Chapter V

Soviet Systems

A. Introduction

From the Soviet perspective, "The development of antiaircraft defense after the Second World War may be divided into two periods: the first, from 1946–53, and the second, from 1954 to the present."[1] The break between the two periods is delimited by the formation of PVO (Strany) as a co-equal with other services of the Soviet armed forces in May of 1954. Coincidently, the 1953 date conforms to more general Soviet military histories, which acknowledge 1953 as the year of Stalin's death and the year in which the Soviet Union demonstrated its first thermonuclear weapon. A third stage seems also to be doctrinally accepted which acknowledges "the revolution in military affairs." This last phase is marked by the formation of the Rocket Forces as another service in 1960 and the adjustment of military doctrine to nuclear and missile weapons. Within these divisions, Soviet writers usually characterize the first period as one in which Soviet air forces were equipped with modern jet aircraft. The second period is generally characterized by the deployment of missiles for both ground and aviation air defense components. The third period might be characterized by attempts at ABM defense. In keeping with the Soviet view of the earliest period, this history will focus on the decisions involved in the process of aircraft modernization and the development of jet technology. Subsequent volumes will focus on surface-to-air missiles and Soviet ABM programs in turn.

Not only does the focus on jet aircraft accord with the Soviet view of early post war history, it also takes advantage of unique insights into the Soviet process of decision making. Aircraft designers and test-pilots occupy a special status among Soviet heroes. They write and they talk more freely about their activities than other segments of the society and they appear somewhat open about their activities with members of the aviation press—that is if a decent period (about 20 years) has passed to preclude possible disclosure of military secrets. In addition to the remembrances of key figures in the Soviet development community, there are also a number of defectors who round out the picture of Soviet aviation, particularly in the areas of applied research and aircraft production. Thus, in retrospect, a fair picture emerges as to how decisions were made with regard to aviation in the late Stalinist period; it is a picture which is substantially corroborated by intelligence of the period and by more recent Soviet official documents.

From the standpoint of historiography, the focus on aircraft developers and development decisions may be dangerous. It may distort conclusions drawn with the benefit of a wider focus. This potential bias is acknowledged, but discounted, for several reasons:

(1) The personal role of Stalin in military decisions, particularly aviation matters

(2) The purge and politicization of air force leadership in 1946

[1] Dzhordzhadze, "The Role of Historical Experience," p. 41.

(3) The subordination of the air forces to ground forces requirements and leadership
(4) The continuing pattern of political domination of the military establishment and military force structure decisions which persisted after the death of Stalin
(5) The exclusion of members of the military and political leadership from weapons decisions made among Stalin and his principal advisors.

These factors lend credence to the picture of Soviet decision makers portrayed in the following materials. A further, and compelling, reason is that few data exist to develop alternate foci. Therefore, the following materials approach aviation decisions through the designers and include additional data which broaden the perspective.

Rather than detail what strategic defense forces developed, or how, the intent is to ask "why?" It is the contention here that design activities provided a menu of weapons from which a number were chosen for production and deployment. It is in this context, that one gains a grasp of "why?"

By extension, understandings gained from a study of aviation decisions can be applied to developments in the realm of antiaircraft artillery, surface-to-air missiles, and radar systems. In two major respects, however, decisions related to complementary defensive systems differ. First, it seems they did not involve Stalin as frequently. Second, they took place in a framework where domestic institutions were less well developed and where reliance on foreign technology was higher. This chapter thus discusses the observable developments within these other categories of systems. It closes with a discussion of civil defense developments to complete an overall appreciation of the strategic defense effort.

B. History of Fighter Aircraft of PVO

1. Pre-War Experience

Patterns of organization, institutional behavior, and decision making in Soviet aviation derive from the pre-WWII formation of the Peoples Commissariat for Aviation Industry and from the emergence during the late 1930's of a group of young and competent designers who since have been sustained in their independent development activities. The industry was *highly competitive* in the process of designing alternative prototype aircraft, *political* in the allocation of resources and *centralized* in the exchange of information.[2] It became an establishment in which the designers played a key role protected by a ministerial-level institution along with key producer industries. Within this establishment, the user organization, the air forces, did not necessarily have the predominant voice.

The character of the Soviet aviation industry was much influenced by the purges of scientists and engineers during 1927–1929. In effect, these purges, which culminated in the Industrial Party (Promparty) Trial of 1930, virtually wiped out the entire technician class of that generation.[3] The principal designers of the thirties—Nikolai Polikarpov, in fighters, and Andrei Tupolev, in bombers—fell into disfavor in 1929 and Polikarpov was imprisoned for industrial sabotage or "wrecking."[4] During this period, the Central Design Bureau was organized under the State Political Administration (GPU or Secret Police). Among its facilities was the "Seventh Hangar" organized under the "internal prison" (Vnutrennaya Turma), where Polikarpov

[2] See Institute for Research in Social Science, and Alexander R&D for detailed description.
[3] Solzhenitsyn, pp. 377–399. Of approximately 30–40,000 engineers in the U.S.S.R., Solzhenitsyn estimates that 5,000 were arrested (p. 387).
[4] "Prolific Pioneer," Flying Review International, July 1968, p. 405.

and other aviation notables lived and worked under heavy guard.[5] During that period, Alexander Yakovlev, Sergie Iluyshin, and probably Artem Mikoyan received their training in this same Central Design Bureau Complex. In 1933, after the successful flight of his I-5 prototype, Polikarpov was released. By 1934, it was Tupolev's turn. He received a ten-year sentence for sale of military secrets to Germany, but worked his way out after two years with the design of the gargantuan eight-engine "Maxim Gorky" propaganda and passenger craft.[6] He was returned to prison on two later occasions in 1937 and in 1940.[7] In 1937, another name in Soviet aviation gained prominence—that of Semyon Lavochkin. The design of the LAGG-I and the team of Lavochkin, Gorbunov, and Gudkov emerged, again from prison.[8]

a. Structure of the Aviation Industry

Four basic functions were organized under the Commissariat and the Ministry of Aviation which succeeded it. They were and (in 1975) still remain:

(1) Basic Research
(2) Prototype Design
(3) Testing and
(4) Production.

