SOVIET ASSESSMENTS OF NORTH AMERICAN AIR DEFENSE

John W. R. Lepingwell

Research Report No. 86-2

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SUMMARY

This report uses Soviet assessments of U.S. weapons and strategy to investigate how the Soviets perceive the U.S. threat, how they respond to it, and what this may tell us about Soviet weapons and strategy. Three principal questions are asked: 1) How do the Soviets assess U.S. weapons and strategy, and what reactions do these analyses prompt? 2) Does the Soviet military press use descriptions of U.S. weapons and strategies as surrogates for Soviet weapons and strategies? and 3) By understanding how the Soviets assess Western weapons, can we understand how they design and assess their own weapons and strategy?

Soviet military publications from the mid-1960's to the present were analyzed to determine the nature and extent of coverage of U.S. continental air defense. Three areas were chosen for detailed examination: air defense control systems (SAGE-BUIC), AWACS, and air defense interceptors. Particular attention was paid to disparities between Soviet and U.S. assessments of U. S. weapons and strategy. Differing assessments were closely examined to determine whether they represented misunderstandings or errors on the Soviet part, or unique Soviet perspectives and biases. Finally, articles on Soviet strategy and air defenses in the restricted circulation Soviet General Staff journal Military Thought were compared with Soviet assessments of U.S. air

defenses, to establish whether the same themes were found in both sources.

How do the Soviets assess U.S. weapons and strategy, and what reactions do these assessments prompt? First, most articles on U.S. continental air defenses were found in the journal of the Air Defense Troops (VPVO), Vestnik PVO. It therefore appears that the VPVO is the service primarily concerned with presenting analyses of U.S. continental air defense forces, rather than the Soviet air force. Second, it was found that most assessments stressed the technical characteristics or technical performance of weapons, rather than estimates of how they might perform under operational conditions. If operational inadequacies in U.S. systems were noted they were usually repetitions of Western criticisms. The ongoing development of U.S. air defense systems was often cited, implying that any inadequacies were being remedied. This results in a tendency to conservative (from the Soviet perspective) assessment of U.S. programs. Third, despite the decline in U.S. air defense capabilities during the 1960's and 1970's, the Soviet press did not explicitly comment on this decline. On the contrary, the impression fostered by the Soviet press is one of a fairly capable U.S. air defense with new weapons being developed and deployed. These findings are consonant with the VPVO's institutional interests in promoting the continued development of Soviet air defenses.

Soviet assessments of U.S. systems are noticeably colored by their own biases and perspectives. These provide insight into how the Soviets address, and conceive of, their own air defenses. Projection of Soviet biases and perspectives was most prominent in the case of air defense control systems and their relationship to air defense organization and strategy. That these biases and perspectives represent important themes

in Soviet air defense strategy was confirmed by comparing Soviet assessments of U.S. air defense control systems with articles in Military Thought. Some of these themes are:

- The importance of centralized automated control systems for countering large threats.

- Centralized command to control the maneuvering of air defense forces to meet changing threats.

- The need to destroy low altitude penetrating bombers carrying missiles before they can launch their missiles. If the missiles are launched, the air defense system must be capable of destroying them in flight.

- Survivability of the control system arises from organizational structure, as well as physical hardening. Provision must be made for operation during nuclear war, even if part of the system is destroyed.

- Reconstitution of air defense capabilities after nuclear strikes should be accomplished rapidly.

The above views are found in several articles and books assessing U.S. air defense, and they are made even more explicit in Military Thought. This convergence of views between the open and restricted Soviet press supports the use of the open Soviet military press as a source of information on Soviet military strategy.

Soviet reactions to U.S. air defense systems may be separated into two categories: emulation and countermeasures. No articles on countermeasures to U.S. continental air defense systems were found. Countermeasures would presumably be developed for the Soviet strategic bomber force, a force whose tactics are not discussed in the unclassified Soviet military press. However, there are some indications of emulation. The deployment of the Tu-126 Moss airborne early warning (AEW) aircraft

in the late 1960's or early 1970's may represent an emulation of U.S. AEW programs, particularly the EC-121 and WF-2 AEW aircraft. In this case the Tu-126 appears to perform much the same function as the EC-121 (overwater early warning), the latter having received a significant amount of attention in the Soviet press. There is also a possibility that some aspects of U.S. automated air defense control systems were emulated. There was strong Soviet interest in automated systems of control for air defense throughout the period under study, and the U.S. SAGE automated control system was widely used as an archetypical large-scale air defense control system. The capability to deploy a large-scale automated network similar to SAGE was probably developed by the Soviets in the mid to late 60's. Given the relatively high level of interest in SAGE, it is quite possible, and even likely, that a similar Soviet system was deployed.

The second question posed is whether assessments of U.S. systems are used as surrogates for Soviet systems. The answer to this must be a qualified no. In the cases studied there is little clear evidence for the use of U.S. systems as stalking horses for Soviet systems. There is some evidence that a few early comments about AWACS were references to the Tu-126 Moss, but the case is not convincing. Continued interest in the YF-12A interceptor after its cancellation may best be explained by a strong Soviet interest in high-performance aircraft, rather than a specific attempt to discuss the MiG-25. Soviet biases come through in their assessments, but this does not mean that they are discussing their own systems.

Turning now to the third question, how do the Soviets assess weapons systems and do we know how they assess their own systems? In the case of air defense control systems, the biases and views of the Soviet authors

were clear enough to provide a good deal of information. This has provided insight into strategy and the type of systems that might be appropriate for that strategy. Thus, we would expect a highly centralized Soviet air defense control system, with extensive attempts at providing survivability or reconstitutability under conditions of nuclear war. The development of the Tu-126 Moss may also be viewed as a case of Soviet assessments of U.S. systems leading to the development and deployment of a similar system. It was also found that automated systems of control are primarily evaluated by their ability to reduce response time to threats.

In sum, we have partly confirmed the hypotheses postulated in this series of reports. The lack of evidence for discussions using U.S. weapons as surrogates for Soviet weapons does not mean that such surrogate discussions do not occur in the Soviet press. It merely indicates that in this case, particularly given our lack of information on Soviet air defense systems, there is insufficient evidence to disprove the hypothesis. However, this report does confirm that Soviet assessments of Western programs and strategies tend to reflect Soviet interests and biases. This confirmation supports the conclusions of other studies of this series, and indicates that close study of Soviet assessments of U.S. weapons and strategy can reveal much about Soviet views of their own equipment and strategy.

Table of Contents

ABBREVIATIONS

AAA	Anti-Aircraft Artillery
AAM	Air-to-Air Missile
ADC	Air Defense Command
ADCOM	Aerospace Defense Command
AEW	Airborne Early Warning
ARADCOM	Army Air Defense Command
ASM	Air-to-Surface Missile
ASU	Avtomatizirovannaya Sistema Upravleniya [Automated Control System
AWACS	Airborne Warning and Control System
BUIC	Back Up Interceptor Control
DEW	Distant Early Warning
DRLO	Dalnego Radiolokatsionnogo Obnaruzhenniya [Long Range Radar]
ECM	Electronic Countermeasures
ECCM	Electronic Counter-Countermeasures
EW	Electronic Warfare
LDSD	Look-down Shoot-down
NADGE	Nato Air Defense Ground Environment
NWS	North Warning System
OTH-B	Over-the-horizon Backscatter radar
PKO	Protivokosmicheskiye Oborony [Anti-Space Defense]
PRO	Protivoraketniye Oborony [Anti-Ballistic Missile Defense]
PSO	Protivosamolety Oborony [Antiaircraft Defense]
PVO	Protivovozdushnoy Oborony [Aerospace Defense]
SAGE	Semi-Automatic Ground Environment
SAM	Surface-to-Air Missile
TAC	Tactical Air Command
ZUR	Zenitniye Upravleniye Raketniye (Surface to Air Missile)

1. INTRODUCTION

1.1 Introduction

This report addresses three important issues concerning Soviet perceptions of, and reactions to, U.S. military programs. First it seeks to determine and explicate how the Soviets assess U.S. weapons and strategy, and what reactions these assessments may prompt. Second, this report investigates whether Western weapons and strategies are used as surrogates for their Soviet equivalents in discussions in the Soviet military press. If this proves to be the case, such discussions may shed considerable light on Soviet military programs. Third, by understanding how the Soviets assess Western weapons, we may understand how they design and assess their own weapons.

1.2 Defining the Problem

Although continental air defense has played a minor role in the development of U.S. defense policy, in the Soviet Union national air defense is a major mission, and the Air Defense Forces (Voisk Protivovozdushnoy Oborony, VPVO) is a separate service.[1] While U.S. air defense capability declined from 1960 to 1980, the Soviet Union continued to invest heavily in modernizing its air defense system. Thus, we have a clear case where the U.S. chose to de-emphasize a mission that the Soviets considered important. How, then, do the Soviets assess this situation? Do they acknowledge the secondary importance of continental

air defense in the West? Do their assessments reflect the decline of U.S. capabilities in this field? If they do discuss this decline, how do they explain it? These questions must be kept in mind in reading this report, for they are crucial to the overall threat assessment performed by the Soviets -- as a whole did U.S. capability decline or increase?

Another important feature of this case study is that the VPVO performs most assessments of U.S. continental air defense. The VPVO has the technical knowledge and interest to assess U.S. air defenses, but it is not the branch that would have to overcome them in case of war. The task of penetrating the defenses would fall to forces formerly associated with Long Range Aviation (LRA),now reorganized into several Air Armies of the Soviet Union.[2] One would expect the Soviet Airforce to be conducting their own analyses of the defenses. What one finds, however, is that all assessments of the U.S. air defense systems appear in the VPVO press: there is no discussion of U.S. continental air defense in the main Soviet Airforce journal, Aviatsiya i kosmonovtika. Since there is no detailed discussion of Soviet strategic bomber force tactics or equipment in the Soviet press it is not feasible to speculate on the LRA reaction to U.S. air defenses. Thus, this report focuses on how the VPVO assessed U.S. air defenses and how U.S. developments may cause reactions such as emulation by the VPVO.

1.3 Sources

Analyzing Soviet assessments of U.S. air defenses requires examining a wide range of Soviet sources and searching for patterns and correlations existing across time and different publications. Soviet military journals are the primary source for this report. Details of coverage of

the journals are given in Table 1. The most useful of these was the Vestnik PVO, the journal of the Soviet Air Defense Forces. Other journals that provided coverage of U.S. air defenses were, Tekhnika i vooruzheniye, Zarubezhniye voeynnoye obozreniye, the Soviet air force journal Aviatsiya i kosmonovtika, and the restricted circulation Soviet journal Military Thought. Most of these journals were used in their english translation, although in many cases the original sources were consulted. The Soviet Ground Forces Journal, Voyennoye vestnik was also examined, but it had no information on continental air defense.

The chronological scope of the study was limited by the available journals. As shown in Table 1, most journals are available from the mid-60's to the present, thus limiting the study to the last two decades.

Several books have been consulted, both in the original and in translation. These include: Krysenko, Sovremennye sistemy PVO; Zimin, Razvitiye PVO; Zimin, Spravochnik ofitsera PVO; Romanov and Frolov, Principles of Automating Control Systems; Mal'gin, Fire Control of Antiaircraft Missile Systems; Ashkerov and Uvarov, PVO; and Peresada, Zenitnye raketnye kompleksy. Parts or all of these books are relevant to control systems for air defense, and various "active means" of PVO. Almost all of the books were published by Voyenizdat, the Soviet military publishing house.

1.4 Methodology

In order to understand Soviet assessments of western technology, it is necessary to do a lot of "signal processing" on the data which emanates from the Soviet Union. Unlike the U.S. where there is a great deal of data coming from many, often conflicting sources, in the Soviet

Table 1: Articles on Continental Air Defense

	VPVO		TV		ZVO		AK	
	Arts	Notes	Arts	Notes	Arts	Notes	Arts	Notes
65	-	-	-	-				
66	-	-	-	-				
67	1	-	-	-				
68	-	-	-	-				
69	-	1	-	-			#	-
70	-	-	-	-			#	-
71	2	-	1	-				1
72	-	-	1	-			-	-
73	2	1	-	-			-	-
74	-	-	-	-			-	-
75	1	2	-	-			-	-
76	1	-	1	-			#	-
77	-	-	-	-			-	-
78	1	1	-	-			-	-
79	1	-	-	-		1*	-	-
80	-	-	-	-			-	-
81	1	-	1	-				
82	-	1	-	-				
83	1	-	-	-	1*			
84	1	-	-	-	1			
Total	12	6	4	0	2	0		

* The whole year was not searched.
# An article discussing the characteristics of the F-15 appeared, but did not discuss its possible air defense application.

VPVO: Vestnik PVO
TV: Tekhnika i vooruzheniye
ZVO: Zarubezhniye voyennoye obozreniye
AK: Aviatsiya i kosmonovtika

Blank cells indicate that the journals for that year are not available or have not been searched.

This table defines continental air defense to include articles primarily concerned with SAGE, interceptors, AWACS, and Patriot. There are 2 to 3 times as many articles which may be in some way relevant.[3]

Union there is relatively little data, and it is often camouflaged. Thus the problem is one of discriminating signal from noise where there is relatively little of either. Several approaches to discrimination and data analysis may be taken, depending on the type of data and the signal one is searching for.

1.4.1 Traffic Analysis Perhaps the simplest method of extracting data is similar to what is called "traffic analysis" in signal intelligence. In this case one is interested in determining a) whether a signal exists, and b) whether the signal varies over time, and if so, if it is correlated with other events. For example, in this report a plot of articles over time might reveal a sudden increase in the number of articles concerning a particular weapon system during a given time period. Such a surge may indicate an increased interest in this topic, and may be correlated with events such as testing and deployment. The observation of an increase in articles must be examined closely to determine possible correlations, and the content of the articles examined to determine whether they suggest the reason for the increase. It is of course possible that such increases may be merely statistical fluctuations, and this possibility must also be examined and tested, by looking at the background noise and determining the likelihood of the observed increase.

The advantage (and limitation) of traffic analysis is that it provides a signal without the necessity of interpreting the data in detail. This means that the biases of the observer are less likely to distort the interpretation of the data. However it also means that the signal does little more than indicate Soviet interest in a given area -- it does not indicate what they think about the topic. Furthermore, there

is always the danger of establishing a false correlation, a danger which is exacerbated if there is little data or many things with which it might plausibly be correlated. Nevertheless, this method can be used to identify possible correlations that can form the basis for constructing hypotheses about Soviet reasons for expressing interest in the topic under examination.

Traffic analysis is necessary to demonstrate Soviet interest in a topic, but it is not sufficient to tell us what importance they attach to it, or its context. For this one must turn to content analysis of the material.

1.4.2 Content Analysis Content analysis looks to the details of the articles on the topic, seeking to divine the viewpoints expressed by the authors and to what extent they may reflect a uniquely Soviet approach to the topic, or whether they merely reflect Western views and assessments. There is also the problem of determining when an author is in fact referring to US systems or plans, and when he is using a discussion of these systems as a screen for a discussion of Soviet systems and plans. This is a task which demands a great deal of the observer, who in essence becomes an interpreter, sifting the Soviet articles through his own knowledge of the subject, and seeking to filter out the Western reflections and to emphasize the uniquely Soviet perceptions.

One of the key problems in this type of research is deciding when an author is referring to a Western system per se and when he is using it as a surrogate for a Soviet weapon system. This calls for a knowledge of both the Soviet and U.S. weapons systems and debates on their use. If Soviet discussions of a certain system bear no resemblance to Western discussions of it, or if the emphasis is very different, there may be

reason to suspect that it is a veiled discussion of a Soviet system. Similarly, if the discussion is out of synchrony with Western discussions but is correlated with the deployment (or testing) of an analogous Soviet system, one may be justified in considering it a discussion of a Soviet system. The analysis of Soviet discussions over time as an analytical tool is discussed in more detail later.

The Soviets always write about "Western assessments" of Western technology, and their data is based on the Western press. It appears that much of their information comes from the open Western military and trade literature, but the assessments published in this literature often tend to be biased themselves. For example, Aviation Week and Space Technology may give very positive coverage to the F-15, while the Atlantic Monthly tells quite another story. It is unlikely that the latter point of view would either (a) be read by the Soviet military, or (b) would be given much credence. The Soviet military probably tends to believe the Western military press (or those close to the defense community) because they have better access to information, and presumably a better ability to interpret it. Selective reading of the Western press would also be consonant with the tendency to worst case analysis which one finds in most military establishments. Thus there is probably a built in tendency for the Soviet military press to pass on only the optimistic assessments of the Western military press, while ignoring the more critical civilian and arms control press.

Another possible problem in interpretation is the tendency for services to assess certain technologies and weapons differently, depending upon the impact they might have on their own operations and preferences. These differing assessments will likely be reflected in military writings on both sides. For example, one might expect an

article written by a U. S. Air Force officer to be rather pessimistic about the survivability of attack helicopters, while being more optimistic about fixed-wing aircraft for close air support.

On the Soviet side, the problem of service perspectives may manifest itself in two ways. First (and less likely) if a Soviet service tends to place more reliance on the corresponding Western service journals, it may "import" Western service perspectives that might then be reflected in the Soviet press. To use close air support as a hypothetical example, if Frontal Aviation officers writing for Aviatsiya i kosmonovtika tended to rely on Air Force Magazine, and Air Force service journals they might come to the conclusion that attack helicopters are quite vulnerable over the battlefield. Conversely, if they consulted sources more favorable to attack helicopters, they might reach a different conclusion.

Second, in some cases Western service perspectives might not transfer to the Soviet Union, and thus Soviet authors might not pick up on some of the service-based assessments. For example, one might not find a split between helicopters and CAS aircraft in the Soviet press because both are in Frontal Aviation. On the other hand, one might find VPVO officers making yet another assessment of the technology and weapons of close air support aircraft and attack helicopters.

In either case, it is important to identify possible service biases both in the Western press and in the Soviet press. Of course, the discovery of a major difference in perceptions between Soviet armed forces branches would itself be quite important.

Once one has identified what appears to be a unique Soviet perception, one has to determine whether it is an "official" view as opposed to an author's perception. This highlights the question of how much autonomy an author in a military journal has, and to what extent his

own biases may color his writing. Our information on this topic is very limited. One study of the Soviet media has suggested that the author has essentially no autonomy and that his work is very closely controlled.[4] This close control is to be expected given the sensitivity of the matters being expressed, and suggests that the latitude available to authors in military journals is very small. Possible exceptions to this close control are represented by the so-called "debates" which may in fact be orchestrated by the editors of the journal. Even in the case of debates, however, it would be unusual for an author to stray too far from the center or the topic under discussion.

