this would appear to indicate engagement either at slant angles or after the aircraft had passed over the missilier.

The second level of air defense is formed by the ZSU-23-4 and SA-9 batteries assigned to the motorized rifle and tank regiments. These units will usually be found 400 meters behind the forward motorized rifle and tank companies. They may, however, be found on a flank that is especially susceptible to air attack. The Shilka and SA-9 Gaskin are themselves relatively exposed to air attack, as the vehicles are not heavily armored. In columnar formations they will normally maintain 150 to 200 meter intervals to avoid mutual destruction if one of the vehicles is attacked. In columnar formation on the move, the air defense units will normally be divided

between the front and rear of the regimental or lead battalion column.[10] In some instances air defense units will be attached to combat units operating away from the main forces (Task Force Organization). In all cases, the air defense units will assume the most favorable formation to give "the most reliable cover to the forces on the main line of advance." In most cases the ammunition trucks of this battery will be found 1.5 to 2 kilometers in the rear of battery.

The first echelon of fire control of antiaircraft appears to be located at this battery's command post. The battery commander apparently acts as the local air defense fire support coordinator. As such he would pass early warning up through the air defense communications system, and, of course, early warning and fire direction data down to his guns and missiles. Much of this data would probably come from the fire direction support integral to the SA-9 system. A further linkage, as seen in East German Air Defense units, is a data link with the Straight Flush radar associated with the SA-6 Gainful system. It is not known if similar linkage would be found if the SA-8 Gecko is present instead of the SA-6.

Of the five batteries of SA-6/8 normally found in a Soviet army, three will be in the first or forward air defense belt approximately five kilometers back and the other two approximately ten kilometers back in the third belt. There is a strong possibility that, as equipment becomes available, there may be both SA-6 and SA-8 regiments in the army. If so, then the SA-8s will be 20 to 30 kilometers back from the FEBA, covering the army's rear and its logistic installations. The SA-4 Ganef will be used to cover gaps in the SA-6/8 coverage. Of the nine batteries expected to be in the type-Soviet army, three batteries will be forward, moving with the attacking elements about ten kilometers to the rear of the FEBA. This will place them in a position where their associated radars can cover the area forward of the FEBA for both detection and acquisition. The remaining six batteries will normally be about 25 kilometers to the rear of the FEBA. The three batteries (18 launchers) of SA-2 Guideline SAMs will be deployed with two batteries at the 45 kilometer line and one at the 80 kilometer line. Other weapons as they appear in the various tables of organization will be scattered throughout the army area.

These ground air defense means will be supported by, and in turn will support the intercept aircraft of the PVO-SV-IA. A graphic depiction of the ground air defense of an army is shown at Figure 7-11. Air defense coverage is complete, overlapping, and redundant throughout the zone. Based on relative effectiveness factors at varying altitudes, however, it may not be all inclusive. Another method of depicting the envelope of this coverage is as shown in Figures 7-12 and 7-13. To an extent the second of the illustrations is somewhat misleading, as it does not indicate minimum effective heights (H_{min}).

Figure 7-14 diagrams the radar and data linkage for these systems as it is understood. Figure 7-15 is a tabulation of the estimated numbers of launchers found in various echelons within the several types of armies. Additional SAM units of regimental or brigade size will be found at the front level. These will normally be composed of 63 launcher batteries, a total of 18 launchers that will function as a part of the integrated front air defense envelope, providing air defense support for the front and army rear areas.