Basic research is conducted within the Central Aerohydrodynamics Institute (TsAGI) for airframe problems and within the Central Institute of Aviation Motor Building (TsIAM), the All Union Institute of Aviation Materials (VIAM), and the Scientific Institute for Aviation Equipment for related subjects. Design activities are the province of the Central Design Bureau (TsKB) and of semi-autonomous Experimental Design Bureaus (OKBs) which operate under it in the fields of airframes, engines, and armament. Testing is conducted by centralized testing establishments, most notably the Flight Test Institute (LII) and the Scientific Testing Institute of the air forces (NIIVVS). Production is organized among individual factories responsible to the Ministry.[9]

b. Elites

Within Soviet air forces, there are two parallel series of ranks; one for the operational side and another for the technical. The operational ranks range up to Chief Marshal, but the engineering ranks stop at the next-lower Colonel-General rank. Notably, only Army officers are eligible for the highest rank, Marshal of the Soviet Union. This, however, does not indicate that officers of the Aviation Engineering Services carry less weight; quite to the contrary:

> It is more difficult to obtain an engineering rank than an executive one, as the prefix "engineer" is only given to those who have received the highest technical air education, and is usually reserved for those who have passed through the Zhukovski Military Engineering Academy. Exceptions are occasionally made for distinguished inventors. In the schools and experimental stations of the Soviet Air Forces, the technical side outranks the non-technical. For example, an Engineer-Major may even hold a post which would normally be filled by a non-technical Major-General.[10]

[5] Ibid. and Yakovlev, *Target*, p. 84.
[6] "Chief U.S.S.R. Aircraft Designer," *Air Intelligence Digest*, Jan. 1950, p. 16 CONF.
[7] "Soviet Big Five Aircraft Designers," *Air Intelligence Digest*, Feb. 1954, p. 32 CONF.
[8] "Lavochkin" *Air Intelligence Digest*, Mar. 1950, p. 36.
[9] Institute for Research in Social Science, and Alexander, *R&D*.
[10] Tokaev, *Soviet Imperialism*, p. 42.

The Zhukovski Academy is a centralized post-graduate institution devoted to aviation studies (and Marxist-Leninism of course). Its students and graduates are distinguished by special pay, privileges, social access, uniforms, and bearing. Its senior staff members frequently enjoy direct access to the Politbureau and some relief from political imperatives which are imposed on the remainder of the Soviet population. Alumni of the academy share a "scientific" ethic and generally recognize each other on the basis of individual competence. ". . . We are therefore school-mates. A strong comradely friendship binds us. We frequently consult with each other and help each other solve complicated problems."[11] Among names frequently mentioned in this study, Yakovlev, Mikoyan, Iluyshin, Lavochkin, and Tokaev were Zhukovski graduates. Tupolev, Polikarpov, Klimov, and Yakovlev were at one time staff members. Those who do not fare as well, Sukhoi, for example, appear to be graduates of other technical institutes.

The ethic which binds the technical elite extends, in part, to their subordinates. The open literature contains several examples of direct appeals as high as Stalin[12] for review of sentences on behalf of technical staff and of confrontations with political officers to allow individuals to continue with competent work with less interference.[13] This "backing up" of personnel may explain the strength and loyalty of design teams.[14]

c. Design Competition

The tradition of design competition evolved during the 1930's as a number of designers began working independently of the major institutes. In 1936, a requirement was issued for a light multipurpose fighter. Four designers responded with development programs. Later that same year, the specification was revised to favor the light bomber role and a Sukhoi prototype (the Su-2), developed independently of his mentor Tupolev, was accepted.[15]

The epitome of design competition was that held in late 1939. Over 20 designers were given assignments to provide prototypes against two or three basic requirements. A fairly detailed account of that competition is resorted to because it is prologue to the decision patterns and criteria that prevailed until Stalin's death in 1953.

The competition derived from a conference in the Oval Hall of the Kremlin. Among those present were "all who had proved themselves to be aviation designers or inventors and who had in recent years made some contribution to aviation."[16] The meeting was presided over by Stalin, V. M. Molotov (Premier), and K. Y. Voroshilov (Minister of Defense), with Molotov moderating. What ensued was a general review of the status of Soviet aviation and a debate over the utility of four-engined bombers. Subsequently 20–25 engine and airframe designers were again called to the Kremlin for personal interviews before a panel of Stalin, M. M. Kaganovich (Commissar for Aviation), Molotov, Voroshilov, F. A. Agal'Tsov (Assistant Director of the Air Force), and another member of the Politburo.[17]

Among Yakovlev's recollection of his interview is the following dialogue:

---

[11] Yakovlev, *Target*, p. 416.
[12] Ibid. p. 420.
[13] Tokaev, *Comrade X*, pp. 112–115.
[14] "Tupolev," *Air Intelligence Digest*, Jan. 1950, p. 15.
[15] Nemecek, Feb. 1966, p. 373.
[16] Yakovlev, *Target*, p. 163.
[17] Ibid.

[Stalin] ". . . Are you aware that we have ordered this kind of fighter from several other designers, and the winner will be the one who not only gives the best fighter in terms of flight and combat qualities but also delivers first, so that we can get it into series production sooner?"

[Yakovlev] "I understand, Comrade Stalin."

[Stalin] "It's not important if you understand. You've got to produce it sooner."

[Yakovlev] "What time limit?" [the key question!]

[Stalin] "The sooner the better. By New Year's?"

[Stalin] "We ourselves are very much aware that we don't need that many planes. But, the good Lord willing, out of all these we'll get five or six that can be put into series production. And that many new aircraft won't confuse us."[18]

Yakovlev states that he left the meeting "inspired with the spirit of creative competition and with unwavering intentions of beating our rivals."[19] Eleven other designers were competing against the same requirement, but Yakovlev produced before his counterparts—by the New Year's deadline. The first three available prototypes (YAK-1, MiG-3, LAGG-3) were committed to production before testing was completed. On January 9, 1940, Yakovlev was appointed by Stalin to be Assistant Commissar for Aviation Industry at age 35.[20]

Several points are illustrated by this vignette which characterize subsequent aviation decisions during the Stalinist era. The points are underscored because they represent a pattern repeated in post war decisions:

(1) The dominant role and personal involvement of Stalin
(2) The weight of *political* and *technical* representation in the process as opposed to the one representative of the air forces general staff
(3) The importance of the design community in the process
(4) The official encouragement of the competition concept
(5) Compressed lead times and the importance of arbitrary and seldomly explicit dates
(6) The rewards, both in terms of production commitment and of other honors, which attend the design of the first prototypes fielded (reinforced by the negative rewards of Hanger Seven)
(7) The continuity of the key figures in the decision pattern. Yakovlev remained Assistant Commissioner until 1948, and the competing bureaus are, for the most part, still active.

d. Information Flows

Among Yakovlev's innovations in 1940 were the design handbooks and reorientation of the TsAGI. The design handbooks amounted to a standardization program for the aviation development community. The multiplication of independent design activities necessitated a common code of procedures. An initial version was produced in 1940. The second edition which appeared after the Soviets entered WWII consisted of 11 parts:

(1) Aerodynamics
(2) Hydromechanics
(3) Strength of materials
(4) Flight tests of aircraft and equipment
(5) Engines
(6) Aircraft equipment

[18] Ibid., p. 165.
[19] Ibid., p. 166.
[20] Ibid., p. 169.