1.4.3 Correlation Over Time A correlation analysis attempts to correlate the views expressed in the Soviet press with both Soviet and Western weapons programs. If a correlation is found to exist between a Soviet weapons program and Soviet discussion of an analogous Western program one might postulate that the Soviet press is in fact discussing its own program.

How to eliminate the possibility that the Soviet views are indeed about the Western system? This may be done by two methods. On the one hand, one can determine if there is a correlation between the Soviet articles and the development of the Western system. If this proves not to be the case then the hypothesis of self-reference is strengthened. On the other hand one can turn to content analysis to determine if there are criticisms or comments about the Western system which do not apply to the Western program, but which do apply to the Soviet program. Thus, misstating of facts and capabilities may be a veiled reference to the Soviet program. If the Soviets express new opinions that have not been expressed in the Western press, they may be referring to their own or to

the Western system, and it requires a very close reading of the context of the discussion in order to determine which may be the case. In most cases it is preferable to use both approaches. It is only when the discussion is correlated with both Soviet and Western systems that the second approach becomes particularly important.

1.5 Applying the Methodology

Although there is a significant amount of information on Soviet SAMs and fighters, there is very little open information on the command structure of the VPVO and the use of automated systems of control (ASUs). Indeed, the paucity of information is such that there is no indication of whether the Soviets even have a centralized automated air defense system, let alone what kind of technology is used in the system. This makes detailed comparisons with the relevant U.S. systems (SAGE and BUIC) almost impossible. Nonetheless, one can still use the second method described above to tell what aspects of the U.S. systems attracted the most attention, and how the assessments of the systems differed from those common in the U.S. For some systems, such as AWACS, there is a corresponding system against to which the first method (correlation) can be applied. However, even in this case there is relatively little public information available, particularly concerning technical characteristics such as radar.

Thus, in this report emphasis has been placed on a very close and detailed analysis of Soviet writings on U.S. air defense. This has been supplemented by an examination of Soviet writings on their own air defense system, as reflected in the journal Military Thought and in some books on the VPVO. The analysis uses these two components to extract

some information concerning Soviet views of their own and U.S. air defense. In the last chapter a synthesis of this analysis is used to determine possible development paths of Soviet air defense during the period under study.

1.6 Overview

This report treats several components of the U.S. continental air defense system separately. First, a brief overview of U.S. continental air defense from 1960 to 1985 is presented to provide background and context for the following chapters. The next chapter emphasizes Soviet assessments of the SAGE continental air defense control system. Then Soviet assessments of one of the successors to SAGE, the AWACS aircraft, are examined with a view to understanding how quickly and how well the Soviets appreciated the capabilities of this unique aircraft. Interceptors are discussed in Chapter 5 as one of the "active means" of air defense.[5] Finally, we turn to the Soviet classified press (Military Thought) to compare Soviet discussions of their own defenses, with their discussions of U.S. defenses. This comparison will illustrate the similarities of these discussions, as well as revealing some particularly Soviet views on the conduct of air defense.

2. A SHORT HISTORY OF CONTINENTAL AIR DEFENSE

2.1 Introduction

To understand and appreciate Soviet assessments of the North American continental air defense system, it is helpful to become familiar with the history of continental air defense. In this chapter I will briefly review the history of North American air defense.

2.2 The Heyday of NORAD: 1955-65

When the Soviet Union developed thermonuclear weapons and intercontinental bombers in the mid-50's the United States faced a new threat. As the "bomber gap" became a matter of public concern the U.S. responded by developing a large centralized air defense system intended to destroying penetrating bombers.

2.2.1 Radar Systems Since the direct air routes from the USSR to the US come over the pole, the desire to maximize warning time and probability of interception called for a warning and interception system as far north as possible. The result of this was the construction of the Distant Early Warning (DEW) radar system stretching from Alaska across Northern Canada to Greenland and Iceland. Secondary radar systems (the Mid-Canada and Pinetree lines) further increased the probability of detection and interception before Soviet bombers could reach the U.S. border.[6] The integration of Canadian and U.S. air defense forces into

NORAD in 1957 led to the creation of an integrated continental air defense system that increased the security of both countries.[7]

In addition to the DEW system, the U.S. also deployed Airborne Early Warning (AEW) aircraft (the EC-121), radar picket ships, and even some converted offshore drilling rigs equipped with radars (Texas Towers). These systems provided complete coverage of the East and West coasts, to supplement the north facing systems. During the early 60's the ships and Texas Towers were replaced by AEW aircraft.[8] At its height in 1961, the various ground, ship, and airborne radars totaled 458.[9]

Control of U.S. air defense resources was vested in the Air Force major command Air Defense Command (ADC). After the formation of NORAD, the commander of ADC also became the commander of NORAD (CINCNORAD). By agreement with the Canadian government the deputy commander of NORAD is a Canadian officer.

2.2.2 The SAGE System In order to coordinate the identification, tracking and interception of a large number of fast moving targets over a vast geographical expanse, the U.S. turned to new computer technology in the form of the Semi-Automatic Ground Environment (SAGE -- also known as system 416L). This system was designed to gather information from radars, identify targets, assign combat resources to targets, provide guidance to targets, and communicate with all other levels of the NORAD system. The project was started in the mid-50's, and was conducted largely by MIT's Lincoln Laboratory. Although the system was primitive by modern standards, employing vacuum tube and ferrite core memory technology, it was pushing the state-of-the-art at the time.[10] Indeed, SAGE stands out as the first truly modern semiautomatic military information and control system.

SAGE became operational in December 1961, but by then it was already obsolete. SAGE's primary flaw was that it was physically very large and vulnerable -- the immense size of the computers made building underground installations difficult, hence all of the U.S. SAGE operations centers were above-ground and unhardened. With the advent of a Soviet ICBM capability the SAGE centers became extremely vulnerable, for not only were they valuable targets in themselves, but they also tended to be colocated with other valuable targets such as SAC bases or large cities.[11] For this reason it was decided to build a separate backup system for SAGE. In 1962 a manual back-up system was put into operation in some important radar stations and work began on developing a semiautomatic system, the Back Up Interceptor Control (BUIC) system.[12] In 1963 BUIC began to be introduced, located underground near prime radars, and as a result some of the vulnerable SAGE sites were phased out.[13]

Towards the end of this period (1964-65) the NORAD command post was moved from a vulnerable above-ground building to a hardened site inside a mountain near Colorado Springs.

2.2.3 Interceptors In order to provide effective interception of bombers a new series of interceptors was planned. These aircraft were to emphasize ground controlled interception of bombers at high altitude, high speed, and long range. Planning for a supersonic interceptor began in 1951, but problems with the radically new design caused a change in the program, and it split into two programs. The first program produced the F-102 Delta Dagger, which lacked the speed and range which had originally been specified. The F-102, which became operational in 1956,

was a stopgap measure to provide a supersonic (or transonic) interceptor until the more sophisticated F-106 was completed.[14]

The F-106 Delta Dart was finally ready in 1959, and the aircraft started to be deployed to ADC units. Some 275 F-106As were eventually deployed.[15] The F-106 was optimized for ground controlled intercept of bombers, and was equipped with missiles only. The F-106 remained the primary ADC interceptor for almost 20 years.

There had been a plan for a follow-on interceptor to the F-106, designated the F-108. However, with the increased threat from Soviet ballistic missiles and the lack of development of the Soviet strategic bomber threat, this plan was abandoned in 1959.[16] During the 1960's there were other plans for a new interceptor (usually called the Improved Manned Interceptor -IMI), with some interest in the YF-12A aircraft. The YF-12A was a Mach 3 aircraft with a very long range and missile armament. The lack of a high-altitude threat rendered such an aircraft of dubious value, and it was canceled in late 1967.[17]

The Canadian government had embarked in the mid-50's on a costly project to produce an indigenous interceptor on the grounds that the great expanse of Canada required a very long range craft capable of high speeds. It was believed that existing and planned U.S. aircraft (including the F-106) did not fulfill these criteria. The result was the CF-105 Avro Arrow, a Mach 2+ delta-wing aircraft with a greater speed and range than the Delta Dart. However the great cost of the interceptor and the gloomy prospects for sales to the US caused the government to cancel the program in 1958, after two prototypes were produced. Instead, an agreement was reached with the US for Canada to acquire 66 F-101B Voodoos, a long-range fighter originally designed for bomber escort but re-equipped for interceptor duty.[18]

By the end of this period, the combined air defense forces disposed of 106 squadrons of interceptors (65 USAF, 38 Air National Guard and 3 Royal Canadian Air Force).[19]

2.2.4 Surface to Air Missiles Although most of the responsibility for air defense went to the Air Force and ADC, the U.S. army also received a mission. This is largely due to a major battle between the two services in the mid-50's. The Air Force wished to create an area defense system that would rely primarily on manned interceptors and long-range pilotless interceptors. The Army, which had responsibility for SAMs advocated a point-defense system to use Nike-Ajax and Nike-Hercules SAMs for defense of population centers. The battle between these two approaches to air defense eventually was settled by a compromise -- a mixed area and point defense system. The area component of defense relied primarily on interceptors controlled by SAGE, but the Air Force also wanted to deploy a long-range pilotless interceptor called the BOMARC. The BOMARC was a winged rocket/ramjet vehicle that came in two versions, the A and B. The A version had a range of 250 miles, a ceiling of 50,000 feet, and a top speed of about Mach 2. It was guided to the target first by ground control from SAGE, and then for the last 10 miles by its own radar seeker. The A version had a conventional warhead. The B version had its range extended to approximately 450 miles, with higher speed, a nuclear warhead, and low-level intercept capability. [20]

All 8 BOMARC squadrons were deployed in 1962, half of them equipped with the B model.[21] Canada also acquired BOMARC-Bs at two bases, as part of the deal in which it acquired the F-101Bs. The BOMARC program had many problems, and the effectiveness of the missiles was dubious. In addition to the operational problems, the acquisition of BOMARCs sparked

a major debate in the Canadian government over whether the BOMARCs would have to be armed with nuclear warheads.[22]

The Army's contribution to continental air defense took the form of Nike-Ajax SAMs, which were replaced in the late 50's to early 60's by Nike-Hercules. Batteries of these SAMs were set up around major cities and other potential targets. The missiles were commanded by the Army Air Defense Command (ARADCOM). [23] Nike Hercules was designed to destroy high altitude, high speed targets and could be fitted with either a conventional or nuclear warhead. Range is approximately 80 miles.[24] In addition to these high-altitude systems, the Army also deployed some Hawk low-to-medium altitude systems in the South during the Cuban missile crisis, and these remained in place.

2.3 Decline and Obsolescence: 1965-75

In the ensuing ten years, the Soviet bomber threat declined relative to the ballistic missile threat, and remained small in absolute terms. Thus the role of NORAD shifted, emphasizing early warning of missile attack, rather than air defense. One indication of this shift in emphasis was the renaming of Air Defense Command to Aerospace Defense Command (ADCOM).[25] As the Soviet bomber force aged, so did the U.S. air defense. During this period no new interceptors or SAMs were deployed. Instead radars, SAGE centers, old interceptors, all of the BOMARCS, and many of the Nike-Hercules were retired. There were, however some operational changes, and new programs were initiated that would lead to deployments in the late 1970's.

2.3.1 Radar Systems Many radar systems were replaced or retired during this period, and the overlap of FAA and USAF radars was reduced.[26] To provide survivable low-altitude target detection and interception, the USAF began development work on a new AEW system, the Airborne Warning and Control System (AWACS). Radars for the system were first tested in 1972, and prototype testing started in March 1974.[27]

2.3.2 SAGE As BUIC was introduced during the mid-60's, some of the SAGE operations centers were phased out. The remaining SAGE centers were phased out and replaced with joint FAA-USAF Joint Control Centers (JCCs) between 1974-76, but this was later changed to a system having four Regional Operations Control Centers (ROCCs) in the continental U.S., one in Alaska, one in Hawaii, and two in Canada.[28] The BUIC systems in the U.S. were placed on standby status in 1972.[29]

2.3.3 Interceptors Existing interceptors were upgraded to include new avionics, and a cannon was fitted in the F-106. However the primary change was the decline in the number of interceptors in the active Air Force and the shifting of many of the older aircraft into the Air National Guard.[30] By the end of 73 there were only 6 USAF interceptor squadrons, with 20 ANG squadrons, and 3 Canadian interceptor squadrons.[31]

As the F-106s aged, ADC began to seek a new more modern interceptor. One candidate was the YF-12A, but it did not meet the requirement for an interceptor able to engage low altitude as well as high altitude targets, and was canceled in 1967. Interest then shifted to a significantly modified version of the F-106 called the F-106X which would be used in conjunction with AWACS. However by the end of 1968 the F-106X was

canceled.[32] Interest then turned to air defense versions of the F-4, F-111, F-14, or F-15 aircraft. The F-4 was eventually assigned to some air defense units, but only after the mid-70's when they were slowly being phased out of front line USAF units.[33] F-15s were not assigned to the air defense role until the early 80s, and even then the F-15s were older models being retired from front-line units, rather than specially modified air defense versions.[34] Throughout this period, ADC was consistently given low priority in aircraft procurement.

2.3.4 Surface to Air Missiles The BOMARCS were not considered very effective weapons, and consequently were phased out during this period. By 1972 all of the BOMARCS had been deactivated.[35] At the same time, the Nike-Hercules were regarded as representing a costly defense against a minor threat, and they were gradually transferred from Army units to National Guard units. In 1974 all of the Army and ANG Hercules batteries were deactivated.[36] The few HAWK batteries used in the Southern U.S. for air defense were upgraded to the new I-HAWK. To replace the Nike-Hercules, and the HAWK low-altitude missile, the Army started the SAM-D missile program in the mid-60's. The intention was to develop a mobile SAM that would be effective at all altitudes. A contract to develop the system was given to Raytheon in 1967, but problems in development and testing caused lengthy delays and the first batteries did not become operational until the early 1980's.[37]

2.4 Reemphasis and Renewal: 1975-85

Over the last decade, the topic of air defense began to receive more attention, particularly after the election of President Reagan. New

systems were deployed for continental air defense, and the reequipping of the Air Force freed old aircraft that were transferred to air defense, replacing the even older interceptor force. In the middle of this period, a major reorganization of the command of air defenses took place, which appears to have weakened the organizational influence of the air defense forces.

2.4.1 Organizational Changes Before the reorganization, ADCOM was a major command having operational control of its own forces. ADCOM had its own wings and squadrons which were administratively separate from those of Tactical Air Command (TAC). The reorganization took effect in April 1980, when ADCOM became a specified command, which has access to those air defense squadrons of TAC, but does not directly operate them.[38] Air defense units were organized under the Deputy Commander for Air Defense, TAC, who is responsible for "providing resources to the Commander in Chief, Aerospace Defense Command (CINCAD) and North American Air Defense Command (CINCNORAD) for air defense operations."[39] At the same time, the Aerospace Defense Center was created, a direct reporting unit which includes the operation of the NORAD combat operations center at Colorado Springs. The Commander of ADC is also CINCNORAD and CINCAD, and more recently has also become the head of Space Command, a major command.[40] Although it doesn't appear likely to have affected the performance of the air defense role, this reorganization does appear to have lowered the profile and probably the organizational influence of ADCOM, while emphasizing the role of space systems and ballistic missile defense (BMD).

2.4.2 Radar Systems Reduction of the number of USAF radars, and consolidation of the radar network with that of the FAA, continued in this period. AWACS development ended and procurement began. AWACS was developed for both continental air defense and tactical missions. In the continental role AWACS was to provide a survivable system for vectoring interceptors to incoming bombers, supplementing or replacing ground based systems. AWACS aircraft were assigned to TAC, and based at Tinker AFB in Oklahoma, and plans call for them to be deployed to regional bases covering the U.S. in the event of an emergency. The role of AWACS in continental air defense will be discussed in more detail in a later chapter.[41]

Complementing the AWACS was the development of Over the Horizon Backscatter (OTH-B) radar, designed to detect aircraft and ballistic missile launches at long ranges. One plan for use of AWACS is to launch them on warning of attack from the OTH-B. However, OTH-B is not effective in the Northern areas of primary concern for bomber attack. OTH-B has been deployed on the East and West coasts for detection of bombers and cruise missiles.[42]

An agreement for replacement of the old DEW line and Pinetree radars was signed between the U.S. and Canada in 1984. The replacement radars will be deployed under the Seek Igloo program, and will both increase effectiveness and reduce manpower costs. The new system will be called the North Warning System (NWS).[43]

A program to establish continual air surveillance in the areas near Cuba using a dirigible based radar was undertaken in the early '80s.[44]

2.4.3 SAGE and Control Systems This period saw the retirement of the last of the SAGE systems and their replacement with a system of 7 Regional Operations Control Centers (ROCC). Integration of these systems with AWACS became an important issue, as ROCCs are intended to be peacetime centers, with most duties being taken over by AWACS in time of war.[45] In 1983 SAGE was finally replaced by the ROCC system, integrated with the FAA--USAF Joint Surveillance System (JSS).[46] Programs were also started to modernize the computer systems at NORAD's Colorado Springs Command Post.[47]

2.4.4 Interceptors During this period the long-awaited retirement of the F-106s began to take place, with USAF and ANG units receiving F-4s and F-15s. The combination of the look-down shoot-down radar of the F-15 combined with the AWACS radar provides a significant increase in the capability of ADCOM against low altitude penetrators.[48]

The Canadian government reached a decision to replace the CF-101B and CF-105 fighters with the F-18, redesignated the CF-188. Two squadrons of these aircraft are to be allocated to air defense.[49]

2.4.5 Surface to Air Missiles The SAM-D system was renamed the Patriot system, and finally became operational in the early '80s. Although the Patriot has a primary role as a field air defense system, the first Patriots were deployed to Army units engaged in continental air defense missions in Alaska and Florida. After this deployment, priority will go to equipping Army forces in Europe rather than setting up a comprehensive point-defense system in the U.S.[50]

2.5 Conclusion

Since the early 1960's continental air defense has been allowed to age and shrink in size and capability as the threat it has faced has become less important. Nevertheless, with the growing interest in strategic defense, measures have been taken to increase the capability of the air defense forces. If an area BMD system is deployed in the future it would obviously require a great increase in air defense capabilities in order to ward off the threat of a bomber and cruise missile attack that would circumvent the BMD system.