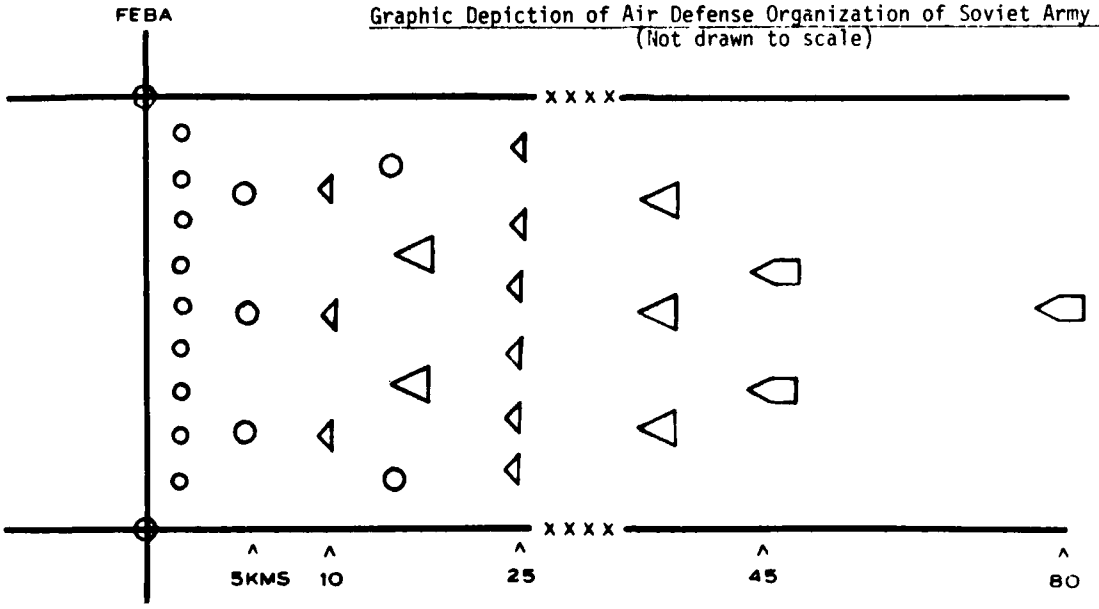
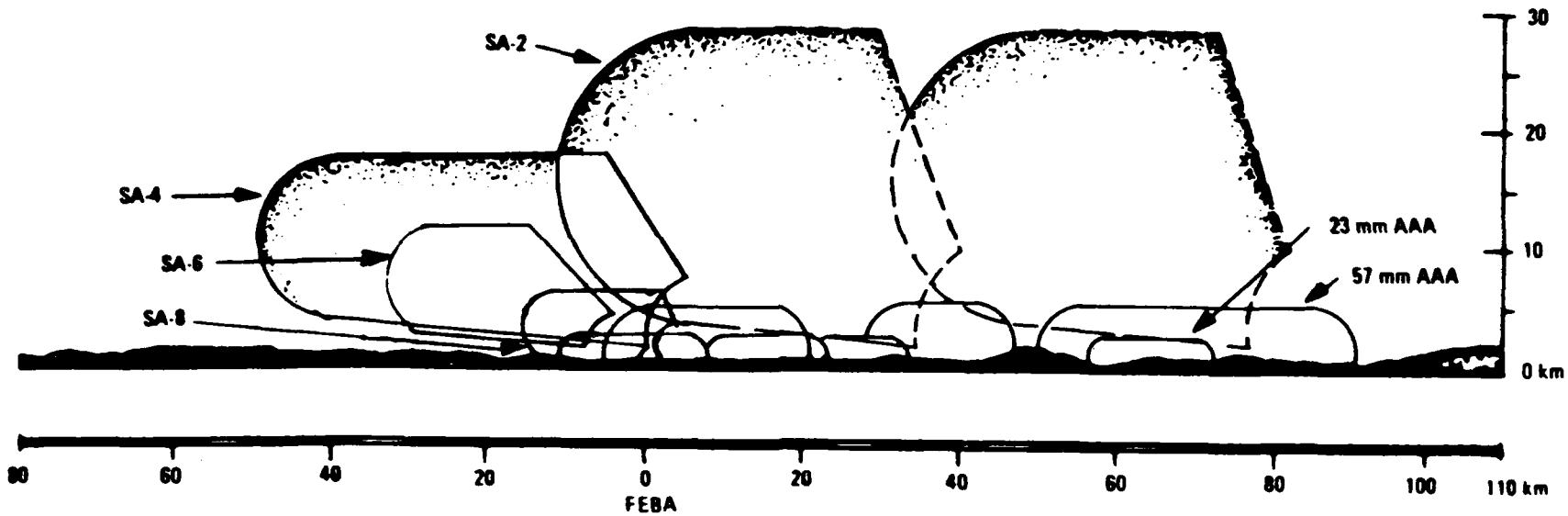


Figure 7-11

Source: Correlated from numerous Soviet and Western documents.