(7) Aircraft armament
(8) Landing gear and mechanisms
(9) Standard systems
(10) Materials
(11) Semiproducts[21]

Among contributors to the handbooks were the foremost Soviet authorities on aviation science and design with a leavening of test pilots. The second edition was intended to incorporate construction and combat experience gained from the immediate pre-war generation of fighters. The design handbooks became a virtual encyclopedia of Soviet aviation and the principal means of communicating research results to the practical engineering level. They also provided a medium for reconciling conflicting perspectives of the military, scientists, engineers, production specialists, and maintenance people. The handbooks are a feature of Soviet aviation today and are thought to be a principal source of continuity and conservation in Soviet aviation technology.[22]

e. Use of Foreign Technology

In its early years, the Soviet aviation establishment relied heavily on foreign technology, but with the express aim of freeing itself from dependence on such assistance as soon as possible. Before 1925, Italy, France, England, and the Netherlands had supplied the Soviet Union with most of her planes and as late as that year a German-directed Junkers Company produced 500 aircraft in Russia.[23] Independent Soviet airframe designs began to emerge during the mid-1930's with independent engine designs emerging somewhat later. Purchases of foreign aircraft were not completely stopped and a concentrated effort to obtain U.S. technology followed the resumption of U.S.S.R. U.S. relations in 1933. As late as 1936, U.S. aircraft were purchased under license.[24]

During the pre-war period, a diversified program to exploit foreign technology accompanied the reorganization of design activities. Emphasis was placed on legitimate procurement of equipment and information, along with official visits and student exchanges. Generally, material was open for sale one year after it began production.[25]

During the war, the United States and Britain sent about 18,000 aircraft to Russia. These are compared by the Soviets to approximately 126,000 Soviet-produced craft to demonstrate that "the Soviet Union fought with its own strength."[26] It is the opinion of Robert Kilmarx that of these thousands of these lend-lease craft were held back to conserve them for use during the later period of transition to jet aircraft.[27] According to General John R. Dean, head of a U.S. military mission to the U.S.S.R., "we never lost an opportunity to give the Russians equipment, weapons, or information which we thought might help our combined war effort."[28]

The overt Soviet effort was supplemented by covert and grey activities. Toward the end of the war, the Soviet Purchasing Commission in Washington numbered over 1,000 people and high priority was given to

[21] Yakovlev, *50 Years*, p. 40.
[22] Alexander, *R&D*, pp. 15–16. Declining influence of the handbooks is discussed in Alexander, 1973 Trip Report, p. 9.
[23] Institute for Research in Social Science, pp. 58–59.
[24] Ibid.
[25] Kilmarx, pp. 165–166.
[26] Yakovlev, *50 Years*, p. 97.
[27] Kilmarx, p. 208.
[28] Ibid.

collection of information on jet aircraft. An effort to obtain information on America's first jet (the P-59) and on General Electric and Westinghouse jet engine developments is well documented.[29] Andrei Schevchenko, a legal representative to Bell Aircraft and later of Amtorg who engaged in espionage, reportedly mentioned a Lenin prize of 500,000 rubles for a jet aircraft design by the end of 1945.[30] Another report of the 1945 deadline is attributed to a Russian in this country.[31]

2. Performance of Soviet Aviation During WWII

In its simplest, the story of Soviet Air Forces during WWII is one of initial debacle and remarkable recovery aided by the overextension of German power. Despite the massive destruction of Soviet aircraft in June of 1941, a credible local defense began to be marshaled around Moscow in that same autumn. The winter-enforced lull in the air war, coupled with increasing numbers of new Soviet fighters, changed the momentum of the air battle. Stalingrad appears to have been the turning point where German aviation operated with impunity during the early stages of the siege, but suffered increasing losses as the campaign wore on. German losses exceeded resupply, while the Soviets were rapidly increasing their air forces based on industrial capacity, recovering from relocation to the east of the Urals.

In January of 1943 USAAF daylight raids combined with RAF night attacks on Germany to force the build-up of Luftwaffe homeland defenses at the expense of forces supporting the Eastern Front. As this homeland air front began to absorb over half of Germany's air resources, the balance shifted overwhelmingly in favor of the Soviets. By late 1943, a Soviet force of from 12,000 to 15,000 thoroughly modern aircraft faced a German Eastern Front air strength of from 2,000 to 3,000. During the Kuban and the Kursk-Orel campaigns in the summer of 1943, Germany did mass to contest the air, but at heavy cost in aircraft and crews. The Soviets could absorb losses; the Germans could not. Thereafter, local Luftwaffe commanders came to regard unfavorable odds of 12:1 as routine.[32]

a. Lessons Learned—Fighter Aviation

Despite Western historians who credit Soviet successes to improved airbase attack, the following emerged in 1949 as doctrine distilled from WWII experience. It relates to the relevance of fighter combat as opposed to other techniques of air defense or air superiority[33]:

(1) The experience of the past war showed that fighter aviation is the decisive factor in the struggle for air superiority. It also showed that the outcome depends mainly on air combat, which is the most effective way of destroying enemy aircraft.

(2) The experience of the war undermined the theory of German-fascist military circles about destroying an enemy air force by lightning war consisting mainly of strikes against enemy air bases.

(3) It also undermined the theories of Anglo-American military circles about gaining air superiority through air strikes at the military economy of the enemy, especially against his aircraft industry, his fuel reserves and his air training establishments. (Concentrated actions against the centers of the enemy's aircraft industry are certainly useful in gaining air superiority and they can hasten the

[29] Hearings, Un-American Activities, Jet Propulsion, p. 121.
[30] Ibid., p. 120.
[31] Ibid., p. 121.
[32] Lee, 1959, p. 70.
[33] Volkov, Col. A., "Fighter Aviation in Contemporary War," Voennaya, Mysl', Feb. 1949, pp. 55–69. From extracts. Note that a separate doctrine of "Air Defense Operations" was emerging among PVO troops during this period. See above Chapter V.

defeat of the enemy air force, but this can be only a supplementary means of winning air superiority. The main method must be destruction of enemy aircraft in the air and on air bases.)

(4) The struggle for air superiority and with it the main efforts of fighter aviation should be centered primarily about the ground effort. The reason for this is that only by means of ground action can the strategic aims of the war be attained. No independent air action can achieve results equal in importance to those air actions carried out in the interest of the success of the overall effort. In this context, air combat becomes as a rule extremely savage and calls for the greatest pressure and energy. Both belligerents can expect to suffer heavy losses as new air reserves are brought into action in the effort to secure freedom of action for the ground forces.[34]

From the contemporary U.S. perspective of "strategic," these lessons appear to relate to "theater" applications. However, from the Soviet experience, the Wehrmacht was Germany's strategic instrument. From the Soviet view:

> . . . Soviet military science considers that the outcome of war under contemporary conditions is decided on the field of battle by means of the annihilation of the armed forces of the enemy and that one of the most important tasks of aviation is active assistance to the ground and naval forces in all forms of their combat activity. This definition of the fundamental mission of aviation is not contradicted by the need to employ part of its forces to strike the deep rear of the enemy, or his military-industrial targets, but our military science does not consider such blows an end in themselves, but only a helpful means of creating favorable conditions for the success of the combat operations of the ground and naval forces. The structure of our military air forces is established on the basis of the scientific definition of the role and significance of aviation in contemporary war.[35]