In the following sections of this report I will examine Soviet assessments of these developments in air defense. In some cases a more detailed examination of U.S. forces will be necessary in order to appreciate and understand Soviet assessments.

3. AIR DEFENSE CONTROL SYSTEMS

3.1 Introduction

In this chapter Soviet assessments of U.S. continental air defense control systems will be examined in detail. The SAGE-BUIC system is emphasized because it formed the basis for NORAD air defense control for almost twenty years. AWACS is considered in a separate chapter since it is a unique system with both strategic and tactical roles to play.

SAGE was the first attempt to design and build a fully integrated semi-automatic air defense control system. It pushed the limits of the computer hardware and software then available, as well as communications and avionics technology. But even though the SAGE and BUIC systems were the backbone of North American air defense during the 60's and 70's there was relatively little discussion of them in the Soviet press. In part this may be due to the fact that by the mid-60's the system was installed and operational -- there was little new about it for the Soviet press to report.

Nevertheless, the discussions of the SAGE and BUIC systems that appear in the Soviet press do present important information on Soviet methods of assessing air defense systems, and possibly even information about Soviet PVO systems.

In examining Soviet assessments of the SAGE and BUIC systems, I will sequentially examine the views of various Soviet analysts, and then present a short analytical summary.

3.2 Krysenko on SAGE

The most comprehensive account of the NORAD air defense system appears in a 1966 book by G. D. Krysenko, entitled Sovremennye sistemy PVO: metody i sredstva upravleniya boyevymi deystviyami (Contemporary Air Defense Systems: Methods and Means of Control of Combat Activities). Krysenko uses SAGE as an example of a modern PVO system. Although the last few chapters of the book discuss some PVO systems in use in European countries, the primary emphasis is on SAGE.

Krysenko states that the book will be of use not only to PVO specialists, but to workers in other fields as well, because the principles used in SAGE can be transferred to other ASUs. SAGE is depicted as an air defense system that has solved many fundamental problems of ASU design, and which may therefore serve as a model for other air defense systems. The detailed and technical nature of the book suggests that it was aimed at a technically sophisticated audience, such as system engineers in an attempt to widely disseminate the technical solutions to general problems of ASU design.

Krysenko starts off by noting that there is a need to introduce automation and computers into the control of PVO forces. SAGE is presented as a good example of an automated system of control (ASU) system for air defense, even though it has some deficiencies.[51] There is little theoretical discussion of the types of control systems, or the benefits that might accrue to them. Indeed, despite claiming to examine SAGE as a system, Krysenko rapidly moves into detailed discussion of operational and technical details.

Krysenko's discussion of the technical and operational aspects of the SAGE system is reasonably accurate. Both technical details and the

rationale behind them are presented clearly. The deficiencies of SAGE are noted, along with its advantages. In the first chapter, Krysenko sets forth some of SAGE's inadequacies:

- Can't provide defense against ICBMs.
- Insufficient level of automation causes it to rely on a large staff.
- Imperfect system of display: not all necessary information can be given to the operator.
- Too unwieldy: it consists of a large number of operating centers and lines of communication.
- Low battle stability: low survivability and noise resistance of the system as a result of the undefended operations centers and large set of open lines of communication.
- Insufficient reliability of the system arising from the complexity of the systems and large number of constituent elements.[52]

These criticisms are consistent with SAGE's acknowledged deficiencies and are similar to those made in the West. Krysenko notes that a number of organizational, tactical, and technical measures were taken in an attempt to overcome these deficiencies and improve the operation of the system, including the creation of BUIC.

The use of area defense for ensuring adequate warning time, coupled with point defense of high-value targets is adequately presented by Krysenko, although his value of only 100 minutes of warning from the DEW line may be a bit low.[53]

Particular attention is paid to the design and operation of the SAGE computer system, including operator's consoles and the communications network. The technical details here are copious and appear to be accurate. In two short chapters at the end of the book Krysenko examines

some other U.S. and European air defense control systems, but in much less detail than for SAGE. The book's emphasis on technical solutions to problems strongly implies that it was intended to present SAGE as a prototype for air defense control system design, and possibly a design that the Soviet Union could emulate.

In 1967, a review of Krysenko's book by Col. G. B. Zabelok appeared in Vestnik PVO.[54] Zabelok has written several articles on air defense systems, and the review is detailed and incisive. His review is quite harsh on both Krysenko and SAGE. First, he notes that a centralized control system like SAGE is vulnerable under nuclear attack, and that if the subordinate units are cut off from the center their effectiveness is reduced. Second, he states that U.S. specialists consider the air defense system to have an effectiveness of not more than 20% (i.e. attrition rate of incoming bombers). Zabelok also notes that "As concerns the control of PVO resources, the system is totally inadequate for the task."[55] In short, Zabelok does not appear to share Krysenko's generally high regard for the SAGE system.

The review also claims that TACS (Tactical Air Weapons Control System) is given a large place in the book, whereas in fact only a few pages are devoted to the system. TACS is a mobile theater level system for tactical air control. This may be either an error, or a suggestion that the discussion of TACS is relatively important.[56]

Zabelok goes on to criticize Krysenko's book for including outdated data, too much detail on forces which change rapidly, and a lack of attention to basic principles of control systems for air defense. One particularly interesting criticism is that Krysenko should not have limited his discussion to defense against strategic bombers and ballistic missiles, since the capitalist's plan to use tactical and carrier

aircraft for nuclear weapons delivery as well. This comment suggests that in reading and reviewing the book, Zabelok is looking for more than information on U.S. systems, and expects to find information relevant to Soviet air defense as well. This straightforward criticism strongly implies that these unclassified books have a dual purpose, both informing readers about foreign systems, and discussing issues of concern to the VPVO and Soviet air defense.

In closing his review, Zabelok notes that the book is useful to "military specialists interested in problems of automation"[57] further confirming that the book was indeed aimed at a technical audience, particularly those involved in ASU development.

The appearance of Krysenko's book and Zabelok's review suggest that there was a significant level of interest in the Soviet Union in ASUs for air defense during the mid-60's. The appearance of Krysenko's book may even be an indicator of the development of a similar Soviet system, a possibility that will be examined in more detail later. In the sections that follow the extent of Soviet interest in ASUs for air defense and its special characteristics will be presented.

3.3 Zimin on Air Defense

A notable discussion of SAGE was presented by General Col. G. V. Zimin in an article in Vestnik PVO in 1971 and subsequently in a book published in 1976. Zimin was appointed a Deputy Commander of the VPVO in 1960, and was Chief of the Military Academy of the VPVO from 1966, so articles and books published under his name may be fairly authoritative.[58]

Zimin's Vestnik PVO article appears to be a condensed version or precursor of a book he later published in 1976. In the article Zimin examines the postwar development of foreign air defense and ABM systems, although the latter will not be examined here.

Zimin suggests that there are two forms of air defense. One is the so-called "dueling" form in which the intruder is directly attacked by an interceptor or SAM. A second approach is raising a barrier in the path of the intruder, such as a barrage balloon system. An allusion is also made to "other methods" of attacking group targets.[59] (Probably by detonation of a nuclear weapon near the group, as is discussed in other Soviet articles.) Zimin discusses only the first form, implying that the barrier method is of limited effectiveness in most cases.

Zimin divides the history of air defense into four separate periods. The first period of the development of U.S. continental air defense began in the 40's. The advent of turboprops and jet engines resulted in a great increase in bomber speed. Air defense methods were limited to antiaircraft artillery (AAA) and fighter-interceptors equipped with cannon. In this stage the offense was dominant.[60]

The second stage started in 1950, with the introduction of SAMs and jet powered fighters armed with AAMs. Zimin claims that: "With the appearance of these weapons the antiaircraft defense acquired an advantage and this led to further increase in the altitudes and speeds of flight of attack airplanes."[61]

The third stage lasted from 1957-58, and includes the massive deployment of air defenses in the U.S. According to Zimin, this period saw the deployment of the Nike-Hercules and HAWK second-generation SAMs, along with a new generation of fighters armed with new AAMs. (The F-102, F-106, and F-101B armed with Falcon and Genie.) Zimin also includes in

this period the [Y]F-12A and F-106X, proposed interceptors. Both of these aircraft are discussed in some detail, even though the YF-12A was canceled in 1967 and the F-106X never got off the drawing board.[62,63]

The fourth stage is the one in which we now find ourselves. It is characterized by the fact that penetration tactics have shifted to low altitude from high altitude. In the U.S. new generations of SAMs (such as the SAM-D) and interceptors (F-14 and F-15) are being prepared. Furthermore, new methods of air defense are being investigated, such as the detonation of large nuclear warheads in the upper atmosphere for the purpose of destroying groups of air targets.

It appears that Zimin is alluding to both Soviet and American systems in the article, although it is difficult to differentiate between the two due to the parallel development of air defense technologies at the time. For example, in the above discussions one could substitute the MiG-21 for F-102 and F-106, and perhaps the Yak-25 for the F-101B. In this case the evidence appears ambiguous, and the description could equally well apply to either side. Indeed, Zimin's discussion does in some places suggest that he is referring partly or perhaps primarily to Soviet systems.

One anomaly is the discussion of the F-106X and the F-12A. Zimin discusses these systems in some detail, even more than for the F-106. This attention to aircraft which were never produced is unusual. It is possible that these aircraft are being discussed because they fit into the Soviet view of how an air defense system should develop, creating new high-performance interceptors to meet the threat. There was little incentive for the U.S. to deploy a high-altitude Mach 3 interceptor such as the F-12A, and the project was canceled in November 1967.[64] The USSR continued development of the MiG-25 Foxbat, which was deployed in 1970

and which has roughly similar performance and missions.[65] Thus the argument can be made that Zimin is in fact referring at least in part to the development of the MiG-25. If Zimin is referring to Soviet systems, it is unclear which system is analogous to the F-106X, although the SU-15 is one candidate.[66] These issues will be discussed in more detail in the chapter on SAMs and interceptors.

After the history of air defense, Zimin sketches the development of ABM systems, turning afterwards to the problem of controlling PVO forces. Zimin notes the importance of automation of data processing and distribution, and that "A basic principle in organizing control of an antiaircraft defense is achieving a high level of centralization."[67] Turning to the overall basic trends in the development of Western air defense, Zimin claims the following to be the main trends:

1. Integralness of PVO systems which are in use and which are being developed anew;

2. Research and testing of new principles governing the destruction of the air-space enemy and improving existing forms and methods used in PVO combat action;

3. Further development of the principles of centralization and automation of control of PVO troop units;

4. The conduct of operational-tactical, technological, and other measures providing the required amount of time for destruction of air-space attack weapons prior to execution by them of their combat missions; and

5. Search for optimal ways of drawing on other services of the armed forces for executing missions designed to dependably protect a country from the air.[68]

Although these trends are supposedly observed in the West, there is good reason to believe that Zimin is here referring to the development of

the VPVO as well. The stress on automation, centralization, and timely destruction of targets often appears in the Soviet press referring to Soviet air defense. Given the general decline in U.S. continental air defense capabilities, few of Zimin's trends would apply to the West, although they may apply to NATO and theater-level air defense. For example, centralization appears to be more of a Soviet trend than an American one, because AWACS is a decentralized system developed to offset the vulnerability of the centralized SAGE system. Furthermore, the use of "other services" to assist in air defense is more common in Soviet discussions of VPVO activities than in Western discussions, since the Soviets could use Frontal Aviation, Ground Forces, and Navy air defense assets to defend strategic targets.

Zimin closes his article with a rather unusual statement, one that differs from the usual comments about either the aggressive capitalists or the aid of the party in developing the VPVO:

> The role and importance of the PVO defense of a country continue to increase. During a brief period in history, as the foreign press stresses, PVO defense, from a measure of secondary importance, has become a factor of strategic importance having a direct influence on the course of combat action, the military-economic potential of a country, and the spiritual state of a people.[69,70]

This statement is unusual in that it does not mention the wisdom of the party in guiding the development of the VPVO. It is also unusual to find a high-ranking VPVO officer noting that the VPVO defense role was a measure of secondary importance, even in the Western countries. The combination of Zimin's strong arguments for continuing development of air defense and ABM systems, with the assertion that some consider defense of secondary importance suggests that he is directing his

criticism against internal opponents. Zimin's article coincides with the negotiations on ABM limitations, suggesting that it is directed against those negotiations and any possible ABM limitations. This argument is strengthened if one notes that the ABM section of the article lists a variety of Western ABM projects of various types, and presents an attack on the imperialist policy of the U.S. before turning to the problem of PVO control systems. The juxtaposition of this attack with the description of ABM systems may be a subtle reminder that the U.S. is not to be trusted. Also supporting the theory that Zimin is arguing against defensive limitations and for a continued strong VPVO is that the article's publication roughly coincides with the introduction of several new interceptors into service with the VPVO, namely the MiG-25, the SU-15, and the MiG-23.[71] It is possible that the stress on the importance of both air and space defense may be an argument for the maintenance of a high level of capability in both areas, and if an ABM limit is reached that air defense remains an important element of defense of the nation.

The supposition that Zimin is only partly referring to Western systems in this article may also hold with respect to a book published "pod redaktsiyey" (under the editorship) of Zimin in 1976, Razvitiye protivovozdushnoy oborony (Development of Air Defense). Although the book purports to discuss the general development of air defense systems, it does not explicitly mention Soviet air defense development. In such a context, it is possible that at least some of the discussion of Western systems may be a screen for Soviet systems. The book features a forward by P. F. Batitskiy emphasizing the importance of VPVO, and in particular of anti-space defense (protivokosmicheskiy oborony PKO). At the time of publication Batitskiy was Commander in Chief of the VPVO, and his

endorsement of the book suggests it is authoritative and representative of the thinking of the top levels of the VPVO leadership.[72]

Zimin's treatment of NORAD is very different from that of Krysenko. Instead of stressing the technical aspects of the system and how they are integrated with mission requirements, Zimin emphasizes the architecture of the control system and how it springs from the demands of modern air defense problems. In the following paragraphs, I shall set out some of Zimin's arguments, and then analyze them for relevance to Western and Soviet systems and practices.

Zimin notes that there are three ways of defending the nation against attack: one can destroy the enemy forces on the ground in his own territory, one can destroy enemy forces in flight, and one can protect the population (civil defense). The first is a clear reference to the use of preemptive strikes against enemy forces, which may correlate with the above-noted trend to use "other services" to protect the country from air attack. It is noted, however, that such a strike would not destroy all the enemy ballistic missiles, alert bombers, and submarines and that a PVO system is therefore still necessary.[73] Preemptive strikes and civil defense are not discussed in much depth, instead the discussion quickly turns to means of PVO. This section of the book clearly reflects the earlier article, for example the discussion of PVO forces again notes that one can employ "dueling", barriers, and special methods for group attacks.[74]

Zimin's discussion of the NORAD command structure emphasizes the centralization of the system, and its ability to perform rapid real time assessment of the air defense situation. This need for centralization and rapid reaction in turn requires the automation of the air defense system.[75] Adequate warning time is required to alert interceptors. This

need for long range warning gave rise to the development of the AWACS system, which can control both interceptors and SAMs.[76] Furthermore, the air defense system must be ready to deal with a synchronized attack by aircraft and rockets, and "cosmic attack". Thus the system must integrate both anti-air, anti-rocket and anti-space means.[77]

For the anti-air component of this integrated defensive system the primary threat is low-altitude penetration. Of particular importance is destroying "rocket carriers" (bombers with air-to-surface missiles -- ASMs) before they launch their ASMs, and if this fails, destroying ASMs in flight. To do this one requires long-range interceptors with an almost autonomous ability to search for targets below the radar screen, radars on board ships and aircraft, as well as an improved control system. In the U.S. the AWACS system has been developed to detect low altitude targets and destroy rocket carriers before they reach the borders of the country and launch their ASMs.[78]

From low-altitude penetration, Zimin turns to the problem of ensuring the survivability of the PVO system. Among the active means of maintaining survivability, Zimin rates camouflage as one of the most important. The argument for this is that PVO sites must be detected in order to be destroyed. Furthermore, the proper construction of SAM installations can increase their survivability. These measures, however, are only effective against conventional weapons or distant nuclear detonations, and so defense must be conducted far from the site itself. Radar antennas are vulnerable, but phased array radars are more survivable. Command posts may be hardened.[79]

The NORAD command post in Colorado Springs is given as an example of a hardened underground command post. But survivability is seen as more than just a physical characteristic and Zimin stresses the organizational

and training factors which go into ensuring the survival of the air defense system. For example, after describing the NORAD command post, Zimin discusses how to organize troops to survive a nuclear attack. The main element in ensuring survivability is the control system. If the system is completely centralized then it could be paralyzed by the destruction of the central command post. So it is proposed that the system have the capability to operate without centralized control. Zimin claims that in the U.S. there are several "regimes" for the air defense control system:

1. A regime where all systems function and control is centralized in one command post.

2. A regime where control is transferred to regional control centers, in essence decentralized control since there are several centers and each is self-sufficient.

3. A regime where the centers are re-subordinated to central control, with the reconstitution of the centralized system.

4. Completely decentralized control where all control is exercised by the command posts of the units.[80]

At the end of the section on survivability, Zimin also notes that it is preferable that command posts not be colocated with radars since they might then be subject to attack by radar-homing missiles.[81]

This discussion brings out several points which are prominent in Soviet literature on air defense. First is the need for a centralized, automated system of control. As Zimin argues, centralization is necessary in order to appraise the overall combat situation when there is a large territory and many units to be controlled. Related to this is the need for a centralized capability to control air defense maneuvers,

particularly for concentrating forces in the areas where the attack is heaviest. The second factor which Zimin stresses, and that appears in other works, is the need to intercept and destroy bombers armed with stand-off missiles before the missiles can be launched, and preferably even before the bombers reach the borders of the target country. AWACS is presented as assisting in early interception, as it can extend radar coverage beyond the borders and coasts. However, if these incentives to centralization are present in the U.S. (as Zimin suggests they are), then they must be even greater in the USSR, where the strategic bomber threat from the U.S. is much larger, and where most bombers are equipped with ASMs. Thus, we might expect this line of argument to apply primarily to the USSR, and that Zimin might even be obliquely referring to Soviet weapons and strategy.