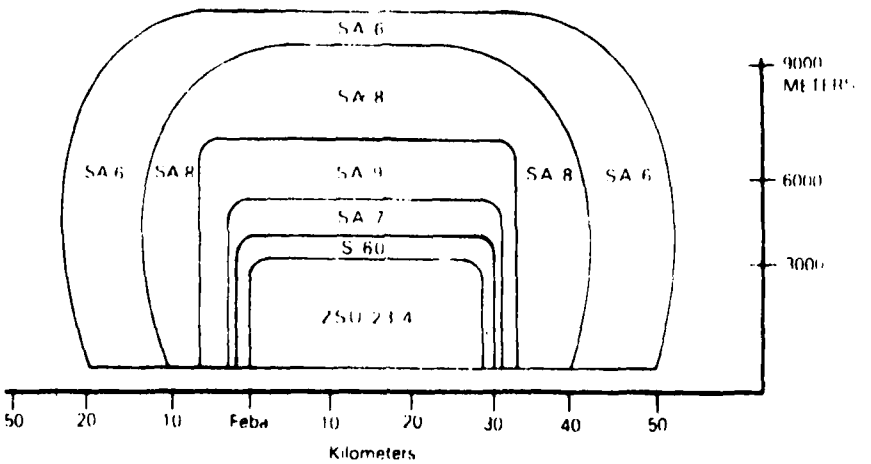
TYPE ARMY AIR DEFENSE ENVELOPE



1. DOES NOT INCLUDE AIR DEFENSE WEAPONS OF MANEUVER REGIMENTS AND LOWER ECHELONS

Figure 7-12

Source: USAITAD 14-U-76.