In the context of early post war decisions these doctrinal statements are interesting in that they obscure the difference between frontal and defense aviation. The perception of an integrated air superiority mission epitomized by fighter-versus-fighter battles simplified potentially conflicting priorities by way of establishing a single set of interceptor requirements. Such a perception was not without foundation until 1957 when SAC released its fighter wings to the Tactical Air Command; U.S. B-36 doctrine called for fighter escort.[36]

b. Lessons Learned—Institutional

Beside the sanctification of fighters as the primary instrument of air power, the WWII experience confirmed the "correctness" of institutional arrangements in Soviet aviation. During the war years the Soviets produced 126,000 to 157,000 aircraft[37] of a quality comparable to those operational anywhere in the world—the German jets excepted. The Soviet perception was that "Our aircraft surpassed the enemy's in both quality and quantities."[38] While this perception of Yakovlev was self-serving since he was then Deputy Commissar for Aviation Industry, it is nevertheless important because he continued in that position through the period of significant postwar decisions. Moreover, it soon became a test of loyalty among the Soviet population at large to put down everything that was foreign and to proclaim the superiority of Soviet technology.[39]

---

[34] Nikitin, Col. Gen. of Avn. A., "Soviet Aviation," Voennaya Mysl', Feb. 1949, p. 62. Quoted in Garthoff, p. 173–174. An early post war attempt to define a strategic doctrine more in line with Douhet's theories was unsuccessful. (Ibid., p. 172.) This does not deny that an extremely high priority was given to long range developments which would lead to an intercontinental "strategic" weapon. See Tokaev, Stalin Means War, pp. 91–121.

[35] 85th Cong., 1st Sess. DoD Appropriation for 1958, HR, Hearings, pp. 917–918. Quoted in Futrell, Ideas, Concepts Doctrine, p. 465.

[36] From Soviet figures. Yakovlev, 50 Years, p. 97. These figures are slightly conservative when compared with U.S. intelligence estimates circa 1949. The range is accounted for by the addition of Jan.–June 1941 (pre-war) production to the lower figure.

[37] Yakovlev, *Target*, p. 286.

[38] Tokaev, *Stalin Means War*, pp. 107–108.

[39] Lee, 1959, pp. 143–144.

The perception of design and industrial success on the part of the Soviets was appropriate in many regards. From the design standpoint, Asher Lee summarizes a widely held respect for the machines that were produced after 1943:

> . . . Their own YAK, MiG and LAGG fighters were more than equal in performance to the British Hurricanes and American Aerocobras and Kittyhawks—even the improved versions which they were getting in hundreds every month under Lend-lease. Indeed, the technical gap between the German and Soviet single-engined fighters had virtually closed by the end of 1943. French pilots who have flown the YAK, the Spitfire and the Messerschmitt 109 declare that the Soviet plane was the equal of its German and British counterparts. . . .[40]

From the production standpoint, the Soviet perception of success also is justifiable when compared with the production of its enemy. By 1944, Soviet monthly aircraft production was running ahead of the German industry. Despite the fact that over half of the Soviet aviation industry was relocated in 1941, production recovered within the year. In 1944, the last full year of the war, Soviet production reached 40,300 and German production was 40,953.[41] (No less remarkable than the Soviet recovery, however, was the German success at maintaining such a production rate in spite of allied air attack by dispersed use of underground facilities and other expedients.) The Soviet 1944 monthly production rate of 3,300 compares with a peak wartime U.S. rate of 7,100 although such comparisons ignore the large proportion of bombers in U.S. production which would reflect on an alternate measure of airframe weight. Despite qualifications, the perspective of institutional success appears justified. The Soviet aviation establishment had fielded a force roughly equivalent to that of its primary enemy; on the other hand, that enemy had other battles to fight. On the Eastern Front the Soviets had a rough 6 to 1 numerical superiority toward the end of the war.[42]

c. Lessons Learned—Design

A primary effect of the war was to emphasize the producibility of Soviet designs and modifications:

> The designer cannot forget for an instant that any improvement, no matter how necessary for increasing the quality of a piece of armament, must be introduced only with the consideration that it be reflected minimally in fulfillment of quotas. Therefore, the designers were in closest contact with the series production plants. Prior to introducing any innovation into an existing piece of armament, they had to anticipate in their own minds in minute detail what difficulties this improvement might entail in the mechanical processes. The designers had to effect their changes in such a way that they might be put into series with only a minimal loss in the daily output quota of aircraft sent to the front. This was an extremely difficult task, especially difficult when a new type of aircraft entered into series production. Under war-time conditions, the designer must also consider this fact in developing a new aircraft and his new product must make maximum use of existing technology in a given series factory.[43]

Another basic lesson was that of a relation between simplicity and utility in combat. Simplicity affected predictability but it also affected how fast weapons were available at the front. To train for the use of simple weapons was easy.[44]

The over-riding lesson was the necessity for technical capability. "To the designer, war is a difficult school. However, the lessons he learns stay with him throughout his life and serve as the motto: 'Be ahead!'"[45]

---

[40] Kilmarx, p. 318.
[41] Lee, 1959, pp. 69–74, passim.
[42] Yakovlev, *Target*, p. 337.
[43] Ibid., p. 357.
[44] Ibid., p. 358.
[45] Ibid., p. 357.

d. The Commitment to Jet Interceptors

The Soviet aviation establishment was left in an uncomfortable position during later stages of the war. Work on advanced designs was discouraged in order not to divert resources from the production effort.[46] However, as Soviet forces penetrated Eastern Europe, the aviation community became aware of the array of weapons its enemy had in prototype and on the drawing boards. In late 1944, Soviet forces captured a quantity of Junkers JuMO-004 and BMW-003A jet engines and a number of these were provided to Soviet designers for experimentation.[47] Later when the German plants were occupied, they were returned to production as Soviet plants tooled up to produce the engines also. About the same time, a program was initiated to copy U.S. B-29 bombers, four of which began to fly into Soviet hands in August of 1944.[48] In November of 1944 with these precedents, a special committee under the Council of People Commissars, headed by Malenkov, was created to oversee the exploitation of the German economy.[49] This appears to have coincided with the focusing of intelligence collection efforts on U.S. jet designs.[50]

It was not until 1945 that a jet aircraft design effort was given official sanction by Stalin. The date may have been either in February[51] or in May when, with the German surrender, aircraft production was sharply curtailed.[52] In June, a party of about ten senior officers was dispatched to Berlin to organize the exploitation of German aeronautical science. By August 15, a Soviet program was initiated for flight testing the German Me262 jet. Meanwhile, during the autumn of 1945, the Aviation Commissariat had developed a detailed review of the "dangerous situation" in advanced technology and design.[53]