Zimin's discussion leaves open the possibility that he is in fact referring to U.S. systems. For example, the Tu-126 Moss AEW system fulfills a role similar to that of the EC-121H, or to a lesser extent AWACS, and was deployed long before AWACS. Indeed, when Zimin wrote this book, AWACS had not yet been deployed by the U.S. This suggests that either the value of AWACS was clearly recognized in advance by the Soviets, or that Zimin is at least partly referring to the TU-126.

In the case of ASM equipped bombers, the situation is different. The USSR's primary bombers, the Tu-95 Bears, were at the time armed with only one ASM, and there were not many of them.[82] The small number of aircraft, coupled with their limited armament, high altitude flight, and large size, rendered the Soviet bomber force a minor threat to U.S. security. Conversely, at the time the larger U.S. bomber force was armed with short-range attack missiles (SRAMs) and gravity bombs, and was well equipped for conducting a large scale attack on the Soviet Union. The

U.S. bomber force posed a serious problem for the Soviets air defense, particularly with the introduction of the SRAMs, which allowed the bombers to attack VPVO sites while continuing on to their primary targets. Zimin's concern with ASMs and reconsititution of air defense must therefore be seen in light of the U.S. threat to the VPVO. Indeed, his discussion of the need for long-range interception, the ability to destroy ASMs, and the ability to reconstitute air defenses, may be seen as a response to the U.S. strategic bomber force, rather than as a discussion of U.S. air defenses.

Zimin's emphasis on organizational structure and survivability also seems to reflect Soviet thinking more than U.S. practices. He considers organizational structure at least as important as physical hardening. This emphasis on enabling the control structure to withstand nuclear attack and reconstitute itself does not usually appear in the Western press. The existence of the four "regimes" in the SAGE system that Zimin describes is possible, but there appears to be no documentary evidence in the Western literature to support his assertions. In this case it is very likely that Zimin is referring to Soviet theory on the organization of PVO control systems, rather than just explaining Western systems. As we shall see in a later chapter, the themes of centralization and reconstitution are common in Soviet discussions of air defense, although they are rare in U.S. discussions of the subject.

Later in his book Zimin returns to the topic of control systems. The section is a largely factual description of NORAD systems, including radar coverage, communication systems, and the integration of ballistic missile and air attack warning systems. The level of detail is moderate, being less detailed than Krysenko's book but greater than that in earlier sections of the Zimin book. Particular attention is paid to the

processing of input information and the display systems for operators and the main screen. SAGE's missions are outlined both in general and for the operations sector. Zimin notes that SAGE's survivability is low and hence the BUIC system was created.

Most of the discussion of survivability concerns the use of mobile command posts that can be used to replace SAGE centers. According to Zimin goal here is to ensure control system survival rather than physical survival of control centers. One system mentioned but not identified can be set up in 4-6 hours in a region where the command post has been knocked out of action. Zimin also describes the 412L control system as including radars, data processing, communications systems, and control of active means. Zimin claims that the radars for this system are mobile, with ranges of 500-600 km for detection and 300-400 km for tracking. These radars can be set up in about 20-30 minutes, with the use of inflatable radomes. Thanks to microelectronics the system is more efficient than SAGE and although designed for use in a small region can be used to control all active means of air defense on the continent.

For more survivability in a nuclear war, flying command systems have been developed, such as AWACS. Zimin mentions that OTH radar is used to launch the AWACS on warning of attack, but does not elaborate on the point. He then goes on to discuss the specifics of control systems for SAMS, a topic that will be addressed in more detail below. Again, he ends by suggesting that the threat of air attack has not diminished, and that the role of anti-aircraft defense in PVO will increase.

In this last section Zimin makes some interesting assertions and interpretations. First, the emphasis on survivability of the system, and its reconstitution within a period of several hours is unusual. There is little discussion of such reconstitution of the defense in the Western

open press, and the utility of reconstituting some hours after a major strike seems dubious. Second, Zimin appears to be inaccurate in his description of the 412L system. According to Jane's Weapon Systems, the 412L system is deployed in West Germany, not the U.S., and it is not mobile, although some components of it might be.[83] It is possible that Zimin is referring instead to the 407L system (Tactical Air Weapons Control System -TACS), which is mobile and can perform many of the tasks Zimin ascribes to it.[84] However TACS is not usually assigned to continental air defense, and probably would not be capable of managing the battle over the entire continent. While the 412L system might be able to coordinate air defense over a continental scale, this does not appear to be its role in Europe, and the system is not deployed in the U.S. Zimin's treatment of these systems is rather unclear, and he seems to be less interested in the accuracy of facts than in general trends and features. Mobility and the ability to replace destroyed control systems seem to be of more importance, than combat capabilities. This section may therefore be a presentation of preferred capabilities for air defense systems, rather than a discussion of either specific U.S. systems or a surrogate discussion of Soviet systems. The factual errors (or confusion) are not the only ones in Zimin's book, suggesting that data for publication is not always carefully checked.

What conclusions can we draw from this examination of Zimin's publications on air defense? Several concerns are evident that are not just passive reflections of Western thinking on air defense:

1. Automated control systems and centralized command are required for modern air defense. The threat of a large number of targets attacking in synchrony requires rapid decision-making and flexibility, as well as the ability to centrally assess and direct the combat situation.

2. The Soviets are particularly concerned with the detection and destruction of low altitude penetrating bombers, particularly those carrying missiles. Emphasis is placed on detecting and destroying them before they can reach the borders of the country or release their missiles. In the event they do launch their missiles, the air defense system must be capable of destroying the missiles in flight.

3. Survivability of the control system is not just a matter of ensuring the physical survivability of its components. Regimes of operation under combat conditions must be worked out and provisions made for continued operation even when part of the system is destroyed. Means of preventing damage to installations such as hardening and camouflage are worthwhile and necessary.

4. Reconstitution of air defense capabilities is important and can be accomplished within a few hours of the destruction of control posts. Mobile control systems are one means of achieving this goal.

5. The use of airborne radar and control systems has the advantage of extending the range of detection of targets, improving detection at low altitudes, and improving survivability during nuclear war.

These conclusions are consonant with Soviet military doctrine and the threat which they face. It is important to note that while this book was being written, the U. S. was working on the B-1 and ALCM, two weapons that would complicate the VPVO's work. The reaction to these weapons would indeed be to seek to intercept the bomber before it could launch the ALCMs. The desire to retain a viable air defense system after the first few hours of a war is consistent with Soviet doctrine that a nuclear war can be fought as a war, and that the maintenance of defenses in the intra-war and post-war period may be necessary. Certainly, if one assumes that the bomber attack will follow ICBM strikes on command posts and air defense sites by a few hours, the need to reconstitute the PVO becomes clear if it is not to be rendered completely ineffective by the

ICBM strikes. These themes recur in several other articles on air defense, as we shall see below.

3.4 Other Soviet Views of U.S. Air Defense

Zimin and Krysenko's books are the most comprehensive examinations of the U.S. air defense system reviewed for this report. However a number of other sources refer to the SAGE and BUIC systems, even if only in passing. Examining the discussion of U.S. continental air defense systems in these sources provides more insight Soviet views on control system automation and the overall problem of air defense. In this section a number of different sources will be examined in order to synthesize an overall picture of Soviet perceptions of ASUs for air defense.

The Zimin and Krysenko discussions of air defense systems concentrated on strategic and operational matters, and they indicated the importance that the Soviets place on the development of automated control systems (ASU) for air defense. A previous report in this series has shown that in modeling air defenses the Soviets use queuing theory, which implies that the primary measure of an air defense system's effectiveness is the time required to engage targets.[85] This is carried over into the specifications and evaluation of ASUs for air defense, as we shall see below.

3.4.1 Control System Automation

In a book published in 1971, A.N. Romanov and G.A. Frolov set forth the principles of automating control systems. This book claims to be the first in which the formation of ASUs is mathematically modeled and systematically presented.[86] Romanov was

the author of several articles in the Vestnik PVO during the 60's.[87] The authors chose the NORAD SAGE system as an example of an air defense ASU.

NORAD is portrayed as a closed loop, in which data on the enemy is processed and fed to the commander who then makes the appropriate decisions, that are then relayed to the operational units.[88] This description of an ASU serving to process data for the commander is typical of Soviet literature on the subject. The basic requirement for combat operations control systems is timeliness of decisionmaking and directing the active means and transmitting commands to the executors.[89] This is represented as:

T(control) = t(proc) + t(solve) + t(transmit) + t(action)

where:

T(Control) = time spent on the control and execution of commands.

t(proc) = time of processing and transmitting status information (e.g proc the signals of radars)

t(solve) = time necessary to understand the situation and to develop a solution

t(transmit) = time of forming and transmitting command information to the executors;

t(action) = readiness time for active means and the time they take to perform the necessary actions.[90]

The action time of the control system is defined to be the sum of the first three times, and t(action) is the action time of the executor. In order to decrease the overall response time it is necessary to reduce the action time of the control system. The best way to achieve faster action times is to automate the system of control.[91] In addition to the advantage of increased time, Romanov and Frolov clearly outline the need for an ASU to coordinate the actions of SAMs and interceptors.[92]

The second chapter of the book picks up on the need to automate the control system, and identifies the areas that would benefit most from automation: data extraction and processing by radars, situation display, information on combat readiness of forces, target identification and ground controlled interception (GCI).[93] It is best to automate all of these systems and interconnect them all, an example of which is the SAGE system. Romanov and Frolov then give a structural diagram of an air defense control system that resembles the SAGE system.[94] The implication is that SAGE may be considered the archetype of the air defense control system.

After the long discussion of processing methods the authors again turn to the subject of "Combat Employment of Automatic Control Systems in Air Defense Forces." SAGE is used as an example of an air defense ASU and the operation of the system is discussed in some detail. No criticisms of the system are presented in this section. Discussion then moves on to the ASUs used to control the Nike-Hercules SAM sites, the Missile Master system. Technical details about Missile Master, as well as mobile versions of Missile Master, the Birdie, Missile Monitor and Helilift systems. The impression one gets from the Romanov and Frolov book is that ASUs for air defense are necessary in order to decrease the overall action time of the air defense system, while giving the commander more information and more time in which to make his decision. SAGE is presented as an example of such a system, and is not subjected to any significant criticisms. Thus, judging by the Krysenko, Zimin, and Romanov and Frolov books, the Soviets were very interested in the system architecture of the SAGE system during the late 60's to early 70's, and despite the outdated technology, felt that it was a good example of an air defense control system.

3.4.2 Fire Control Systems Another discussion of ASUs for air defense appears in Mal'gin's book on fire control systems for SAMs.[95] Mal'gin's book is primarily concerned with battery and division level systems. However, it does contain some discussions that use SAGE as an example of the design of large-scale ASUs for air defense. SAGE's interaction with SAM battery control systems is highlighted, which is in accord with the emphasis of the book.

Mal'gin again uses execution-time formulas similar to those presented in Romanov and Frolov to explicate and measure the effectiveness of SAM fire control systems. It therefore appears that the time-based measure of effectiveness is an accepted method of assessing of air defense control systems.

3.4.3 PVO Handbook The PVO handbook was edited under the direction of Zimin, and is an authoritative guide and handbook for the VPVO officer.[96] The authors of individual sections are experts in their respective fields, with many of them having contributed articles to the Vestnik PVO and other journals. The section on Control Systems was written by Mal'gin, and he again uses the execution time method of assessing the effectiveness of air defense control systems. The appearance of this methodology in Romanov and Frolov's book, in Mal'gin's own book, and in the Handbook suggests that it has become a standard method of measuring the effectiveness of VPVO ASUs. This finding that ASUs are primarily assessed on the basis of their ability to decrease reaction time confirms the results of Finn and Meyer.[97]

3.4.4 Articles on SAGE and BUIC The Vestnik PVO paid comparatively little attention to the SAGE and BUIC systems. As suggested earlier, one

possible reason for this is that during the time period scanned the SAGE system was already in place, and there was little new to write articles about. The Krysenko book would have served as a basic text on the SAGE system for those interested in it. A few articles that examined or mentioned SAGE were found, and they were generally accurate descriptions of the system and its purpose. The tendency to stress survivability and the benefits of centralization were not observable in these articles. It appears most likely that the articles were written primarily for the information of VPVO officers rather than as surrogates for discussion of Soviet systems.[98]

3.5 Summary and Conclusions

In this examination of the Soviet literature it is clear that the Soviet assessment of U.S. air defense capabilities is not merely a reiteration of Western assessments but is uniquely Soviet in many respects. This is evident in their concern for survivability of the air defense system, the emphasis on reducing reaction time, the interest in mobile command posts, discussions of camouflage, and other respects. There is also more concern with centralization of control and the transition from centralization to decentralized control in the event of damage to the system. Overall, the impression is of a greater interest in the prolonged war-fighting capability for air defense than one finds in the U.S.

The distribution of the literature is also of interest. Most of the discussions of U.S. continental air defense took place in books, rather than in journals. This may imply that knowledge of such systems is not

very important to lower level VPVO officers, but is rather of specialized interest and is better disseminated in book form.

The appearance of the technical discussions of Krysenko, Romanov and Frolov, and Mal'gin suggests that there was a great deal of interest in the details and development of air defense control systems in the late 1960's to early 1970's. Given the VPVO's concern with centralization and the development of modern computers in the USSR during this time, it is reasonable to speculate that during this time the VPVO was undergoing extensive modernization and computerization of its control systems. While there is little public data available on the structure and technical details of the VPVO's continental defense control system, the interest expressed in SAGE and its repeated use as an example of a centralized control system suggests that the USSR may have either emulated it or used it as an archetype for the development of its own system. Assessments of the development of Soviet computer technology show that the USSR developed computers roughly comparable to the AN/FSQ-7 (IBM 7090) in the early to mid-60's, suggesting that early installation of a SAGE-like system may have taken place about the time of the publication of Krysenko's book.[99] While this must remain a conjecture, other articles appearing in the Soviet press (discussed in a later chapter) tend to confirm a change in level of automation and increased centralization during this period.

The hypothesis that Soviet publications use discussions of Western systems as screens for discussions of their own systems and concerns seems to be supported by the literature cited above. These discussions thus provide valuable insights into how the Soviets perceive their own air defense systems, and how they evaluate their effectiveness. In subsequent chapters we shall examine other components of air defense,

such as interceptors, and the development of AWACS, in order to further study Soviet assessments of air defense.

4. AEW and AWACS

4.1 Introduction

Although AWACS was the first AEW aircraft to capture much public attention, the development of airborne radar systems started in World War II.[100] The U.S. Air Force started using AEW aircraft in the early 1950's, although the AWACS aircraft was not deployed until the mid-70's. During this time the Soviets paid attention to the development of U.S. AEW aircraft, and developed their own AEW aircraft, the Tu-126 Moss. In this section the evolution of Soviet interest in AEW aircraft will be examined.

4.2 Early AEW Systems

The first USAF AEW aircraft was ordered in 1951, and dedicated AEW aircraft for long-range radar coverage were deployed in the mid-50's.[101] The EC-121H, deployed in 1962-63, provided extended radar coverage over the East and West coasts with direct radar input to SAGE via the Airborne Long Range Input (ALRI) system.[102] The EC-121 had a very limited overland low-altitude detection capability and was therefore used for overwater surveillance. Despite this limitation the EC-121 provided a useful supplement to U.S. radar coverage and allowed the retirement of the Texas Towers and some radar picket ships.[103]

Initial Soviet reactions to the deployment of the EC-121H are difficult to assess, since our journal database does not extend back to

1962. The earliest reference found to U.S. AEW is in Ashkerov's 1960 book on the PVO.[104] In a section on radar systems and radar coverage, he notes the use of the RC-121C aircraft (the earlier designation of the EC-121C) and gives a radar range of 200 km with the capability of detecting both aircraft and ships. According to Ashkerov's book the RC-121C could transmit data to ground posts and to fighters in the air.[105] This information appears to be correct, although at the time the RC-121C did not have direct input to SAGE. The RC-121C is not emphasized much, and the RC-121C illustration is in fact a picture of a Navy WF-2 AEW aircraft.[106]

Krysenko discusses AEW in some detail, noting that it was used to replace the Texas Towers and that one aircraft can cover an area of 500,000 sq km in a patrol. Most of the discussion is accurate, and Krysenko points out that the EC-121C has interceptor direction and jamming capabilities. Detection range for low-flying targets is described as being 2 to 3 times greater than for a ship or ground station. Krysenko also notes the differences between the EC-121C and the EC-121H, the latter being equipped with ALRI for SAGE input. Only two anomalies stand out in Krysenko's discussion. First is the ascription of a submarine tracking role, which is not mentioned in the Western press. Here Krysenko may be confusing the EC-121C AEW aircraft with the EC-121P which did have an anti-submarine radar picket role.[107] Second is Krysenko's mention of the EC-121 variant (designated as the Navy WV-2E) variant with a rotodome mounted above the fuselage. (Radars in the EC-121 series were mounted on the fuselage in ventral and dorsal radomes which did not rotate.) This experimental WV-2E aircraft with the rotodome is pictured as well as the standard EC-121. The WV-2E rotodome variant was tested in 1956, and provided data leading to the development

of a non-rotating above-fuselage radome for the WF-2, and later the rotodome for the E-2 series. The WV-2E itself was experimental and was never deployed. The rotodome used in the WV-2E does, however, bear a very strong resemblance to that of the Tu-126 Moss, suggesting that the configuration was copied by the Soviets.[108]

In addition to discussing the EC-121, Krysenko also mentions the Navy WF-2 AEW aircraft, the predecessor of the E-2 Hawkeye. Krysenko ascribes a radius of detection of 300 km to the WF-2, and notes it's capability to detect targets at low altitude and to control interceptors. Inclusion of the WF-2 in Krysenko's book is interesting since the WF-2 did not have a continental air defense role, being intended for tactical carrier-based operations.[109]

The confused illustration of AEW aircraft in both Ashkerov's and Krysenko's books may be due to poor editing, or it may reflect the fact that pictures of the WF-2 and WV-2E were common, perhaps because of the Soviet interest in them. In either case, both authors evince significant interest in AEW, and particularly in the WF-2 approach using a above-fuselage radome.