Air Defense Ground Means Schematic Envelope

Figure 7-13

Source: USAITAC IAG 13-U-78

DATA LINK AND RADAR FREQUENCIES USED IN SOVIET AIR DEFENSE

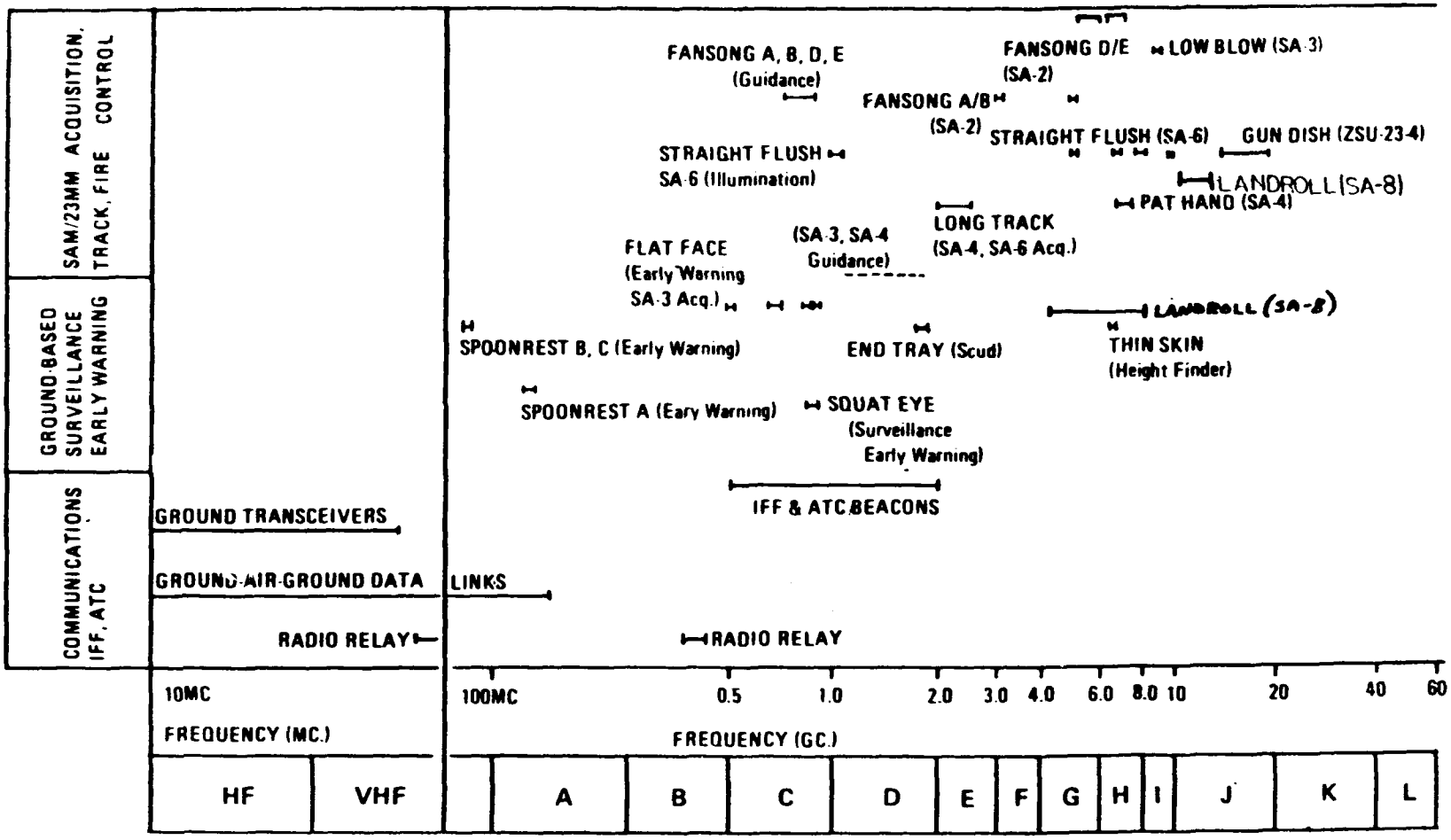


Figure 7-14

Source: USAITAD 14-U-76 modified from Zaloga, 88.

Figure 7-15

Estimated Capacity Air Defense Ground in Type Soviet Army
PVO-SV

Weapon	Battalion		Regiment		Division		Division ABN	Army	
	MTZ	TK	MTZ	TK	MTZ	TK		Combined	TK
ZU-23-2							36	114(1)	114(1)
ZSU-23-4			4	4	16	16		80	80
S-60 57mm								138(2)	138(2)
SA-2								18	18
SA-4								36	(3)
SA-6					20	20		120	100
SA-7	9	(3)	36	(3)	116	36	(3)	420	224
SA-8					20(4)	20(4)		100	80
SA-9									

Notes:
(1) Reported in one source as being deployed across army front.
Data may be obsolete or obsolescent.
(2) Reported in one source as being 23x6 gun, radar controlled batteries in army.
Data may be obsolete or obsolescent.
(3) Suspected of being on hand.
(4) The SA-8 may be found in place of SA-6 or as an additional asset. SA-6 would probably be shifted to Army control if replaced at division by SA-8.

Sources:
Zaloga, 72-88; Malone, 82; USAITAC 1AG-13-U-78; USAITAD 14-11-76.