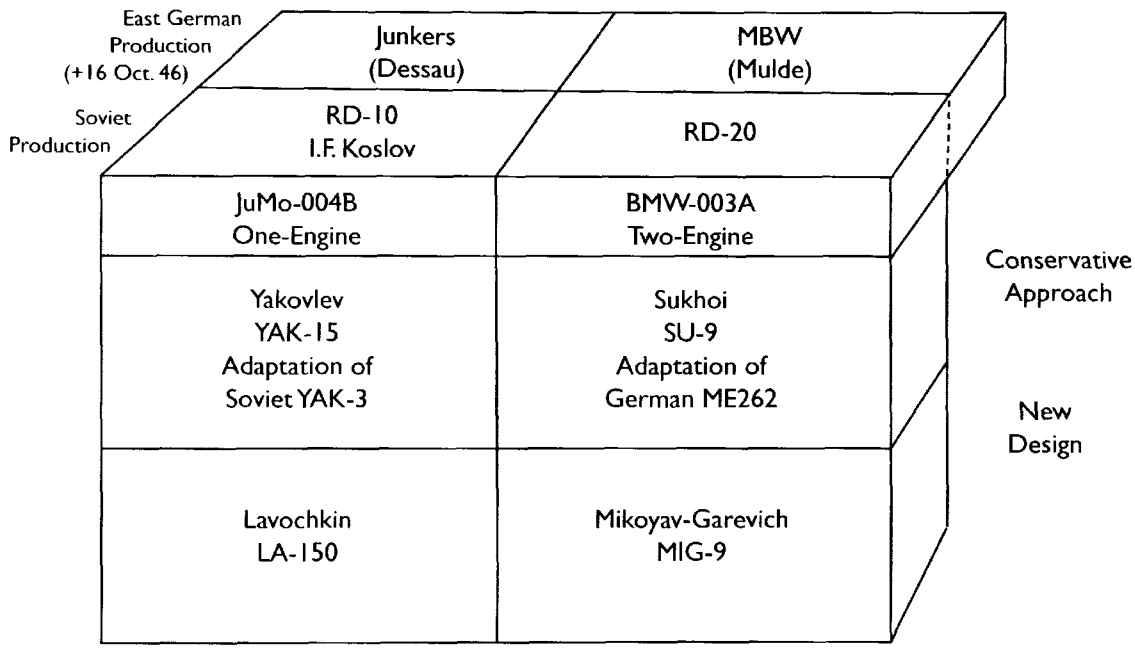
Among proposals surfaced in conjunction with the Commissariat review was one to commit the Me262 to production. During the presentation of the Commissariat's proposals to Stalin, however, Me262 production was opposed by Yakovlev on the basis that the aircraft was unstable and unsafe, that such production would divert resources from native designs and that more advanced prototype would soon be forthcoming from both his own and the Mikoyan-Gurevich design teams.[54] The proposal was rejected and a tentative deadline, the August 46 Tushino air show, was set for the new prototypes. Detailed project designs were approved for Lavochkin, Mikoyan, Sukhoi, and Yakovlev at about the same time. Concurrently, the Commissariat was reorganized as the Ministry of Aviation Industry and M.V. Khrunichev was appointed as Minister replacing Kuznetsov. The name and the appointment accompanied a general realignment of Defense Ministries. Nonetheless, it would be Khrunichev's responsibility to give concrete form to the Party commitments.

In all, four designer teams were involved in building fighter prototypes around the captured Junkers and BMW jet engines. Those which received the more powerful Junkers engines of 2,000 lbs. thrust, Yakovlev and Lavochkin, focused on a single engine design. Those which received the 1,800 pounds of thrust BMW engines, Sukhoi and the Mikoyan-Gurevich team, would focus on a two-engine design. Within both the single- and double-engine approaches, divergence emerged as to the conservatism of

[46] Lee, 1959, pp. 231–232.
[47] Green, "Billion Dollar Bomber," July 1971, p. 105.
[48] Kilmarx, p. 213.
[49] Hearings, Jet Propulsion, p. 121.
[50] Air International, "First of Many," p. 233.
[51] Yakovlev, *Target*, p. 362.
[52] Ibid., p. 363.
[53] Yakovlev, *50 Years*, p. 102, and *Target*, pp. 363–364.
[54] Air International, "First of Many," p. 233.

design. On the single-engine side, Yakovlev took the more conservative approach of fitting the new engine to an established airframe—that of the YAK-3 fighter. Meanwhile, the Lavochkin team committed itself to a new design. Among the two-engine competitors a like phenomenon was observed. The Sukhoi design focused on a refinement of the general concepts of the Me262 while the Mikoyan-Gurevich collective attempted a new design. Meanwhile, the aircraft engine establishment attempted to bring both the engine types into series production—the Jumo as the RD10 and the BMW as the RD20. Although the intention does not appear to have been documented, the program decisions for a successful jet were well hedged. Should either engine prove unworkable, an alternative was available. Should either the MiG or the Lavochkin designs fail, a more conservative back-up design was in progress using either engine. Should either domestic engine program fail, East German factories were kept in operation. A matrix of this hedging effect appears in Figure 7. Predictably, Yakovlev's re-engined version of the established conventional aircraft was the first of the four ready for testing in October of 1945. Not predictably, all four prototypes were basically successful.

Figure 7—Hedging Effect of Initial Jet Prototype Design Decisions



The claims about which Soviet jet aircraft was first to fly are[55] in dispute. Supposedly it was settled by the toss of a coin. Full flight of Yakovlev's aircraft had been delayed pending wind tunnel tests during the winter of 1945, while airfield conditions delayed both Yakovlev and Mikoyan until April 24, 1946.[56] With the coin toss, Mikoyan's air craft flew first and Yakovlev's followed. Both aircraft were supposedly demonstrated at the Tushino show on August 19, although only the MiG-9 was reported by USAF intelligence. The Su-9 flew in August and the La150 in September.

[55] Yakovlev, *Target*, p. 365.
[56] Ibid., p. 371.

3. Post–World War II Developments

a. The Ministry of Aviation Production Plan

In December of 1945 the status of Soviet aviation had come under debate in the Party Central Committee. The Aviation Commissariat proposals debated at that time culminated in a comprehensive program to eliminate any lag in the field of aircraft design or research. In March of 1946 a party of senior aviation personalities, Yakovlev among them, visited Germany to assess first-hand what could be obtained there. By April 2, a long-range plan for the development of jet fighters was laid before Stalin.[57]

The strategy for post war development of jet fighters was based on the rapid achievement of superior jet engine capability. Although the Soviets had some background in jet turbine design dating back to 1937, the work of its most experienced jet technician, Arkhip Lyulka, had been interrupted during the war. After working on an unheralded rocket aircraft project, Lyulka returned in 1942 to jet turbine work. By the end of the war he was bench testing an experimental engine of 1,543 pounds thrust and had initiated work on a 2,866 pounds thrust engine intended for flight testing.[58] It was apparent, however, that these engines were behind the world standard and would require extensive development while German engines were already available. The Commissariat plan would allow attention to be given to advanced engine design while native designed aircraft would be based on engines of foreign derivation. Key to the strategy was the purchase of British Rolls Royce centrifugal compressor engines—the Nene and the Derwent. In reacting to this strategy, Stalin is said to have remarked, "Just what kind of fool would sell his own secrets!"[59] Nevertheless, the Russians had had considerable experience with the British unclassified lists during the war and were aware that licenses for production of these engines were being sold in a number of countries. The successful attempt to purchase these engines would proceed.

The 1946 Plan addressed three stages of engine development with associated design activities[60]:

(1) Transitional aircraft based on 1,800–2,000 pounds thrust German engines. This stage was nearing fruition as the YAK-15 and MiG-9 were already in preliminary testing.