Operationally, Krysenko notes that AEW aircraft allow the rapid filling of gaps caused by the destruction of ground stations.[110] Although this is one of the uses of AWACS, the limited overland capability of the EC-121 would have rendered it relatively ineffective in this role. The increased reliability of AEW over ships is noted, since in the Greenland-Iceland area shipboard systems were often hampered by the weather.[111] Krysenko also claims that AEW aircraft give 40-50 minutes of warning time before aircraft reach the coasts.[112] These are generally fair assessments of the EC-121 system.

Krysenko also discusses the development of dirigible-based radars, although it appears that most research in this area was conducted at a low level in the 60's after some initial interest in the late 50's.[113]

Krysenko's discussion of AEW systems indicates that he thinks they are fairly valuable, both for extending warning and for the detection of low-altitude targets. These are fair assessments that recur frequently in Soviet discussions of AEW.

Although Krysenko pays attention to the use of AEW aircraft, an article appearing in Military Thought in 1966 by Major General of Aviation A. Kravchenko appears to almost dismiss AEW aircraft.[114] In his review of trends in the development of aircraft, Kravchenko devotes only one paragraph to AEW, and in closing notes that the EC-121 aircraft are being retired and that AEW is only being retained by the Navy.[115]

Kravchenko's brief mention of AEW in the course of what is otherwise an extensive and detailed article suggests that he saw little significance in the use of AEW aircraft. Although at this time there may have been plans to retire the EC-121s (they were not retired until 1976) there were still ongoing AEW development programs in the U.S.[116] The use of EC-121s in the Vietnam War, however, demonstrated the utility of AEW aircraft and ongoing research into over land detection pointed towards the development of a new generation of AEW aircraft.[117] Soviet assessments of this new generation of AEW aircraft are presented in the next section.

4.3 Assessments of AWACS

There was little Soviet discussion of AEW until the early 70's. The reasons for this may be twofold. First, development work on the AWACS

system started in the early 70's, prompting several Soviet articles on the topic. Second, the Tu-126 Moss was apparently deployed in the late 1960's to early 70's. If the Soviets were discussing AEW as pertains to their own aircraft, one might expect to find interest in the topic expressed before AWACS and in more general terms. If the discussions of AWACS really are discussions of AWACS and not Moss, one would expect them to follow the development and deployment of the system both in terms of article content and in number of articles. In fact, both of these phenomena are observable. There are a few early articles extolling the benefits of AEW systems, and there are quite a few articles discussing the AWACS program and its development. In this section the evolution of Soviet assessments of AWACS will be traced.

One of the first references to the use of an AEW aircraft with the PVO can be found in a Military Thought article from 1969, written by Major General of Aviation Lyubimov. The article is primarily concerned with the interaction of PVO and naval forces for the defense of coastal areas and strategic targets.[118] In this context there is a brief discussion of the use of radar-equipped aircraft for patrols beyond reach of ground-based radar. Radar patrol aircraft would interact with naval forces providing both surface and airborne radar coverage. Defensive means would be provided by SAMs based on ships and medium and long-range interceptors, and the problem of coordination of surface and air forces is noted.[119] Although mentioned in passing, this appears to be the first direct reference to Soviet radar patrol aircraft, and it roughly coincides with the first release of Soviet pictures of the Tu-126 Moss.[120] There is the possibility that the radar patrol aircraft that Lyubimov refers to is an electronic warfare (EW) version Tu-16 Badger or the Tu-142 Bear-C, but the implication is that the radar aircraft is to

search for aerial targets, a mission for which these two aircraft do not seem to be well suited.[121] Given the limited overland capability of the Tu-126 Moss, it appears likely that a coastal picket role would be given to it, and thus it is probable that Lyubimov is in fact referring to the Tu-126 Moss.

Apart from the Lyubimov article, which appeared in a classified journal, there are no direct references to Soviet AEW aircraft and their use. The discussions of PVO operational art and control systems that took place in the late 60's and early 70's do not refer to AEW aircraft, and there is no suggestion of using them as survivable command posts for managing the air battle. In the unclassified Soviet press, however, there was quite good coverage of the development of the AWACS system, and one can obtain an understanding of Soviet views on AEW by looking at their treatment of AWACS.

One of the earliest references to AWACS appeared in Vestnik PVO in 1971 in a set of two short articles examining the F-15 and AWACS.[122] The technical characteristics of both aircraft are presented in detail, particularly given their early stage of development. AWACS is described as a means of strengthening the air defense of North America, detecting low altitude targets and directing interceptors to them. AWACS would be launched on warning from an OTH-B radar, and interceptors would follow it to the patrol area. This requires a capability to interact with SAGE and BUIC, and for the aircraft to either remain in the air continually or to be on alert. The article notes that it is planned to use the F-15 in conjunction with AWACS. Tactical and EW missions for AWACS are mentioned, but they are considered secondary. Details of engines and an outline of the on-board electronic equipment are given. There is little data on the radar, probably because at this stage the final radar for

AWACS had not yet been chosen. Receipt date of the first AWACS is given as 1976, with a planned order of 42.[123]

Most of the information in the Vestnik PVO articles is correct given the state of the AWACS and F-15 programs at the time. The fact that these systems were noted and examined at such an early stage (the AWACS prototype had not yet flown) suggests a fair amount of interest in them. In this case it appears that the assessment was clear and accurate.

During 1971, Soviet authors appear to have started paying more attention to the development of airborne radars. This may be due both to the U.S. development of the AWACS and to the deployment of the Moss.[124] During 1971 one finds more references to the value of airborne radar systems.

In Zimin's Vestnik PVO article reviewing the development of air defense, he notes the importance of the development of airborne radars:

> Radar stations mounted in airplanes have been added to the network of ground radar stations in the USA for the purpose of supporting the weapons used in combat. According to the press, the new "AWACS" system for weapons control makes it possible to detect and track air targets at all altitudes, including those against the background provided by the earth.[125]

This mention of the AWACS system may be a veiled reference to the Tupolev Tu-126 Moss, as Zimin discusses the use of the aircraft in the present tense. Given the general nature of Zimin's article (see the previous chapter) it appears possible that he was promoting the Moss as well as discussing the AWACS. Whether the Moss was capable of living up to the description given by Zimin is not important, what is clear is that the potential contribution of AEW to air defense was recognized fairly early. An article in Tekhnika i Vooruzheniye on radars also appeared in

1971 and was sanguine about the uses of airborne radar.[126] In the article the author notes that, "Above ground radar is thought to be the most effective antiaircraft resource created in the last 20 years, especially against low flying targets."[127] The advantages of AEW include a 2 times increase in range over ground based radars as well as the ability to locate low flying targets. A discussion then follows of the technical problems of radar design for airborne installation.

Also in 1971, Aviatsiya i kosmonovtika published a short note on AWACS, noting that it was to be a system of early warning and control for PVO forces.[128]

In sum, in 1971 there were a number of references to, and articles about, AWACS. Most of the characterizations of the system were accurate and appear to refer directly to AWACS rather than to the Moss. The triggering event for this spate of articles was probably the signing in mid-1970 of a contract with Boeing for a prototype AWACS.[129] This event increased the visibility of the system and portended future deployment, probably stimulating the interest of Soviet officers and authors. There is little direct evidence that references were being made to the Moss, although the comments by Zimin and others suggest that at the least the value of such AEW aircraft was clearly recognized.

During 1972 there was little discussion of AWACS in the Soviet military press. The AWACS prototypes underwent testing during 1972 and the Westinghouse radar was chosen for further development in October 1972. A decision to start full scale development was announced in January 1973.[130] After this decision and the fixing of the operational characteristics of the AWACS, the Soviet press began to publish more articles about the system.

A detailed article on AWACS appeared in the Vestnik PVO in June 1973.[131] Its description is very similar to that of the 1971 article. As portrayed in the article, AWACS's mission was to provide radar coverage for North American air defense, detecting low-altitude aircraft, and controlling interceptors and SAM systems. AWACS was to rely on OTH-B radar for launch on warning of bomber attack. According to the article the AWACS radar was considered the most important element of the system as it provides the capability to detect and track objects in ground clutter.

This article provides a good general overview of the AWACS, although it errs in suggesting that there was to be an on-board control post with a large screen.[132] This requirement was apparently dropped earlier in the design stage, although AWACS retained a significant control capability.[133] Plans for combined use of AWACS with the F-15 are also noted, and it is observed that the combination of systems allows aerial targets to be destroyed at long range from the targets being protected. Details on the F-15 are also given, which are accurate apart from the range (4800 km) which appears to be a ferry range.[134] The use of OTH-B is also discussed briefly. In operation, OTH-B is used to alert the AWACS and vector it to the general area of the target, with interceptors being launched either simultaneously or subsequently. Aerial refueling will be used to increase the time spent on patrol.[135]

In summing up, the author notes that the problem of combat with low-flying targets has not been completely solved, although the Pentagon is spending a great deal of money on AWACS and expects to have them in production by 1975.[136]

The 1973 Vestnik PVO article appears to have been the first detailed examination of AWACS after the production decision. It is an accurate

and informed analysis, although the development of the AWACS and OTH-B programs has in time rendered it partly incorrect. For example, use of OTH-B has proven impossible in Northern regions and there the DEW line is used for early warning. It should also be noted that the article focuses completely on the use of AWACS in a strategic air defense role, there is no discussion of tactical uses. This is probably due to the fact that AWACS was primarily planned at this time to be used for continental air defense, and it was not until the late 70's that the tactical role became predominant. It should also be observed that given the VPVO's orientation it would be natural to stress the strategic air defense role over the tactical role. One other area that the article does not comment on is the interaction between ground-based systems such as SAGE and the AWACS. Finally, there is no evidence in this article that the discussion refers to Soviet AEW systems.

In a 1973 Military Thought article, Marshal Batitskiy, the Commander of the VPVO, underlined the importance of the development of AWACS and OTH-B:

> At the present time the following are considered the most effective air target detection systems: for the United States -- a combination of a network of below-horizon radars and the airborne AWACS long-range radar detection and guidance system; for the Western European NATO nations -- a dense radar network providing solid all-altitude radar coverage, as well as employment of autonomous antiaircraft missile troops and AAA detection gear.[137]

Batitskiy also notes that air defense systems depend on the geographical position and scientific level of a country. The implication here is that the system that is appropriate (and achievable) for the U.S. may not be for the Western European nations. Although Batitskiy does not address it, this statement raises the question of what type of system

would be most appropriate for the Soviet Union. The answer is unclear, although given the mixed threat that the USSR faces (one over land from Western Europe and one over water from the North), the optimal system might be dense radar coverage in the European theater combined with AEW and radar for the northern approaches.

Batitskiy goes on to briefly mention some of the characteristics of the AWACS and OTH-B systems, as well as the need to develop look-down shoot-down radars for interceptors. Completion of these projects would provide detection of aircraft at any altitude out to 4000 km giving a warning time of 2-3 hours.[138]

The attention Batitskiy pays to the development of AWACS and OTH-B suggests that the VPVO took these new systems quite seriously and believed that they had significant potential. Although Batitskiy earlier noted the increased importance of low altitude target detection due to the adversary's switching to cruise missiles and low-altitude penetration, it does not appear that he is presenting a discussion of Soviet systems while using the U.S. systems as a screen. It is likely, however, that the U.S. approach to these problems is being presented as one avenue that the PVO could follow, with the second avenue perhaps being represented by the NATO approach.

Last in the series of references to AWACS in 1973 is a book published by a Soviet expert on SAMs and air defense discussing AWACS in the context of overall air defense systems.[139] AWACS is characterized as an early warning system with the capability of directing interceptors. A range of 640 km is given for the AWACS radar, presumably against high-altitude targets.[140]

In most of these articles and references AWACS is presented primarily as a new method for detecting targets. The command and control

capabilities of AWACS do not get as much attention, apart from noting that AWACS has the capability to direct interceptors. Use of AWACS as survivable command posts for directing the anti-air battle in the event of nuclear war receives relatively little attention during this period. It may well be that the extent of the AWACS's C^3 capabilities were not yet appreciated by the Soviets, or that these battle coordination capabilities are more important in the context of tactical air warfare.

During the mid-70's there seems to have been a decline in interest in AWACS. There were some short notes on, or passing references to AWACS, but no long articles primarily concerned with the system.[141] These notes mentioned stages in the development of AWACS, but offered little in the way of assessment.

In the late 70's to early 80's attention to AWACS seems to have increased, although with a somewhat different emphasis. These discussions of AWACS stress the interaction of AWACS with air defense control systems, and feature AWACS in a tactical role more than a strategic role. This shift was probably due to the deployment of AWACS in the U.S. and the decision to purchase AWACS for NATO use. For example, in 1975 the article "Sovremennaya avtomatizirovannaya sistema upravleniya PVO" in Vestnik PVO discussed SAGE and other NORAD systems in some detail, but gave comparatively little attention to AWACS. AWACS was portrayed primarily as part of a radar system together with OTH-B, with SAGE remaining the basic control system.[142]

A similar article in 1976, in Tekhnika i vooruzheniye on ASUs for air defense discussed AWACS along with the new developments in U.S. continental air defense.[143] AWACS is again presented as acting in concert with the OTH-B system. Here, though it is also noted that AWACS can be used to replace destroyed ground stations. AWACS receives

relatively little emphasis, with most of the discussion given over to changes in NORAD regional operating centers and the development of the NADGE system for NATO.[144]

The characterization of AWACS as primarily a radar system is continued in a 1979 article in Vestnik PVO by the same author.[145] In the article the reorganization of NORAD and the replacement of the SAGE system with ROCCs is discussed, as is the use of AWACS. The policy of launching AWACS on warning is reiterated, and it is noted that they are capable of replacing ROCCs that are knocked out of action. In keeping with this, it is noted that experiments are being conducted to network AWACS to Nike-Hercules radars, allowing the former to replace the ground-based search radar.[146]

In the early 80's one finds several articles with discussions of AWACS.[147] These articles continue, for the most part to refer to AWACS as a radar system (DRLO- Daln'ego Radiolokatsionnogo Obnaruzhenniya [Long Range Radar]), stressing its low-altitude target detection capability. To some extent these articles appear to have been triggered by the decision to develop and deploy the improved E-3B for NATO.[148] By this time the tactical role of AWACS was fully recognized, both in the West and in the Soviet Union.

One example of the recognition of the tactical role of AWACS comes in a 1979 Aviatsiya i kosmonovtika article on USAF tactical aviation.[149] The article describes the plans of United States Air Forces in Europe (USAFE) for conducting the air battle, and notes that the E-3A is to be used for controlling tactical aviation.[150] An accompanying illustration shows AWACS with the caption "flying command post (VKP)." This change from a DRLO to a flying command post is indicative of the change in emphasis from AWACS as a flying radar station to a full-functioned radar

and intercept-controller that can even guide friendly forces over enemy territory.

This new emphasis on AWACS may be more prominent in Aviatsiya i kosmonovtika, although it also appears in Vestnik PVO. AWACS and related AEW aircraft are still usually referred to as DRLO aircraft, even though more attention is given to their tactical and C^3 capabilities. For example, in a 1981 article in Tekhnika i vooruzheniye, the development of DRLO aircraft is described as "one of the most important directions for heightening the effectiveness of the automated system of control of tactical aviation of the NATO countries."[151] DRLO aircraft are now charged with not only the usual tasks of radar surveillance and patching holes in radar coverage, replacing ground-based PVO ASUs if they are knocked out, but also controlling air superiority and ground-attack missions.[152] Most of the article goes into detail on the electronics and capabilities of the E-3, rather than its missions, but the change in emphasis is clear. Some inadequacies of the E-3A are pointed out, such as lack of maritime surveillance capability, insufficient tracking capability, low jam resistance, and insecure communications.[153] Most of these criticisms were common in the West , however, as the author notes, they were being addressed by the development of the NATO E-3B.[154]

The articles during this period note that the E-3A had some deficiencies which limited its use in the European theater. After noting this, though, the articles go on to describe the upgrades that resulted in the NATO E-3B. There is little criticism of this later model, implying that they consider it capable of carrying out its assigned missions. For example a discussion of the deployment of the E-3B notes the deficiencies of the E-3A then points out that an upgrade plan has been completed.[155]

In the most recent article to appear in Vestnik PVO on the subject of AWACS, the phrase DRLO has been changed to "samolety sistemy DRLO i upravleniya aviatsiyey" (aircraft system for long-range radar detection and control of aviation) suggesting that the change in emphasis has required a change in nomenclature, just as the acronym AWACS implies more than AEW.[156] In this phrase the significant C^3 and tactical control capabilities are recognized. Again the differences between the E-3A and the E-3C are pointed out in detail, and the technical characteristics of the E-3C are presented. There is no detailed discussion of the operation of the E-3, and the article does not stress either the tactical or strategic role of the E-3, although it does claim that there are 30 E-3Bs available for continental air defense.[157] (This number is both correct and incorrect. There are about 30 E-3Bs in USAF service, but not all of these aircraft are designated for continental air defense duty, for which about 7 alert aircraft are needed.[158])

4.4 Summary

Soviet coverage of the development of AEW and AWACS for continental defense was quite accurate and straightforward. There is little evidence that discussions of AWACS were used as surrogates for discussions of the Moss. However, the coverage of AWACS, particularly in later years, shows a significant level of Soviet interest. As we have seen, AWACS was originally regarded primarily as a means of extending radar coverage and detecting low-flying targets. As AWACS capabilities developed and the system was deployed in Europe, Soviet discussions began to emphasize the tactical employment of the aircraft over its strategic employment. The combination of long-range radar capability with direction of strike

groups seems to have been an important development from the Soviet perspective. Indeed, it is likely that the Soviets are more concerned with the tactical employment of AWACS and the advantages it gives NATO than they are with its strategic role.

Before closing this chapter, it should also be noted that in the Soviet AEW literature consistent attention is paid to radars carried by dirigibles. Several of the discussions of AEW aircraft mention balloon-based radars as well.[159] Given the relative lack of interest in such systems in the West during the 60's and 70's this continuing Soviet interest seems unusual. It may well be that in this case we are witnessing a surrogate discussion for Soviet systems, although I have found no Western references to Soviet balloon-borne radars.

In this case the Soviet military press did a good and accurate job of following the development of a Western military system. The level of interest shown in AWACS may be an indicator that the Soviets considered the development of AEW aircraft important, particularly in the context of controlling tactical air operations and combating low-flying targets.