A normal scenario for operations within the air defense element of any size Soviet ground organization would probably be as follows: Upon receipt of a warning of approaching aircraft, the commander would bring his subordinates to full alert. Predicated on such variables as the level of the unit, the situation, and the terrain, this alert would probably be given before positive identification-- friend or foe --is made. The question of upward notification may be presumed to be governed by the same factors, although in this case the established method of sectoring the operational area of operations as developed in World War II still applies. When the units involved were brought to full alert and preliminary firing data and orders were issued, units with their own fire direction would engage the target when it came into the range envelope. (As a rule, units with the most effective weapons systems defend the most important points, and so on down to the lowest echelons. Usually several units would provide overlapping fires, with zones of fire defined by azimuthal boundary indicators on a horizontal plane.) Wherever possible during the actual air defense engagement, the senior air defense commander would maintain centralized control and shift missions to other units, based primarily on weapons effectiveness. All subordinate units would be continuously updated with the current data. In the case of surprise air attack, air defense units appear to have the prerogative of independent engagement. As the air defense system within the PVO-SV appears to be well integrated, surprise should be a relatively rare occurrence. Radio and radar technical units associated with air defense have a high-probability capability of supplying continuous surveillance and early warning through radar detection, and radio intercept and direction finding.

As discussed earlier, when the ground combat elements are in the offensive or on the move, air defense means are integrated into the combat formations. On the move (in march column) the senior air defense commander in the column is responsible for antiaircraft defense. While the larger SAMs, such as the SA-4 Ganef, will normally move by battery, units equipped with ZSU-23-4 and SA-9 Gaskin may be found alone or in pairs in the march column. All units so equipped will be prepared to fire on the move. Other units that do not have that capability may move by bounds to insure their part

in the 360° air defense envelope that should be maintained. If the column is taken under attack, AAMG mounted on vehicles in the column will participate in the defensive fires. In the attack, antiaircraft elements will normally be found well forward in the battle area with primary targets enemy close air support (CAS) aircraft and attack helicopters.

In the defense, air defense assets are organized in depth throughout the battle area with major emphasis given to the most dangerous enemy air approach axes. A formal air defense plan is developed that graphically illustrates the integration of all pertinent data. In this situation, maneuver by fire will be the rule, and fires will be shifted to cover multi-target arrays or will be concentrated on single targets as required.

CHAPTER VII

Notes

1 John Marriot, compiler, RUSI and Brassey's Weapons Technology, ed. by the Royal United Services Institute for Defence Studies, 2nd Edit. (London: Brassey's Publ. Ltd, 1978), pp. 154-55.

2 William F. Scott, "Troops of National Air Defense," Soviet Aerospace Almanac in Air Force, (March 1978), 56-62.

3 Harriet Fast and William F. Scott, The Armed Forces of the USSR (Boulder: Westview Press, 1979), p. 148.

4 "Die sowjetische Heimatluftverteidigung," Osterreichische Militärische Zeitschrift No. 2 (1979), 151. Robert P. Berman, Soviet Air Power in Transition (Washington: 1978), p. 14.

5 Figures 7-1 and 7-2 are taken from John Erickson, Soviet Military Power USSI Report 73-1 (Washington: United States Strategic Institute, 1973), pp. 18, 45.

6 Vice Admiral Z. Studzinsky, "Our Unbreakable Combat Union," Krasnaya Zvezda, March 28, 1975.

7 See for instance P.I. Skuybeda, ed., Tolkovyy Slovar' Voyennykh Terminov, (Moscow: Voyenizdat, 1966), pp. 348-349.351; John Erickson, Soviet-Warsaw-Pact Force Levels USSI Report 76-2, Washington: United States Strategic Institute, 1976), pp. 44-45; R. Bonds, ed. The Soviet War Machine (London: Salamanda, 1976) pp. 57-58.

8 Zaloga, "Modern Soviet Armour," 87-88.

9 A.E. Scheglov. "The Commander of an AntiAircraft Battery Controls the Fire," Voennyii Vestnik, No. 3(1971), 133.

10 Malone, 82.

11 Col. V. Subbotin, "An Antiaircraft Battalion in an Offensive Battle," Soviet Military Review, No. 11 (November 1978), 16.