(2) Combat capability based on British Nene and Derwent engines of 3,500–4,850 pounds thrust. A requirement for such aircraft would emerge concurrently with the plan.[61] All four fighter design teams would submit prototypes which evolved to the MiG-15, the YAK-23, Su-11, and the La-15.

(3) Advanced aircraft based on engines by Klimov, Mikhulin, and Lyulka in the range of 6,600–17,600 pounds thrust. It was planned that these would be available in 5 to 6 years. Eventually, the Klimov VK-1 would power the MiG-15 bis, and the MiG-17; the Mikhulin AM-5 would drive the MiG-19 and YAK-25; the Lyulka AL-7 eventually powered the Su-9 and Su-11 of the late fifties.

The 1946 plan coupled with the December 1945 commitment of resources by the Central Committee would allow the Soviets to achieve superiority in jet engine technology in the early 1950's.[62] It facilitated early emphasis on advanced technology by leap-frogging intermediate stages of development with adapta-

[57] Air Enthusiast, "Lyulka," pp. 297–298.
[58] Yakovlev, *Target*, p. 372.
[59] Ibid., and Yakovlev, *50 Years*, p. 103.
[60] Flying Review International, "Mikoyan Quarter Century," Nov. 1965, p. 159.
[61] A regression analysis of Soviet and U.S. jet engine characteristics, conducted by RAND, concludes that Soviet jet engine technology led U.S. technology until roughly 1950–1953 depending on whether U.S. or Soviet forecasting equations were used. See Alexander and Perry, 1972, pp. 30–32.
[62] U.S. evolution from British technology is described Ibid., pp. 11–19.

tions of foreign designs. In effect, the Soviets would be mastering British jet technology almost concurrently with the United States.[63] In the meantime, native airframe designs would continue on a par with those of other countries. One consequence of the resulting engine allocations, however, was that available power may have prejudiced the success of early prototypes in the program. It appears that early success may have prejudiced later success.

b. The Debate Over Use of German Technicians

Among issues addressed in conjunction with the April plan was the question of how to use German personnel:

> During the meeting the question arose relative to the possibility of using German specialists who were working in East Germany in aircraft factories. Khrunichev and I expressed doubts of the wisdom of such steps. We felt it unwise to expose our newest research institute secrets. However, with a wide-spread research experimentation at the base of our Soviet institutes, the activities of the German specialist would be fruitless. They would be able to create nothing.
>
> However, this consideration was paid no heed. I was looked upon not so much as Assistant Minister as a designer and it was obviously assumed that in fearing competition from German scientists and designers, I might not be sufficiently objective on this question.
>
> As is well known, German specialists arrived in the Soviet Union, but attempt to use them were unsuccessful, although costing a great deal.[64]

During the summer of 1946, Germans who had been working with the Soviets were transported to the U.S.S.R. in a well-coordinated surprise movement. On October 21, 1946, dozens of trains in one night moved some 40,000 Germans under a five-year "contract" to various Soviet locations. Some 3,000 of these were aviation specialists.[65] The program was not without difficulties, however, as a conversation five months later between Col. G. A. Tokoev and Stalin discloses:

> " . . . we certainly need more German specialists. There are a great many who are being wasted at present, through being given completely unsuitable jobs."
>
> "But why should that be. Why can't you rope in all the Germans you need?"
>
> "Principally because the Germans fear to enter our service more than anything, Comrade Stalin," I answered. "Since German specialists were removed wholesale to the U.S.S.R. in 1946, whether they wanted to go or not, the whole population are afraid of us. And some of our own officials, for their part, are prejudiced against employing Germans. For instance, Doctor Kurt Tank, who was chief designer during the war for the firm of Focke Wulf, offered of his own free will to join us. He was turned down by General Kutsevalov, and General Lukin, on the grounds that he had been a member of the Nazi party."
>
> "And what are your own feelings on that point?"
>
> "I don't agree with the Comrades concerned."
>
> "Where is Tank now?"[66]

What ensued was a comic-opera effort to kidnap Tank, involving the Dictator's son Vassily Stalin, and the then Deputy Chief of the KGB Ivan Serov. Added to this duo, the main task of which was to pursue the exploitation of remaining German aviation talent, was the same General Lukin who had a notorious reputation among Germans for the pillaging and deportation of their aviation industry and technicians in the

[63] Yakovlev, *Target*, p. 371.
[64] Stockwell, pp. 42-45, from German press accounts.
[65] Tokaev, *Stalin Means War*, p. 116.
[66] Tokaev, *Comrade X*, p. 316.

previous year.[67] Notably, serious efforts to improve voluntary cooperation were lacking. Tokaev, the senior Soviet technical advisor on aviation matters in Berlin, by his admission, discouraged a member of potential collaborators by his honest portrayal of the reality of their service.[68] The upshot of the story is that Tokaev defected and Kurt Tank eventually designed jet aircraft for the Peron government in Argentina.

The same General Lukin (by Tokaev's account)[69] and Vasily Stalin (by Solzenitzn's account)[70] were the source of denunciations which eliminated the top echelon of the post war Soviet air forces. In March 1946 the Commander-in-Chief of Soviet air forces Chief Marshal of Aviation Alexander Novikov was arrested and imprisoned along with his Deputy, Colonel-General Repin, the senior officer of the Aviation Engineering Services.[71] Although reasons for the arrests vary, the purge accompanied a reorganization and a tightening of political controls within the armed services. Marshals Vershinin and Sudets took their places in the high command. So it was that Sudets had a role in the formalization of the requirements for the MiG-15[72] and the date of the Air Forces requirement is placed at the time of the April plan. More importantly, the Air Forces leadership was in a state of upheaval while the future of its capabilities was being decided by the Ministry of Aviation Industry.

c. Success of First Prototypes (YAK-15 and MiG-9)

Although the political and strategic implications of the April date of the first jet flights are unclear, the implications on fighter characteristics were. A month after its first flight, the initial prototype nosed into the ground killing its pilot. Another prototype was made available in July to continue the test program. Mark Gallai, the test pilot, relates that during his baptism with the second machine, the trim controls were reversed, the engines would not throttle back fully, and the nose-wheel collapsed.[73] Nevertheless, both the YAK and MiG aircraft were ready for the Tushino show on 19 August 1946. Stalin demonstrated his jets in the first post war Aviation Day flying display. If haste was evident in the construction of the prototypes, what followed demonstrated even more vividly the priority attached to the program.