5. INTERCEPTORS

5.1 Introduction

SAMs and interceptors are what the Soviets call the "active means" of air defense, in that they are the executive arm of the air defense. In appraising Soviet assessments the dual purpose nature (tactical and strategic) of these arms presents a problem. This is particularly the case for SAMs, which are now almost entirely assigned to theater missions. There are still, however, a significant number of aircraft assigned to the air defense role, and this section will examine only Soviet assessments of air defense interceptors. In the U.S. interceptors are not developed solely or even primarily for strategic air defense, as they are usually multi-purpose fighters used in an interceptor role. Thus, Soviet assessments of the capabilities of fighters usually focus on their primary roles of air combat and ground attack, rather than their secondary continental air defense role.

As noted in Chapter Two, the primary U.S. interceptor through the 60's and 70's was the F-106 Delta Dart. No Soviet articles were found devoted largely, or even to a significant degree, to the F-106. At various times plans were advanced to replace the F-106 with a newer interceptor. In this section Soviet assessments of the proposed new aircraft are presented.

5.2 The YF-12A and the F-106X

These aircraft may be considered together as they were both proposed in the 60's, although they were never procured. The F-106X was to be an upgraded version of the F-106, while the YF-12A was the interceptor version of the Lockheed A-11 aircraft, a larger version of which became the SR-71.[160] Although the Soviet press did not devote any articles to these two aircraft, they were mentioned in several discussions of U.S. air defense.

The history of these systems can be broken down quite simply into a pre-procurement decision period and a post-decision period. In 1967 F-12A development was discontinued in favor of the F-106X program, and this is an important turning point for evaluating the evolution of Soviet assessments.[161] By 1970 it became apparent that the F-106X program was also a dead end.[162]

Soviet assessments of the YF-12A before 1967 are relatively few. The earliest appears to have been an article by Major General of Aviation A. Kravchenko that appeared in Military Thought in June 1966.[163] In his article Kravchenko reviewed trends in the development of military aircraft, including interceptors. Kravchenko claims that the mix of interceptors to SAMs is changing in favor of SAMs, but that interceptors retain their usefulness in being able to attack targets at great ranges from defended points. Air-to-air missiles provide interceptors with the capability to attack penetrating aircraft in all weather at ranges up to 30 km. According to Kravchenko, these AAMs allow intercept with "head-on" and "head-on-intersecting" courses, implying an all-aspect capability.[164]

Kravchenko regards the development of the A-11 as an example of the increasing capability of interceptors. He states that it has AAMs with a range of 160 km, and a maximum speed of more than 3000 km/hr at an altitude of 30 km.[165] Yet after giving these characteristics, Kravchenko goes on to observe that the development of look-down shoot-down (LDSD) radar is necessary to deal with low-altitude targets. He even claims that "radar sights" not subject to ground clutter had already been installed in U.S. aircraft, allowing LDSD.[166] Indeed, one might observe that given the shift to low-altitude penetration, an aircraft with the characteristics of the YF-12A would be useful only if equipped with a LDSD capability. Kravchenko does not make this point, although it logically follows from his discussion.

No other sources were found that refer to the YF-12A before its cancellation. Surprisingly, though, several post-1967 sources refer to the YF-12A. Zimin, in his 1971 article on the development of air defense, refers to both the F-12A and the F-106X as being completely tested and developed. The F-12A is presented as being designed for long-range interception of bombers equipped with ASMs. Maximum speed at 22,850m is given as 3700 km/hr, with a range of 4600 to 6500 km. The F-12A is equipped with 8 Falcon AAMs with either a conventional or nuclear warhead, and either radar or IR homing. The F-106X, according to Zimin, is being proposed for use as the basis of a second echelon of defense deep in the country.[167]

Zimin's discussion of the F-12A came some 4 years after the cancellation of the project. By that time there was no likelihood of its deployment, and little for the F-106X. He is correct in asserting that the F-12A was developed and tested, and the description of the armament proposed for it is also basically correct.[168] However, the range of the

F-12A would probably have been closer to 4000 km than the higher numbers Zimin cites.[169] This interest in a canceled program suggests that the PVO was quite interested in long-range, high-altitude interceptors. The technical characteristics Zimin gives resemble the F-12A more closely than the MiG-25, but Zimin's implication that the interceptor is in use does raise the possibility that Zimin may be using it as a surrogate for the MiG-25. Although the MiG-25 is a less capable aircraft than the F-12A (it has less range and speed) it does fulfill much the same mission that Zimin proposes for the YF-12A. It is most likely that in this case the interest shown in the YF-12A is more a reflection of Soviet interest in high-performance interceptors than a surrogate discussion of the MiG-25.

Almost the same discussion of the F-106X and F-12A is found in Zimin's book, published five years after the article.[170] Zimin's book gives more detail on the F-12A's radar: a purported range of 800-1300 km for detection, and tracking at 320-480 km. The section ends with a note saying that there is a debate about procuring the F-12A because of its expense.[171] The ranges Zimin gives for the radar are far too high. The most advanced fighter radar now available is that of the F-14, which can only track targets at a range of 160 km.[172] Even the AWACS radar cannot observe targets beyond about 400-600 km.[173] In short, Zimin's figures for radar range seem to be in error, and do not appear to be a reference to a Soviet system as it is unlikely that any such system could be developed.

Zimin's book also gives slightly more information on the F-106X, claiming that it is being proposed for use as a second echelon fighter. These claims suggest that Zimin is either referring to Soviet systems or that his research work was not done very well. The second option appears to be more convincing. While the mention of the F-12A and F-106X could

be veiled references to the MiG-25 and SU-15 or MiG-23, the errors in ranges and other data suggest that they are more likely to be research errors that were carried over from the article to the book. This surmise is supported by the fact that Zimin also lists the Canadian CF-105 as one of the interceptors available for use in continental air defense, even giving its top speed as an example of modern interceptor capabilities. However, the CF-105 was canceled in 1959.[174] This error concerning the CF-105 is also found in Krysenko's book, suggesting that Zimin may have taken this information either from Krysenko or from a common source.[175] In this case poor scholarship is a more plausible explanation for these anomalies than a surrogate discussion.

One other reference to the YF-12A appears in the Soviet press, in a 1973 Tekhnika i vooruzheniye article on military aircraft.[176] This article presents a review of a number of Western military aircraft, and one of the first that it discusses is the YF-12A (erroneously identified as the UF-12A). The common ancestry of the YF-12A and SR-71 in the A-11 is noted, and most of the discussion centers on the unusual design of the YF-12A. There is no discussion of its mission, and only a brief mention of its armament. A range of 6000 km is given, the same as that given for the SR-71. The article does not mention that the aircraft was never deployed.[177] It seems likely that the YF-12A was discussed in this article primarily because of its interesting design, rather than as part of a threat assessment. In this case the numbers seem to have been derived from data on the SR-71, and they do not exactly match those given by Zimin. There is no discussion of radar or fire control systems.

The discussions of the YF-12A and the F-106X do suggest that the Soviets considered the deployment of a high-altitude high-speed interceptor to be a logical step in the development of air defense.

Their continuing interest in the YF-12A may represent a fascination with the design and technology of the aircraft more than a conscious effort to use it as a surrogate for the MiG-25. The Soviets tended to emphasize the speed and ceiling of the aircraft, suggesting a belief that these characteristics are important determinants of the effectiveness of an interceptor.

5.3 The F-15

After the cancellation of the YF-12A and the F-106X, ADC continued to investigate other possibilities for a new interceptor. This project was conducted under the name the Improved Manned Interceptor (IMI) and it examined a variety of other aircraft. Of these, only the F-15 has been deployed in an air defense role. Soviet comments on the other proposed interceptors were minimal or nonexistent, and will not be discussed here.

The F-15 program began as the F-X in the mid-60's, but it was not until January 1970 that a contract for total system development was given to McDonnell-Douglas.[178] After this the Soviet press paid consistent attention to the F-15 program. The F-15, however, was primarily developed for tactical air superiority, and the continental air defense role was added by ADC to a program already under way.

Interest in the F-15 started very early, particularly in Aviatsiya i kosmonovtika, the journal of the Soviet air force. In a short article on the plans of the U.S. Air Force both the F-14 and F-15 were discussed, particularly the F-14 which was in a more advanced state of development.[179] The description of the F-15 notes its armament as Sparrows and a new close-in missile, and points out that the decision between fixed and variable wings had not yet been made. The requirement

for high maneuverability and high thrust to weight ratio is also noted. Thrust to weight ratio is given as 8, which is far too high, and appears to be a typographical error. From the figures given in the article (weight of 19-20 T, 21.4 T thrust) one obtains a thrust to weight ratio of about 1, which is approximately correct. Range is specified as 480 km for the fighter version, and 230 km for the interceptor variant. This range figure is anomalous, since 230 km is too short for a normal continental air defense interceptor. Such a short range is at variance with U.S. requirements for long-range aircraft for air defense interceptors, and also seems to go against the tendency for Soviet interceptors to increase in range. This most probably represents an error, or perhaps the use of a range figure for a non-representative mission. Other data on the aircraft are presented, and appear to be generally accurate. In 1970, after the development contract had been given to McDonnell-Douglas, another short article appeared in Aviatsiya i kosmonovtika that examined the F-14, F-15, and MRCA "Pantera".[180] Again, the F-15 is described as designed for air combat, with a fixed wing chosen to allow high wing loading. The discussion of the radar system (one paragraph) was lifted verbatim from the earlier Aviatsiya i kosmonovtika article on the F-15. Range figures are the same as those given in the previous article, although a new range for a high-low-high mission profile of 1230 km is given.[181] This range is much greater than that for the air defense variant, suggesting that the low range for air defense is a matter of choice, not of capability.

Subsequent articles appearing in Aviatsiya i kosmonovtika discuss the F-15 in the context of the new tactics and strategy of USAF and its emphasis on specialized air superiority aircraft rather than multi-role

aircraft.[182] Little in the way of new or more data on its technical characteristics is presented.

The first article on the F-15 in the Vestnik PVO appeared in June 1971, paired with the article on AWACS discussed in the previous chapter.[183] The Vestnik PVO article discusses the F-15 in more detail than the Aviatsiya i kosmonovtika articles. According to the article the F-15 was developed for the air superiority role, and to interact with the AWACS system. It was designed for air combat at high speeds and close to the ground. Variable geometry wings were not chosen, as they would add 1000 to 1200 kg to the weight of the aircraft. F-15 performance was based on the experience of the USAF in Southeast Asia, where combat usually took place between Mach 0.6 to 0.7, and heights of 1500 to 10,000 m. Again, ranges for the F-15 are described as 480 km for the fighter and 230 km for the interceptor version. The continued publication of these ranges suggests that the same data was used by the various publications and that little interpretation of the data was done. Other performance characteristics are also given, and they appear to be generally correct.[184]

The rest of the article describes the engines, control systems, and proposed armament of the F-15. The only unusual description is that of a joint IR, laser target designation system that does not appear on the F-15 but may have been a forerunner of the Low Altitude Navigation and Targeting Infrared for Night (LANTIRN) system. The on-board radar is described as being capable of search for, and tracking of, low-flying targets. [185]

Zimin also mentions the F-15, along with the F-14, and notes that they may be used as interceptors but does not give any details on the aircraft.[186] Compared with his description of the F-12A, this neglect may

represent either a lack of information or a greater interest in the F-12A. More information is presented in Zimin's book, but there is not much emphasis on the F-15.[187]

After the initial development of the F-15, most articles in the Soviet military press stressed the tactical role of the aircraft. There was some recognition of the new trend in the U.S. away from multi-role aircraft and towards more specialized aircraft, particularly those suited to air combat.[188] Coverage of the possible continental air defense role of these aircraft was usually quite minimal. The only article found that discussed interceptors for continental air defense was published in Zarubezhniye voyennoye obozreniye in 1979, rather than in the Vestnik PVO.[189] After surveying both the existing interceptors, their armament, and training procedures, the article notes that the F-106 and CF-101B are old, and that ADC is planning on replacing them with an interceptor version of the F-15. The F-15 interceptor was supposed to have greater range and different electronics than the air superiority model, and an estimated order of 170 aircraft is indicated.[190]

In sum, the Soviet press covered the development of the F-15 quite closely, but it paid little attention to the continental air defense role of the aircraft, probably because the type was not deployed in this role until the early 1980's. The concentration of the Soviet press on the F-15's unique air combat capabilities and the lessons learned from Vietnam and the Middle East appears to have been an accurate assessment of the F-15's role and tactics.

5.4 Summary

The lack of interest in interceptors for continental air defense shown by the Soviet military press is understandable when one considers the few U.S. programs in this area. Most discussions of fighters stressed their tactical use in the European theater. Even in the Vestnik PVO, most articles on Western fighters appear to be oriented towards Soviet fighter pilots who would be fighting them, rather than appraising them for a continental air defense role. There is also little evidence that U.S. interceptors were used in surrogate discussions of Soviet interceptors. Zimin's rather puzzling interest in the YF-12A may be considered at most a reflection of Soviet interest in high performance aircraft for air defense, rather than a surrogate discussion of the MiG-25. On the whole, though, the Soviet military press did pick up and describe important programs such as the F-15, and kept its readers informed of the progress of the program and its most important characteristics.

6. MILITARY THOUGHT ON THE VPVO

6.1 Introduction

Several articles on air defense topics appeared in the restricted Soviet journal Military Thought during the late 60's and early 70's. These articles explicitly discuss the VPVO as well as U.S. forces, providing insights into problems the VPVO was confronting and the development of VPVO forces and operational art. This allows us to determine whether Soviet assessments of Western air defense systems and strategy conform to their assessments of their own systems and strategy. If there is some similarity it strengthens the argument that Soviet discussions of Western systems provide insight into their assessments of their own forces.

The articles examined here discuss both the history of the VPVO and current topics in air defense, giving important insights into the concerns and thoughts of the top leadership of the VPVO during this period. In several areas they advance arguments that complement or extend those presented by Zimin and Krysenko.

Of particular interest are the articles signed by P. F. Batitskiy, the Commander in Chief of the VPVO. In this chapter I shall examine Batitskiy's articles in some detail, as well as articles on VPVO operations written by lower ranking officers.

In some articles the discussions of contemporary VPVO issues are couched in historical terms, whereas other articles explicitly discuss modern problems and issues. Although there are several articles on the

VPVO in the periods of 67-68 and 72-73 there does not appear to be a "debate", and the apparent clustering may be due to the fact that the coverage of Military Thought is incomplete. Nevertheless, it should be noted that the first set of articles appeared just after Batitskiy became Commander in Chief of the VPVO, and it is possible that a reexamination of VPVO strategy and operational art was undertaken at the time.

6.2 1967-1968

The first article by Batitskiy appears in October 1967, and is concerned with the development of VPVO tactics and operational art.[191] Most of the article discusses World War II and the use of anti-aircraft artillery (AAA), but towards the end Batitskiy turns to post-war developments. Batitskiy observes that the development of ICBMs and nuclear equipped aircraft, combined with the development of new VPVO weapons, brought about the establishment of the VPVO and an increase in support for its mission.[192] In addition to the deployment of jet interceptors and SAMs, he points out the development of control systems:

> The capabilities were also greatly increased for the centralized control of the troops and for the execution of operational maneuvering not only involving a single PVO formation but also between formations.[193]

This reference suggests that significant changes took place in the late 50's and throughout the 60's that increased centralization and the capability of the central leadership to move VPVO forces about the country. Further evidence of the introduction of ASUs into the VPVO is provided later, where Batitskiy points out that the introduction of ASUs raised new questions about the control of troops. These questions are not expounded upon, and Batitskiy merely notes that they were resolved.

We may speculate that the introduction of ASUs presented such problems as a need for more highly trained personnel, more costly weapons, and it may also have sparked some discussion over whether automation be used in a centralized or decentralized system.[194]

Batitskiy goes on to note the importance of a unified air and space defense plan, and suggests that such a plan exists.[195] Central coordination of such a plan would require coordinating air and space surveillance, along with centralized control, implying that a Soviet equivalent of the NORAD command post exists. Furthermore, Batitskiy claims that defense against attack would take the form of "air-space defensive operations" using large forces and operational maneuvering.[196] Between the conduct of such operations, Batitskiy suggests that VPVO troops will carry out their daily combat operations, implying that he does not envision one large defensive operation but rather a series of them, which could conceivably be spread out over a period of hours or perhaps even days.[197]

Batitskiy is thus presenting a view of a combined air, ABM, and space defense system that would be centrally coordinated and capable of meeting several waves of attack. These themes recur frequently in the Military Thought articles, and we have already seen some of them in the discussions of Western systems.

In 1968 a book on the history of VPVO was published "under the direction" of Batitskiy.[198] This book may be considered fairly authoritative since it has Batitskiy's name on it, and the chapters were written by high ranking officers.[199] In discussing the development of the modern VPVO this book emphasizes many of the same points as Batitskiy's 1967 Military Thought article.

One section of the book presents the operational and tactical principles of the VPVO, stressing the importance of area defense with the use of massed PVO forces, circular defenses in depth allowing interceptors to maneuver, all weather capability, and camouflage of defended points.[200] Forces are to be echeloned, with the first echelon consisting of Fighter Aviation (of the VPVO) acting in concert with the PVO of the troops and the fleet. The second echelon includes VPVO forces of the border regions, and the third echelon is that covering the region containing the target.[201] This listing is significant, for it sets out the importance of starting the defense at the earliest possible time. The ascription of an air defense role to the Soviet Navy is an important difference from U.S. air defense, where the USN plays no role. The emphasis on defense in depth and destroying targets as far out as possible is a consistent theme in Soviet writings on air defense, and one that we have encountered in discussions of U.S. air defense.

The importance of the maneuverability of VPVO forces is also stressed in the book. Maneuver is claimed to offset the advantages of incoming bombers, by allowing the defense to move forward and destroy bombers before they can launch their missiles.[202] The book reiterates the concern expressed in Batitskiy's earlier article for stability and survivability in the face of nuclear attacks and jamming.[203] Thus, Batitskiy's book again stresses the importance of centralization, maneuver, and survivability, themes that are repeated in much Soviet writing on the VPVO.