CHAPTER VIII

SOME CONCLUSIONS ON SOVIET AIR DEFENSE

Because of the scope of the work encompassed in this study, only the most general observations seem appropriate as a conclusion. To say that the USSR has come farther, faster than any other nation, in its development of air defense would not be true. It is probably more accurate to say that the Soviet Union has maintained itself apace with the rest of the world in the technologies required for a competent, effective air defense system and has maintained the system at a high degree of readiness. Why it achieved this level of proficiency is somewhat outside the scope of this study in that a lengthy discourse on whether the Soviets are imitators of the West, steal every idea they have,or are, as a matter of fact, mirror-imagers themselves does not appear germane. What is important is that the Soviet Union has a decent, effective air defense system which, in fact, shows some innovation. How they do it as they do may hold some more immediate meaning.

This should surprise no one. Any nation that suffered the destruction visited on the Soviet Union in World War II would almost certainly consider one of its most vital national interests to be the defense of its territory. The very nature of the Soviets' geographic arrangement makes the key element of such homeland defense planning the defense against air attack, or, probably more aptly stated in the present situation, attacks from the aerospace environment. Thus, from at least the end of World War II, the USSR has gone to some rather extraordinary lengths to insure that this emphasis is maintained. Using the data from World War II, and air defense data collected from other countries as well, Soviet planners have continually improved the nature and substance of their air defense. This has been made possible because of the monolithic nature of the Soviet eco-political

system that has allowed the level of expenditures necessary to build the system we see today. This same idea of self-preservation will almost certainly continue to drive future improvements both in techniques and in hardware. As in the past, any future modifications to the system will be based on a clear need established by the historical record. Since the USSR has not overtly participated in a war since the end of World War II, it may be assumed that the data they may require will be forthcoming from nations acting either as surrogates for the Soviet Union, or as clients of the Soviet "Lend-Lease" program.

A quick check of the current Soviet inventory shows that the major portion of their air defense assets is of fairly recent vintage. Granting that obsolescence in the air defense environment is a way of life, the Soviets seem to have planned well for their future requirements.

Using interim equipment items as stopgaps during the inception to production and operational employment cycle, the Soviets have developed a family of air defense weapons and associated equipment that should remain a viable deterrent to any notion of unopposed air attack on the Soviet Union and its satellites and friends for some time to come. Not only can this be said about the operational capability of Soviet homeland defense -- the PVO Strany -- but it can now also be said about the Soviets' ability to give air defense protection to their troops in the field. At the present time, for example, there are ten surface-to-air missiles in or on the way into the Soviet inventory. Of this number, one, the SA-1, is probably considered obsolete, but not necessarily unusable, by the Soviets. Another missile, the SA-X-10, still not really understood fully in the West, has not yet entered the inventory, but it appears to be the Soviets' answer to Western moves toward future reliance on the cruise missile as an offensive weapon.

Of the remaining missile types available, the SA-2, SA-5, and SA-3 are the only ones in the PVO Strany inventory as far as is known. Of these, only the SA-5 is or was specifically dedicated to PVO Strany. It is probable, therefore, that the SA-2 and SA-3, while designed for

PVO Strany, were pressed into interim service with the PVO Voisk under the belief that any defense is better than none. Thus, the bulk of the present number of air defense missile types available to the Soviets appear to have been designed specifically for use as field weapons. This may in and of itself be a major indicator of the true nature of Soviet long-term national objectives and goals. There would be little reason for these missile systems if the Soviets intended only to defend the homeland. Rather, in that situation, the PVO Strany would have been strengthened even more than it has been up to the present. It appears more likely that the Soviet planners working out their offensive scenarios against the West saw the necessity of providing extensive air defense protection to their troops, who would be advancing out from under the protective PVO Strany envelope. Using the experience of World War II alone as a guide, the Soviets would have appreciated that Soviet gains in the war, that is, those gains stressed in the prime directive of spreading socialism, were made after the territories of the USSR were cleared and troops of the Red Army moved into Central and Western Europe. One might say, at this point, that such an offensive action is the normal conclusion, or should be, to any defense against and expulsion of an enemy from the homeland. This is true, but there is little or no evidence that the Soviet leadership believes its own propaganda that the west is preparing to attack the Soviet Union precipitously that would make this logic applicable. Rather, it must be assumed that the heavy development of Soviet air defense systems for use with troops in the field in a highly mobile environment was and is continuing to be made solely for offensive operations planned and executed outside the USSR.