The day following Tushino, Mikoyan and Yakovlev were summoned to the Kremlin. There Stalin directed that 10–15 aircraft of each type be prepared for the October Revolution Parade 80 days thereafter. Both designers were dispatched to production plants with an Assistant Minister of Aviation to act as expediter. Despite the obvious enormity of the task, 15 MiGs and 15 YAKs were ready by 7 November. In spite of all the effort, the November parade was weathered in—the scheduled fly-by was grounded.[74]

Curiously enough, U.S. intelligence only observed the MiG-9 at the August show.[75] However, 50 YAK aircraft were observed during the following May Day celebration while only 40 MiGs were seen. The MiG being the more difficult of the two aircraft to build suggests the MiG and YAK were concurrent programs. Nonetheless, the above landmarks are standard features of more recent Soviet aviation history.[76]

---

[67] Ibid., pp. 347–361, passim.
[68] Ibid., p. 317.
[69] Solzhenitsyn, p. 447.
[70] Tokaev, *Soviet Imperialism*, p. 43.
[71] Gurevich, p. 17.
[72] "First of Many," Flying Review International, p. 237. Also in Gallai.
[73] Ibid.
[74] "Soviet Air Shows," Air Intelligence Digest, Oct. 1949, p. 4, passim, thru 1955, CONF.
[75] Izmaylov (Ed.), p. 630.
[76] Flying Review International, "First of Many," p. 237.

The MiG was the more successful of the two aircraft owing mainly to the greater power available from the two-engine configuration and to its all-metal construction. Its 560-knot speed compared favorably with its contemporaries, the U.S. Shooting Star and the British Vampire. Gallai recounted recently:

> In the air the MiG-9 turned out to be unexpectedly simple to fly—its characteristics were modest and unassuming. One might even go so far as to term them agreeable. I say 'unexpectedly' advisedly, as before the service introduction of jet aircraft, there was a certain fear among [Soviet] fighter pilots that these novelties would be difficult to handle in the air; it was widely believed that jets could be flown only by 'extra special' pilots and then only after protracted training. In the event, reality proved very different—the MiG-9 could be flown by the average fighter pilot. Indeed, it was easier to fly than its contemporary, the YAK-15.[77]

Sometime afterward, Yakovlev was to explain that the YAK-17, a refinement of the YAK-15, intentionally designed as a transition aircraft with the specific purpose of allaying fears of the new technology. "We made up our minds to create an aircraft in which only the engine would be new and everything else possible would remain the same as in a piston aircraft. The flier . . . would find himself in a familiar setting and not feel the difference between jet and piston aircraft."[78]

Despite its lack of performance, the YAK was a notable step forward. It made lesser demands of the airframe industry used to working in mixed wood and metal designs and the single-engine arrangement caused less demand on engine production. As later modified, it would provide training aircraft and early combat aircraft for the Soviets, the Chinese, and the East Europeans.

d. The Unsuccessful Prototypes

A similarity between Sukhoi's SU-9 and the Messerschmidt 262 was to serve him poorly. A number of modifications were incorporated into the German concept, including the retrograde return to tapered as opposed to slightly swept wings, but the SU-9 was doomed by two characteristics. First, it was later than the YAK and MiG; it first flew on 18 August, only two days before its predecessors were committed to production by Stalin. Secondly, by following the basic architecture of the ME262, it appeared to contradict Stalin's December decision. Following Yakovlev's argument, the political mind was probably loath to support a Soviet design which appeared to copy that of the former enemy.

Nevertheless, the basic design was sound. Due to a higher surface (wetted) area, the craft was inherently somewhat slower than the similarly engined MiG and it had a slightly lower ceiling. Nevertheless it had a comparable climb rate and was notably superior to the MiG-9 in endurance and ammunition capacity.[79] Indeed Yakovlev, himself, would resort to similar underwing-pod engine mountings four years later.

The Lavochkin aircraft suffered as did Yakovlev's from lack of power from the single Jumo engine. First flying in September of 1946, it was late for the production decision. Although more advanced in concept than Yakovlev's plane, it was too complex a design for the performance it promised. Various alternate prototypes (the LA-152, 154, and 156) were attempted which compromised somewhat with the YAK concept. Anticipating the more powerful British engines, the LA-152 was rebuilt with 35° swept wings in 1947.[80]

---

[77] Yakovlev, *Target*, p. 365.
[78] Nemecek, "Turbojets and Tribulations," pp. 489–490.
[79] Green, "Last of Lavochkins," p. 220.
[80] Gurevich, pp. 19–42. The design achieved a ceiling of 40,000+ feet.

Although the design (LA-160) was little more than an experimental adaptation, its early testing served to assuage the reluctance with which the Soviets (among other nations) approached swept-wing designs.

e. The MiG-15

The YAK-15 and MiG-9 were obsolete before they flew. In March or April 1946, before the first jet flights, an air force requirement was probably incorporated in the Aviation Ministry Plan brought before Stalin on April 2, 1946. According to an account attributed to Gurevich, the specifications envisioned "aircraft to climb rapidly to a height of ten kilometers [38,000 ft.] and to maneuver quickly at that altitude at a good speed and with a heavy cannon . . . . We were to provide for only one pilot and to stay aloft for one hour. Otherwise we were not restricted in our design besides the usual strength requirements and the need for close attention to metal working."[81]

The requirement was based on a 4,400 pound thrust engine that was to be available within a year.[82] In fact the British granted permission to export ten of the 4,800 pound Nene engines to the Soviets in September of 1946. In all, 55 Nene and Derwent engines were shipped to the U.S.S.R. in 1947.[83] At the time the design started, however, all that was available was the RD-21, a slightly improved version of the BMW-003 rated at about 2,200 lbs. In effect, reliance on British engines facilitated a design based on twice the power then available from native engines.

It has been common to erroneously attribute the MiG-15 to a design by Kurt Tank, who had been chief designer for Focke-Wulf during WWII. Although the fuselage arrangement bears a superficial similarity to Tank's later Pulqui II aircraft, the wing planform is decidedly different. Further, Tank himself went through a straight-wing configuration in 1947 before producing his Argentine swept-wing prototype in 1950.[84] In fact, the Soviets may have understood theoretical aspects of transonic flight some three years before the West.[85] An effort began in 1942 to develop a unified general theory of supersonic wings. Results of the coordinated inquiry were published in 1946 and 1947. Among the contributions was an exploration of the application of conical flow theory to delta wings; it was written by Mikhail J. Gurevich. Therefore, it seems appropriate that one consider the theoretician Gurevich and the production expert Mikoyan perfectly capable of developing an impressive machine. The apparent similarity between the U.S. F-86 Sabre, the MiG-15, and Tank's designs derives from a common reliance on the 1940's technology and from the principles of aerodynamics as given practical meaning by extensive German wind tunnel testing available to all competing post war nations.

The MiG-15 had several faults, most notably its dangerous spin. It was found necessary to send air force test pilots to units converting to the aircraft in order to demonstrate proper spin recovery measures. For a period spinning was banned, pending the investigation of a number of accidents; even afterward, special clearances were required for the maneuver.[86] Early attention was given to a trainer version and use of YAK-17 trainers, but numerous pilots graduated directly to the MiG from conventional aircraft.

---

[81] Ibid., p. 19.
[82] Nemecek, "Turbojets and Tribulations," p. 492.
[83] *Jane's All the World's Aircraft 1956*, 57, pp. 39–40.
[84] "Soviet Aerodynamics Research," *Air Intelligence Digest*, Nov. 1955, pp. 9–11. CONF.
[85] "From Cambodia to Cuba," *Air Enthusiast*, p. 303. Per memoirs of the test pilot Pyotr Stefanovsky.
[86] Opinion of Kilmarx, p. 239. Summaries of pilot opinion appear in Stockwell, pp. 50–54. See chart on comparative characteristics, Section III.