The importance of strategic maneuver of air defense forces is again emphasized in a January 1968 article by Col. Ye. Kalugin, on "The Nature of Combat Operations of the Air Defense Troops."[204] Kalugin's article goes into more detail than Batitskiy's and even though it may be less

authoritative, it is still very informative. First, Kalugin notes that PVO now includes PSO and PRO but that although things have changed since WWII the same basic principles apply. According to Kalugin, strategic defenses will have to deal with phased attacks by ICBMs, ASMs, and bombers. Of particular importance for the air defense regime is the problem of combating low flying targets.[205] Again, however, it is the problem of maneuvering forces which gets a great deal of attention:

> In repulsing a mass attack of missile-carrying aircraft, it might be necessary to maneuver the air defense forces and means. The nature of this will depend on the formation of the enemy attack. Thus, during operations of attacking aircraft on a broad scale, maneuver along the front might be the most widespread type of maneuver. It permits interception of the largest number of aircraft which are approaching the defended territories simultaneously. If the attack is made in a narrow zone, the chief type of maneuver, evidently, will be a maneuver from the rear to the front. This permits the sequential commitment of forces at the corresponding lines, in accordance with extent of approach toward them of the echelons of the aerial enemy.[206]

In this context, one may question exactly what sort of maneuver is involved. In Soviet military strategy, maneuver can mean retargeting or redirection of forces rather than physical relocation. It may be that Kalugin is discussing the allocation and concentration of forces in being, rather than bringing in forces from distant areas, but the explicit nature of his argument strongly suggest that actual physical movement of forces would be involved. This movement, even with fairly high speed aircraft, would require a great deal of warning time, accurate attack assessment, and robust control systems for managing the relocation and dealing with the sudden surge in forces in one area. In terms of hardware, this form of maneuver would be more appropriate to interceptors than SAMs, and would favor the creation of long-range high speed aircraft

over the shorter range aircraft then in the VPVO inventory. Even with these capabilities, however, it is difficult to imagine that the system would work well if ICBM precursor strikes were aimed at important VPVO installations. It may well be that the dispersal of VPVO forces on strategic warning would be necessary.

These deductions are largely supported by Kalugin's later points. For example, noting that ABM and space defense systems will also be involved in the defense, he argues for centralized control, with all troops and services commanded from a central command post, like that of NORAD.[207] The functions of this command post include early warning, organization and guidance of troops through regions and sections, and organization and maintenance of coordination of Air Defense troops during the conduct of combat operations. This list of tasks is very similar to that of the NORAD command post, and suggests that the Soviets were seriously considering the organization of their air defense system along these lines, if they had not already done so.

Kalugin also explicitly addresses the problem of the trade-offs inherent between centralized and decentralized control. His comments are a clear and concise encapsulation of Soviet thinking on these trade-offs:

> Centralized control must be completely automated due to the extremely limited amount of time. This form of control, judging by the development of air defense means, will be used more and more broadly. However, the number of problems resolved at the level of the highest organ will be limited by the optimum capabilities of existing and future needs for processing incoming information and by the time needed to make decisions and send them back to the operational units. Therefore, in the system of leadership of the troops, especially in the field of antiaircraft defense, attention should also be devoted to decentralized control, which permits the command element of an operational or tactical unit to make decisions independently within the framework of

> the missions assigned to them and depending on the specific conditions which develop within their regions or objectives. Such control will also be broadly used in case of loss of communication with the center, when it is necessary to supervise independently the intercept and destruction of means of air and space attack, and also in combating low-flying targets.[208]

The approach to the topic is interesting. Central control is clearly preferred, but it is implied that existing data processing and command structures are not capable of allowing completely centralized control, particularly given the short warning times (because of reduced detection ranges) of low-flying targets. The vulnerability of the centralized structure to attack also requires some degree of decentralization. Clearly, though, the preference is for strong centralized control, and one would expect that as the technology for centralized control (e.g. ASUs) develops the arguments for centralization would still hold and would drive the VPVO towards a centralized, possibly SAGE-like system. This discussion expresses concerns similar to those articulated by Zimin in his book, where he noted the vulnerability of centralized systems and proposed a multi-level system of control regimes.[209] It appears that the dialectic between centralized and decentralized control was of great concern to the VPVO leadership, and a compromise system allowing for local control in event of loss of contact with the center may well have been developed.

Kalugin's views are largely supported in an article on the maneuver of VPVO forces published by Col. N. Svetlishin in September 1968.[210] Svetlishin mentions at the beginning that he is discussing "domestic assignment" troops, rather than ground force PVO troops.[211] In the article, Svetlishin notes that the opponent can choose his avenue of attack, and thus that some areas will need to be strengthened, while

those which have been attacked will need to be reconstituted. Thus, "PVO strany troops, during the course of combat against aerial attack should be constantly prepared to regroup and redeploy their personnel and equipment."[212] Note that this is during combat -- the maneuver is to take place not before the nuclear attack begins, but during it.

According to Svetlishin maneuver of PVO forces may be conducted at three levels, the tactical, operational, and strategic.[213] Strategic movement would be controlled by the Supreme Command, and would be executed only when the situation was changing greatly and a major reallocation of troops was required.[214] The other levels of maneuver would involve smaller scale movements, probably within air defense districts. It is noted that in some cases maneuver would be possible without changing the airbase, suggesting the sort of redirection mentioned earlier. This form of maneuver may just involve changing the priority of the defended sites within the air defense district. The physical movement of forces is suggested by Svetlishin as well, however, for he notes that forces may be moved from secondary to primary areas.[215] Svetlishin gives several reasons for conducting such maneuvers of forces, the first two being the concentration of forces on the attacking force and the reconstitution of PVO forces after a nuclear attack.[216] One reason for conducting a strategic maneuver is particularly interesting:

> In particular, such a maneuver will obviously be necessary if the PVO grouping which is protecting an important area is rendered ineffective as a result of a mass enemy attack or if changes take place during the course of a war in the location of military-industrial targets, particularly following nuclear attacks.[217]

The latter reason maybe interpreted two ways. First, it may involve the relocation of industry away from attacked areas (as in World War II).

Second, it may involve abandoning the defense of certain areas which might have been devastated by nuclear attack. In either case it assumes a relatively long period in which PVO protection of military-industrial sites would be necessary.

Finally, Svetlishin discusses the need for more preparation for maneuver during war, citing the need for training in maneuver, the organization of reserves, and the logistical requirements for supplying airfields among other matters.[218]

Svetlishin's article makes it clear that the VPVO did not intend to defend only once against incoming nuclear strikes. The reconstitution of forces is clearly an important capability, and this explains the appearance in several books and articles, particularly Zimin's, of discussion of these areas. This is not a U.S. concept that has been borrowed as there is very little discussion of such matters in the U.S. press, and one could argue that there isn't much of an air defense to reconstitute in any case. In sum, this cluster of articles suggests that the VPVO was introducing the strategy of maneuver into the forces, or re-emphasizing it. Strong centralized control is demanded by such a strategy, and this implies that only at this stage did warning and control systems become sufficiently sophisticated to allow such maneuvers. Finally, the emphasis on reconstitution and intra-war maneuvers suggests that in this area the Soviets were not just copying U.S. strategy, but were clearly and explicitly enunciating their own.

6.3 1972-73

The next cluster of articles on the topic of the VPVO appears in 1972-3. Again, one of the most interesting authors is Col. Svetlishin,

who contributed an article on the experience of the VPVO troops in the beginning period of World War II. Noting that the topic is a large one, he points out that it is not only of scientific importance, but also of practical significance.[219] Svetlishin starts by outlining the air defense system in existence at the beginning of the war, noting that it was capable, but that its basic problem was the absence of nationwide centralized control, as the command of the air defense was in the hands of the military district commanders. During the beginning of the war, both military districts and fronts proved incapable of managing the air defense because the districts were concentrating on mobilizing and the fronts on repelling the enemy on the ground.[220]

Svetlishin then goes on to describe the organizational changes of the VPVO troops during the war, along with the development of PVO tactics. The organization changes which Svetlishin lauds tended to increase centralization of control of air defense forces. This centralization allows the conduct of "air defense operations" and the use of massed air defense forces under central control and coordination.[221] This development of the command structure, and increased specialization of the air defense troops, also contributed to the development of the VPVO as a separate service.

Svetlishin seems to be subtly arguing for much the same points as in his earlier article. He emphasizes the need for centralized control and the capability to concentrate and maneuver forces to allow massed attacks against incoming targets.

In a two-part set of articles, Marshal Batitskiy surveyed the development of air defenses from their inception through to 1973. The first article covers the period from World War I to the end of World War II, and includes fairly detailed discussions of Soviet air defense

operations and organization.[222] The second article starts with the post-war period and follows air defense developments through to 1973, referring primarily to Western air defense systems.[223] Both of these articles are of relevance here, particularly the second one.

In his review of the performance of the VPVO in World War II, Batitskiy makes many of the same points that Svetlishin made earlier. Batitskiy again criticizes the lack of centralized control at the beginning of the war, although not as strongly as Svetlishin, and notes the increase in defense effectiveness when a centralized control was created.[224] He also notes the use of massed air defense forces, and points out that PVO operations during the war shifted from site defense to area defense of regions containing important targets.[225] These elements of Soviet air defense are presented in a manner that suggests that they are still relevant.

Even more revealing is Batitskiy's second article on the VPVO troops. Although much of this article discusses Western systems, several parts of it explicitly discuss Soviet air defense. Batitskiy starts out by noting that the development of nuclear weapons has made air defense even more important than before, and has given it the possibility (according to foreign military leaders) of altering the balance in favor of countries with strong defenses.[226] (This is a clear case of using "foreign military leaders" to state what the Soviets believe to be true.) Batitskiy then examines the performance of air defense systems in Vietnam and Egypt, concluding that the systems were successful, and noting that these conflicts provide good data for evaluating the performance of air defense systems.[227] From this discussion, Batitskiy turns to note the high demands placed on air defense systems by nuclear weapons, and the need for an almost leakproof system. The requirements of an air defense

system are presented as usual: continuous high combat readiness, swiftness of action, and stability and survivability of the system. Batitskiy notes that the last demand has increased in importance.[228] Returning to his historical discussion, Batitskiy notes that the development of Soviet air defenses in the post-war period forced the enemy to develop low and extremely low altitude penetration, as well as air-to-surface missiles. Vietnam and the Middle East experience forced the enemy to pay even more attention to low altitude penetration.[229] With this shift in tactics to low altitude penetration, the air defense also developed new methods for detection at low altitude and long-range, particularly before cruise missiles could be launched. Here again we see concerns about low altitude penetration, and interest in destroying bombers before they can launch their ASMs, concerns that were also manifest in Zimin's discussions of U.S. air defense.

Although the main threat is low altitude penetration, Batitskiy point out that the detection of aircraft at long ranges and all altitudes is also necessary. NATO's use of a dense radar network in Western Europe is noted, as is the development of AWACS aircraft acting in coordination with OTH-B. To supplement the radar coverage, fighter-interceptors capable of look-down shoot-down are being developed. A 2-3 hour (4000 km) warning time for the combined OTH-B, AWACS system is claimed.[230,231] Batitskiy also stresses that AD systems must be all-altitude, jam-resistant, and capable of attacking missile-firing aircraft before they can fire, and of destroying ASMs in flight. It is noted that NATO prefers a deeply echeloned defense.[232] Batitskiy observes that NATO believes it needs a unified air defense system, such as the NATO Air Defense Ground Environment (NADGE) system which he discusses briefly.

NORAD is also mentioned as an example of the need to design unified air defense forces on a multinational scale.[233]

Batitskiy notes that there has been in recent years a tendency to "organize coordination even between combined air defense systems."[234] His example of such coordination is the use of the NADGE system as "a forward air defense detection and warning line for the North American continent."[235] This assertion is rather puzzling, for there does not seem to be any useful way that NADGE could contribute to the NORAD task, simply because the threat to North America is more from the North than the East coast. Although much of the discussion on the topic of NADGE appears to be accurate, this comment suggests that perhaps there is some implicit reference to the need to unify Warsaw Pact forward air defenses with VPVO air defenses. This reference is perhaps not surprising, given that Batitskiy was also the Commander in Chief of the Warsaw Pact Air Defense Forces, implying that the strong centralized control would encompass both Soviet and Warsaw Pact air defense forces.[236] Indeed, it appears that the Warsaw Pact radar system is netted into the VPVO warning and control system.[237] After the discussion of NADGE and unified air defense requirements, Batitskiy turns to the topic of Soviet air defense. After discussing the combat capabilities of the various troops of the VPVO, he notes that they are all receiving new equipment, and that "A typical development is the adoption and extensive utilization at all echelons of automated control systems and high-speed communications devices, which makes it possible to utilize antiaircraft defense hardware quickly and effectively."[238] Batitskiy then observes that the revolution

in military affairs applies not only to military equipment, but also to the structure and conduct of air defense. He notes that

> Formerly the basic principle was concentration of air defense forces on the immediate defense of important installations, while under present-day conditions the principle of concentration of efforts to destroy air attackers at a maximum distance from a country's defended installations and areas has assumed primary importance. [239](Emphasis in original)

This statement further confirms that the Soviets stress area defense, particularly a deeply echeloned defense intended to destroy bombers before they can launch ASMs. This is in keeping with the development of the Tu-126 Moss aircraft, if it was intended for patrolling the coastal areas of the border in cooperation with the Tu-28 long-range fighter. Both the Tu-126 and Tu-28 aircraft appear to have been developed by the late 60's, raising the possibility that they were at least partly designed to work together. The Tu-28 is apparently deployed in the north of the USSR in an attempt to intercept bombers as far north as possible.[240] If the Tu-126 Moss were used in conjunction with naval forces, or the Tu-28, it would allow an extension of air defense coverage a significant distance out from the Soviet coastline. The comments on the introduction of ASUs and communication devices suggest that the VPVO was at this time modernizing its control system.

The next section of Batitskiy's article surveys the potential of ABM defenses (limited by SALT), and the continued importance of the airborne threat in view of the development of the B-1 and cruise missile.[241] In closing, Batitskiy notes the importance of developing automation:

> Automation is the principal trend in improving control at all echelons, since only with automation is it possible to satisfy increased demands for flexibility of control

> entities, particularly in the collection and processing of data on the enemy and friendly troops. Automation alone can ensure practically instantaneous reaction to a situation change, decision-making in seconds, assignment of missions to the troops and verification of mission execution. Increasingly complex problems pertaining to the continuous maintenance of operational and tactical coordination among various forces (antiaircraft missile troops, fighter aviation and other services) are also being solved on the basis of control automation.[242]

This is a clear statement of the importance of automation to the VPVO, and underscores Batitskiy's other statements on this matter. The evidence seems clear that the VPVO recognized the need for increased automation, and was probably engaged in a widespread program of modernization, automation, and increased centralization.

6.4 Summary

The articles appearing in Military Thought offer many consistent themes, and reveal a conception of air defense quite different from that of the U.S. The differences in stress include an increased concern with stability and survivability of the air defense system, centralized control of all VPVO troops, maneuver to meet operational and tactical developments, reconstitution of VPVO forces, and planning to maintain defenses for a prolonged period even after the initial nuclear attack.

Soviet views of air defense do appear in some Soviet assessments of U.S. continental air defense. Zimin's writings, in particular, show a preoccupation with these themes that is superimposed on his discussion of U.S. systems. Yet many of the other discussions of U.S. systems do not reveal these concerns, and confine themselves to more factual discussions of the characteristics of the weapon systems. This suggests that the less technical an article the more likely it is to be a screen for other

concerns. Furthermore, it should be noted that Zimin is a fairly high-ranking officer of the VPVO, and may have more latitude in his writings, particularly if they are cleared at a high level. These issues will be discussed more in the concluding chapter.

7. SUMMARY AND CONCLUSIONS

We may now return to the questions posed in the Introduction, and synthesize the results of these studies of Soviet assessments. These questions were 1) how the Soviets assess U.S. weapons and strategy, and what reactions these assessments may prompt, 2) whether Western weapons and strategies are used as surrogates for their Soviet equivalents in discussions in the Soviet military press, and 3) whether by understanding how the Soviets assess Western weapons, we may understand how they design and assess their own weapons. Let us now turn to the first of these questions.

A fairly clear picture of how the Soviets assess U.S. systems emerges from the data. Soviet assessments of U.S. weapons tend to stress their technical characteristics: for ASUs there is a great deal of discussion of the number of consoles, for AWACS figures for radome size and engine type are given, and for fighters ceilings and maximum speeds are noted. Discussion of the operational use of these weapons is not usually integrated into the technical articles, and when it does appear it is usually in a non-technical article. It is rare to find an estimate of the effectiveness of an air defense system, and rarer still to find one that is credible.[243] No instance of a Soviet discussion of how to overcome U.S. continental air defenses was found.

Although the issue of operational effectiveness was rarely addressed in the Soviet press, in some cases Soviet assessments did note the

inadequacies of a U.S. system (particularly SAGE). When problems were noted with a U.S. system, however, they were problems that had already been noted in the U.S., rather than a new assessment made by the Soviets. Thus, in the case of AWACS Western criticisms of the E-3A system were repeated in the Soviet press. Furthermore, when problems were noted, it was usually noted that they were being resolved, and the Soviet assessments seemed optimistic that the problems were being overcome.[244] A picture of U.S. systems emerges that for the most part portrays them as capable, if not perfect, and being upgraded and perfected.

Although U.S. air defenses were in a state of decline during most of the 60's and 70's, this fact was never remarked upon by Soviet authors. There were no articles describing the decline of U.S. forces, and their absence is significant. Only articles that portrayed either a constant or growing air defense capability were published. This accentuation of the growth aspect of U.S. air defense implies that a Soviet officer getting most of his information from the press would form an impression of a fairly sophisticated U.S. air defense system. There is no attempt to provide a balanced description of U.S. capabilities: the emphasis is clearly on the strengths of the U.S. forces, not their weaknesses. Conversely, the few articles on the performance of Soviet air defense systems (such as those used in Egypt) stress their high performance. The message to the reader is clear and, given the context, sensible: air defenses play an important role, and must constantly be strengthened. Reporting U.S. views on the declining importance of air defense would clearly be inimical to the VPVO's institutional interests, and might lower morale amongst middle-level officers.

We also asked whether the Soviets react to U.S. actions, and what form these reactions take. However, in this case the actions that the

Soviets might take as a consequence of U.S. programs are difficult to isolate. Causality is difficult to determine in such a case, particularly since the Soviets are all too willing to claim that they are only reacting to U.S. initiatives. As I shall discuss below, however, there does seem to be some evidence that the Soviets may have emulated U.S. systems.