One of the premises upon which this study was conducted was whether or not there was any type of historical basis upon which the Soviets have relied in their various actions concerned with air defense. In a word, the answer is yes. There is no question that the Soviets are still teaching the lessons of the past to avoid having to relive them, as George Santayana predicted. Almost every recent issue of those journals published in the Soviet Union that deal with some aspect of military arts and sciences produces at least some reflection of the Great Patriotic War.

These examples of history take on an allegorical nature in that all seem to teach a basic moral lesson applicable to the present; the fact that the Party above and beyond all else planned, executed, and successfully prosecuted the war against Fascism; that perseverance and dedication were always rewarded with success; and, no less important, that paying attention to detail and sticking to procedures is the right way to operate. Two points may be adduced from this: the Soviets do indeed find the use of historical example a beneficial means of education and indoctrination, and, second, conformity, not only to the Party but also in the more mundane areas of procedural adherence, is a key to the maintenance of control over all facets of whatever is being done. While this may not be as important in air defense, in what must be considered by its very nature a restricted environment, as it might be in a combat command where initiative is crucial, it does indicate a very serious lack of trust on the part of the Soviet hierarchy in the stressing of initiative among subordinates.

Even so, examples of initiative are seen on a rather grand scale in the history of Soviet air defense. Changing the directions of boundaries between air defense fronts by 90^{0} in wartime is no mean feat, nor is the extensive reorganization of forces seen early in World War II, at the height of German advance, a particularly easy thing to do. Initiative, then, seems to devolve from the actions of the high command and to be almost universally applied when exercised. The course of Soviet military history is replete with other examples to justify this idea and deserves more study. For the future of air defense in the Soviet Union, the use of initiative seems to imply that the system will be adhered to at all levels until such time as it is changed or modified from the top.

Another manifestation of this same logic may be seen in the Soviet adherence to the use of antiaircraft artillery after much of it had disappeared from use elsewhere in the world. In one sense, this was a case of pragmatism on the Soviets' part as they took time in developing newer systems, such as surface-to-air missiles. History has certainly taught the leaders of the USSR that the methods used in many western countries of building a new weapons system and then looking for a mission to assign it to is highly uneconomical and inefficient. Rather, it appears that the Soviets determine their mission requirements and design a system or systems

to fill the need. Also, historically, the Soviets must look with some satisfaction on their lack of the types of eco-political debates seen in the west over the issue of arms expenditure. To be sure, there are such debates in the high councils of the USSR, but the very nature of the debate is different in that it focusses more on needs than on vested political interest. In this context, the debate between the proponents of airpower as the best air defense weapon as opposed to those who adhered to the use of ground air defense means was not a guns or butter debate but one centered on the issue of how best to fulfill a requirement.

It may be postulated, therefore, that when the Soviets discuss a problem such as airplanes or SAMs, the issue is one where the decision has already been made and what is needed is the most viable means to implement it. When the public discussion stops, the means to the desired end has been decided upon. As found in the Soviet decisionmaking process in other weapons systems, which has been detailed elsewhere, this same type of historical logic could be applied against future air defense developments in both the doctrine and the hardware areas. In the meantime, it may be said that:

> The Soviet Union will continue to maintain and improve its air defense systems both for homeland defense and for protection of its troop units at roughly the same level, and,
>
> The Soviet Union will continue to improve its equipment relative to changing needs and requirements with which it is faced.

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