The second question posed is whether assessments of U.S. systems are used as surrogates for Soviet systems. The answer to this must be a qualified no. In the cases studied there is little clear evidence for the use of U.S. systems as stalking horses for Soviet systems. There is some evidence that a few early comments about AWACS were references to the Tu-126 Moss, but the case is not convincing. The case of the YF-12A may best be explained by a particular Soviet interest in high-performance aircraft, rather than a specific attempt to discuss the MiG-25. It does appear that Soviet biases come through in their assessments, but this does not mean that they are really discussing their own systems.

Apart from answering these questions, this report sheds some light on some other aspects of the Soviet assessment process. One interesting fact is that certain authors seem to have particular specialties. Thus, Mal'gin appears to be a specialist on fire control systems, Omel'chenko on ASUs, Peresada on SAMs, and Zabelok on ASUs. Most of these authors are Colonels, and most of them have a Kandidat degree in either technical or military science. It is likely that these officers work in the military academies, and that they publish their work in the journals as a sideline. Since many of the more prominent authors publish books as well as articles, it appears unlikely that they are journal staffers. Thus, these articles may provide some insight into the views of the faculty at some of the leading academies.

There is also evidence that the military journals limit their coverage to their own service. Between Vestnik PVO and Aviatsiya i kosmonovtika there was a marked difference in coverage of U.S. air defense systems, with the latter publishing very little on this topic. This implies that threat assessment articles for Soviet strategic bomber crews are not published in Aviatsiya i kosmonovtika, suggesting that other means are used for the general education of bomber crew members. The Vestnik PVO did, however, provide good coverage not only of U.S. air defenses but also of the technical developments in Western air forces and their tactics.

Turning now to the third question posed in the Introduction, do we understand how the Soviets assess weapons systems and have we gained insight into how they assess their own systems? The foregoing chapters do reveal a particularly Soviet approach to the assessment of U.S. weapon systems. Soviet biases and concerns do show through their assessments of U.S. weapons and strategy. We have seen that many Soviet writings stress the importance of stability and survivability of the control system, the use of ASUs in a centrally controlled system, and reconstitution of forces. These concerns are in several cases projected onto their assessments of U.S. systems. Explicit discussions of these questions with respect to the VPVO confirm these observations, and give us even more insight into their own assessment process. The contributions of Mal'gin also give us a good idea of how the Soviets do some simple assessments of their own systems.[245] We can conclude that in assessing (and presumably in designing) their PVO systems the Soviets stress survivability, quick reaction time, and centralized control.

From the Soviet assessments of U.S. air defense we can go even further, and speculate on what a Soviet PVO control system might look

like. First, we should expect unified control of air, space, and ABM capabilities in a hardened command post. Backup posts might be provided to enhance survivability. Automation would be stressed, networking the numerous VPVO sites to the central command post. Second, interceptor units might be moved to dispersal air bases in order to decrease their vulnerability and to allow concentration of forces in a given area. It is also possible that mobile SAM units would also be dispersed and camouflaged, in order to reduce vulnerability to ICBM precursor strikes. Third, we would expect a deeply echeloned defense, with the first line of defense consisting of Moss aircraft with long-range interceptors (probably Tu-28s) patrolling off coastal regions and relaying data back to the ground. (The Moss probably would serve much the same role as the EC-121H did in the SAGE system.) Inner echelons would consist of shorter range interceptors acting under ground control, along with SAMs for point and barrier defense. Fourth, in the case of disruption of the centralized control system provision would be made for decentralized control, perhaps as far down as the unit level.

What evidence is there to support such speculations? Unfortunately there is very little unclassified information concerning the control structures, automation level, and deployment of VPVO forces. However, the capability to deploy a large-scale automated network similar to SAGE was probably developed in the mid to late 60's. Given the relatively high level of interest in SAGE, it is quite plausible, and even likely that a similar Soviet system was developed.

The deployment of the Tu-126 Moss aircraft in the late 1960's or early 1970's suggests emulation of the U.S. AEW program. The interest in the EC-121 shown in Krysenko's book suggests that the utility of AEW was recognized, and may have prompted the development of the Moss. The

limited capability of the Moss does suggest that it is analogous to the EC-121H, and it is likely that it serves a similar role. Its deployment may be an indication that a SAGE-like ASU was developed at about the same time.

In this case we see the Soviet reaction as an emulation of U.S. air defense systems, rather than the development of systems to counter them. This is, of course, largely a result of the scope of the study. Undoubtedly there are countermeasures to U.S. continental air defenses, but these have not been published in the open Soviet literature.

In sum, we have partly confirmed the hypotheses postulated in this series of reports. The lack of evidence for discussions using U.S. weapons as surrogates for Soviet weapons does not mean that such surrogate discussions do not occur in the Soviet press. It merely indicates that in this case, particularly given our lack of information on Soviet air defense systems, there is insufficient evidence to disprove the hypothesis. However, this report does confirm that some Soviet assessments of Western programs and strategies reflect Soviet interests and biases. This confirmation supports the conclusions of other studies of this series, and indicates that close study of Soviet assessments of U.S. weapons and strategy can reveal much about Soviet views of their own equipment and strategy.

-- Notes --

1. The air defense forces were formerly known as the PVO Strany. In this report, I shall refer to the service as VPVO. Soviet terminology for air defense is not always consistent. Thus, protivovozdushnoy oborony is often used as an umbrella term to include anti-aircraft (protivosamolety oborony PSO) defense, anti-missile (protivoraketny oborony PRO), and anti-space (protivokosmichesky oborony PKO). This range of activities might in the West be referred to as aerospace defense. Sometimes, however, PVO is used to refer to air defense, not including PRO and PKO. For our purposes I will use PVO in the more restrictive sense of air defense, that is the topic of interest in this report. The abbreviation PVO will therefore be used to designate air defense, and when there is an ambiguity in the original Russian it will be pointed out.

2. Scott (1981; 155-57)

3. VPVO is in the original Russian. TV is available only in English up to 1979, and in both Russian and English thereafter.

4. Dzirkals (1982; 35-36)

5. Surface-to-air missile systems have not been included in this study because there was little interest in these systems for continental defense purposes. Most U.S. SAMs were developed for theater use, and were assessed as such by Soviet analysts.

6. For details on the Soviet assessments of radar and other early warning systems, see Partan (1986)

7. McLin (1967; 46-7)

8. Dept. of Defense, (1964; 16,252)

9. U.S. Congress (1971; 3530)

10. See Astrahan (1983), Jacobs (1983)

11. U.S. Congress, (1964; 7012-3)

12. Dept. of Defense, (1963; 11-12)

13. Dept. of Defense (1964; 16), U. S. Congress (1964; 7012)

14. Knaack (1978; 159-162, 207-9)

15. Knaack (1978; 220)

16. Knaack (1978; 331)

17. Knaack (1978; 333-4)

18. McLin (1967; 61-84, 100-105)

19. International Defense Review (1971; 317)

20. McLin (1967; 85), Gunston (1979; 174)

21. Dept. of Defense (1963; 12)

22. Mclin (1967; 84-100)

23. International Defense Review, (1971; 321)

24. Pretty (1976; 64)

25. Knaack (1978; 216)

26. International Defense Review, (1971; 317)

27. International Defense Review, (1971; 320)

28. Pretty (1976; 249), Carson (1984; 81-2), Ulsamer (1978; 32), Aviation Week and Space Technology, (1985; 63)

29. International Defense Review, (1971; 319)

30. Air Force Magazine (1981; 144), International Defense Review, (1971; 318)

31. International Defense Review, (1971; 317)

32. Knaack (1978; 215-6)

33. Carson (1984; 81)

34. Carson (1984; 81), O'Lone (1981c; 40-41)

35. Gunston (1979; 174)

36. Pretty, (1976; 65)

37. Gunston (1979; 178-9), Pretty, (1981; 84-5)

38. Air Force Magazine (1981; 131-2, 106-7)

39. Air Force Magazine (1981; 106)

40. Air Force Magazine, (1981; 131,100)

41. Air Force Magazine (1985; 109)

42. Pretty (1981; 233-4), Aviation Week and Space Technology (1985; 56-63)

43. Aviation Week and Space Technology (1985; 56-63)

44. (Pretty, 1981 p. 234, 597.)

45. Pretty (1981; 233-4)

46. Carson (1984; 82-3)

47. Aviation Week and Space Technology (1980; 38-40)

48. Carson (1984; 81)

49. International Institute for Security Studies (1984; 36)

50. Meller, (1980; 499)

51. Krysenko (1966; 5)

52. Krysenko (1966; 12-13)

53. Krysenko (1966; 32)

54. Zabelok (1967)

55. Zabelok (1967; 168)

56. Zabelok (1967; 169). Pretty (1976; 250)

57. Zabelok (1967; 171)

58. Voyennyy Entsiklopedicheskiy Slovar' (1983; 277)

59. Zimin (1971; 78)

60. Zimin (1971; 78)

61. Zimin, (1971; 79)

62. Knaack (1978; 333)

63. Knaack (1978; 216)

64. Knaack (1978; 333)

65. Gunston (1980; 268), Panyalev (1977)

66. Gunston (1980; 330)

67. Zimin (1971; 82)

68. Zimin (1971; 82). The translation of this passage was taken from PVO Herald (same date), p. 129)

69. Zimin (1971; 82)

70. It is unclear whether Zimin is here using PVO in its general sense (including ABM) or the more restricted sense of air defense.

71. Gunston (1980; 266-8,330)

72. Voyennyy entsiklopedicheskiy slovar' (1983; 69-70)

73. Zimin (1976; 99-100)

74. Zimin (1976; 100-101)

75. Zimin (1976; 102)

76. Zimin (1976; 103)

77. Zimin (1976; 104)

78. Zimin (1976; 106)

79. Zimin (1976; 107)

80. Zimin (1976; 108)

81. Zimin (1976; 108-9)

82. Gunston (1918; 358)

83. Pretty, (1981; 231)

84. Pretty, (1981; 235)

85. Finn and Meyer, (1984)

86. Romanov and Frolov (1973)

87. Romanov (1967), Romanov(1968), Romanov (1969)

88. Romanov and Frolov (1973; 5)

89. Romanov and Frolov (1973; 9)

90. Romanov and Frolov (1973; 9) Notation has been changed for clarity.

91. Romanov and Frolov, (1973; 10-13)

92. Romanov and Frolov (1973; 12)

93. Romanov and Frolov (1973; 17)

94. Romanov and Frolov (1973; 20)

95. Mal'gin (1978)

96. Zimin (1981)

97. See Finn and Meyer (1984)

98. See Kochkov (1971), Alekseyev (1976), Omel'chenko (1979), Valentinov (1981), Ignat'yev (1983)

99. Cave (1977; 407), Campbell (1976; 133)

100. See Hirst (1983), and Jackson (1985)

101. Hirst (1983; 66), Jackson (1985; 283)

102. Dept. of Defense (1964; 252), Jackson (1985; 283)

103. Dept. of Defense (1964; 16,252)

104. Ashkerov (1960; 141)

105. Ashkerov (1960; 141)

106. The WF-2 was a navy carrier-based AEW aircraft with an above-fuselage radome. See Hirst (1983; 69)

107. Streetly (1983; 75)

108. Krysenko (1966; 44-45), Hirst (1983; 69-70)

109. Krysenko (1966; 45-46)

110. Krysenko (1966; 46)

111. Krysenko (1966; 42)

112. Krysenko (1966; 48)

113. Hirst (1983; 72-3)

114. Kravchenko (1966)

115. Kravchenko (1966; 46)

116. Hirst (1983; 66,101,104), Jackson (1985; 283)

117. Jackson (1985; 283)

118. Lyubimov (1969)

119. Lyubimov (1969; 40)

120. Hirst (1983; 146), Cherikow (1975; 677)

121. See Streetly (1983; 102-105) for details on these aircraft. The Tu-142 is the EW version of the Tu-95 Bear strategic bomber.

122. Vestnik PVO (1971a,b)

123. Vestnik PVO (1971b)

124. The actual deployment date of the Moss is not known. Cherikow (1975; 677-8) gives 1970, which seems plausible and accords with other estimates.

125. Zimin (1971; 79,125E)

126. Kulikov (1971)

127. Kulikov (1971; 60)

128. Aviatsiya i kosmonovtika (1971; 46-47)

129. Hirst (1983; 103)

130. Hirst, (1983; 107-8)

131. Pukhov (1973)

132. Pukhov (1973; 77)

133. See Hirst (1983; 104-105)

134. Pukhov (1973; 77)

135. Pukhov (1973; 78)

136. Pukhov (1973; 78)

137. Batitskiy (1973b; 37)

138. Batitskiy (1973b; 38)

139. Peresada (1973)

140. Peresada (1973; 230)

141. See PVO Herald (1973; 139), Vestnik PVO (1975; 87), Nevedomskiy (1975)

142. Kochkov (1975; 84)

143. Omel'chenko (1976)

144. Omel'chenko (1976; 17)

145. Omel'chenko (1979)

146. Omel'chenko (1979; 70)

147. see Ionov (1980), Andreyev (1981), Kondrat'yev (1983), Aleksandrov (1984)

148. For information on the decision to purchase the E-3B and its differences from the E-3A, see Hirst (1983; 115-116,121-125), Boyle(1977), Furlong(1975)

149. Aleseyev (1979)

150. Alekseyev (1979; 47)

151. Andreyev (1981; 37)

152. Andreyev (1981; 37)

153. Andreyev (1981; 39)

154. Andreyev (1981; 39). For Western discussions of the need to improve AWACS see Pretty (1976; 658-660), Hirst (1983; 108-125), Furlong (1975), Boyle (1977).

155. Kondrat'yev (1983; 55)

156. Aleksandrov (1984)

157. Aleksandrov (1984; 77)

158. Hirst (1983; 121,125)

159. See Krysenko (1966; 43-44), Omel'chenko (1979; 70), Aleksandrov (1984; 78)

160. Dornan (1978; 190), Knaack (1978; 215-16) The prefix Y denotes a prototype or experimental program. Most Soviet sources drop the initial Y, although the correct designation is YF-12A.

161. Knaack (1978; 216)

162. Knaack (1978; 216)

163. Kravchenko (1966)

164. Kravchenko (1966; 45)

165. Kravchenko (1966; 45)

166. Kravchenko (1966; 46)

167. Zimin (1971; 79)

168. Dornan (1978; 190)

169. Dornan (1978; 190), Knaack (1978; 333)

170. Zimin (1976; 133-34)

171. Zimin (1976; 134)

172. Gunston (1980; 192)

173. The F-12A would fly higher, and thus have a greater radar horizon, but it would also have a less powerful radar.

174. McLin (1967; 79)

175. Krysenko (1966; 23)

176. Smolin (1973)

177. Smolin (1973; 46)

178. Knaack (1978; 334-35)

179. Aviatsiya i kosmonovtika (1969) The F-14 is, of course, a Navy aircraft.

180. Aviatsiya i kosmonovtika (1970)

181. Aviatsiya i kosmonovtika (1970;45)

182. See Babich (1973a, 1973b), Babich (1976a, 1976b), Krasnov (1978).

183. Vestnik PVO (1971a; 89-90)

184. Vestnik PVO (1971a; 90)

185. Vestnik PVO (1971a; 90)

186. Zimin (1971; 79)

187. Zimin (1976; 135)

188. Krasnov (1972)

189. Ignat'ev (1979)

190. Ignat'ev (1979; 48)

191. Batitskiy (1967)

192. Batitskiy (1967; 38)

193. Batitskiy, (1967; 38)

194. For a study of the debate over the use of ASUs in the Soviet Ground Forces, and some discussion of the problems the PVO faced in this regard, see Bremner (1983)

195. Batitskiy (1967; 39)

196. Batitskiy (1967; 39)

197. Batitskiy (1967; 39)

198. Batitskiy (1968;

199. The members of the editorial group also included V. P. Ashkerov and G. V. Zimin, among others.

200. Batitskiy (1968; 354)

201. Batitskiy (1968; 354)

202. Batitskiy (1968; 364)

203. Batitskiy (1968; 369)

204. Kalugin (1968)

205. Kalugin (1968; 43-4)

206. Kalugin (1968; 46)

207. Kalugin (1968; 49)

208. Kalugin (1968; 51-52)

209. Zimin (1976; 80)

210. Svetlishin (1968) Svetlishin was also one of the authors of the book edited by Batitskiy. In 1967 he was also serving on the Editorial Board of the Military Historical Journal. See Douglass (1982; 252).

211. Svetlishin (1968; 34)

212. Svetlishin (1968; 34)

213. Svetlishin (1968; 34)

214. Svetlishin (1968; 35)

215. Svetlishin (1968; 35)

216. Svetlishin (1968; 34)

217. Svetlishin (1968; 35)

218. Svetlishin (1968; 37)

219. Svetlishin (1972:68)

220. Svetlishin (1972; 69)

221. Svetlishin (1972; 80)

222. Batitskiy (1973a)

223. Batitskiy (1973b)

224. Batitskiy (1973a; 39)

225. Batitskiy (1973a; 48)

226. Batitskiy (1973b; 33)

227. Batitskiy (1973b; 34) It appears that this article was written before the October War, and that Batitskiy's claims were based on the second part of the War of Attrition. It should be noted that Batitskiy appears to have played a major role in setting up the Egyptian air defense system, including visiting Egypt in late 1969 before the rapid buildup of Soviet air defense personnel and equipment in that country. See Herzog (1982; 214)

228. Batitskiy (1973b; 35)

229. Batitskiy (1973b; 37)

230. Batitskiy (1973b; 37-8)

231. See the chapter on assessments of AWACS for a discussion of these issues.

232. Batitskiy (1973b; 38)

233. Batitskiy (1973b; 39)

234. Batitskiy (1973b; 39)

235. Batitskiy (1973b; 39)

236. Scott and Scott (1981;123)

237. Arkin and Fieldhouse (1985; 77)

238. Batitskiy (1973b; 41)

239. Batitskiy (1973b; 41)

240. Gunston (1979; 342-3)

241. Batitskiy (1973b; 42-44)3

242. Batitskiy (1973b; 46)

243. See page 27

244. See page 62

245. Mal'gin (1978). See also Finn and Meyer (1984).

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