Beside the spin problem, the aircraft was poorly armed. It mounted two 23-mm. and one 37-mm. cannon. The 23-mm. lacked punch and the 37-mm. lacked firing rate. All three lacked sophisticated ranging devices.

That the MiG-15 was a brilliant accomplishment became apparent in Korea. It had put Soviet aviation ahead of European rivals and nearly equal with the United States. It out-climbed, out-maneuvered, out-accelerated, and flew higher than its principal opponent, the North American Sabre. It maintained a speed advantage until the F model of the Sabre appeared late in the Korean War. Its record was marred by poor guns and bad pilots.[87]

The MiG-15 first flew on December 30, 1947, barely three months after the American F-86.[88] The Gurevich account talks of an initial prototype, however, which flew on July 2 and was to have been ready for the Tushino show—a plausible objective.[89] This otherwise undocumented prototype purportedly crashed soon after its first flight. (This portion of the account may be intentionally confused with the first MiG-9 prototype.) Nevertheless, the MiG-15 as we know it flew only some 20 months after the first Soviet jets and confirmation of the requirement. The design was thought to be so successful that a production commitment was made in March 1948—before aircraft tests were half through. This rather drastic step is a measure of the importance attached to the MiG-15 program.

f. MiG-15 Competitors

The same type of hedging pattern observed in the program for the first jet prototype can also be seen, to a lesser degree, in the program which resulted in the MiG-15. Yakovlev continued to upgrade the YAK-15 straight-wing configuration with the Derwent engine as opposed to the Nene engine used in the MiG-15. Lavochkin was also allocated the less-powerful and wider Derwent but would work both swept and straight wings. Eventually, he too would proceed to a Nene-based prototype.[90] Meanwhile Sukhoi re-engined his two-pod SU-9 to produce a multipurpose fighter capability, the SU-11, with Derwent engines.

1]The YAK-23

Yakovlev had improved the basic YAK-15 with a tricycle landing gear, a slightly improved version of the Jumo engine (the RD 10A), and more metal components. The result was the production version of the YAK-17 which appeared in mid-1947. Before the YAK-17 entered production, however, another aerodynamic and all-metal improvement, the YAK-19, appeared. Although the YAK-19 was not produced, a second prototype proved useful as a flying test platform for the Derwent engines and as an experimental predecessor for the YAK-23.

The YAK-23 was the Derwent-powered MiG-15 competitor or, possibly, back-up. The first prototype flew in June of 1947 and conformed to a possible pre-Tushino deadline. Notably, the successful flight nearly coincides with the ill-fated MiG prototype referred to in the Guervich account. Yakovlev's incremental approach again assured that he would be first to fly, but even though a production decision was favorable,

[87] First F-86 prototype first flew October 1, 1947. First production model flew May 20, 1948. Janes All the World's Aircraft 1956-57.
[88] Gurevich, p. 42.
[89] "How Russian Stormed Sonic Barrier," *Aviation Week*, Sept. 12, 1965, p. 22. From the Soviet Journal Ogonyok, and Green, "Last of the Lavochkins," April 1968, pp. 221–222.
[90] "Yakovlev's Lightweight—the Yak-23," *Air Enthusiast*, May 1973, p. 230.

the bolder design of the MiG-15 drew more attention, offered more promise, and was produced in greater number. The YAK-23 was ordered into production with minor modifications in March of 1948 after a complete and successful test program.[91] The MiG was ordered to production about the same time without complete tests.

A common contention is that the YAK was an intentionally tapered wing back-up to the more risky MiG design. It is equally likely that both were in response to the same air force's requirement, with Yakovlev adopting the more conservative approach to ensure meeting an implied, if not specific, Tushino deadline. This strategy had worked successfully in 1939 and 1946. It did not work in 1947. The divergence in designs probably became apparent when a preliminary MiG concept known as the "pre-project" was submitted for Ministry of Aviation and Air Force approval. If this logic holds, it explains when and why a YAK-25 swept-wing design was abandoned and why that number was also assigned to a later and more important aircraft.[92]

In its own right, the YAK-23 was a successful machine in a league with the British Gnat. It was used widely as a transition lightweight fighter for many of the Warsaw Pact forces. Even ten years later, in 1957, it would set world climb-to-altitude records for 3,000 and 6,000 meters.[93]

2) The La-15

While Yakovlev had taken an incremental approach, and MiG a bold one, Lavochkin's efforts scattered. Despite his experience with the swept-wing La-160, his treatment of airframes for the British engines was hedged by an additional retrograde straight wing, but thin-wing, design. Given the more powerful Nene engine, he then committed himself to the swept-wing which he himself had popularized. His timing and the engine allocation were against him. It appears he spent too much time with the advanced swept-wing mated with the German technology engine. The La-160 flew only three months before the MiG-15. By the time his Derwent-powered prototype came out, the MiG had been committed to production. Nevertheless, the resulting La-15 was produced in limited numbers after state acceptance in June of 1948. Because of a lower ceiling than the MiG (incurred as a result of the Derwent-type engine) the aircraft was used as a ground-support, rather than interceptor, aircraft. Subsequently, Lavochkin did receive a Nene engine and the prototype which carried it was credited with being the first Soviet aircraft to break the sound barrier in a dive.[94] While this event of 26 December 1948 is marked in Soviet aviation history, interceptor development was by then focused on the MiG-15 and its successors.

3) The SU-11

In the meantime, Sukhoi had become involved in a multitude of programs which diverted him from the mainstream of interceptor development. Among these were a conventionally powered two-engine reconnaissance plane, and a four-engine light bomber. Both designs were powered by Derwents.[95] As in the MiG-15 case, the bomber with the more powerful Nene engine was produced, in this instance the IL-28. Nonetheless, the Sukhoi Bureau did participate in interceptor development with the British engine, again

[91] Ibid., p. 231.
[92] Ibid., p. 229.
[93] Green, op. cit., May 1968, p. 291.
[94] Nemecek, "Turbojets and Tribulations," pp. 491–492.
[95] "From Cambodia to Cuba," *Air Enthusiast*, p. 203.

the Derwent. Apparently he had not learned from the SU-9 experience and again reverted to the unpopular "German" twin-pod configuration. Although the prototype SU-11 flew before the MiG-15, it lacked the speed and maneuverability of all its rivals.

g. Soviet Engines

The 1946 plan for native designed engines met with fruition at the turn of the decade. In 1950, Vladimir Ya Klimov produced a much improved centrifugal flow engine. Although it was based on his early experience with the Nene, the RD-45 copy and some of its minor improvements, the VK1 was generally larger but also lighter. The result, with water injection, was thrust improved from 5,952 pounds to 6,750. With a 200-pound weight reduction it contributed significantly to the performance of the MiG-15.[96]

Meanwhile, Arkhip Lyulka was testing a design for the AL-5 in the realm of 10,000 pounds of thrust. This engine continued to be associated with unsuccessful prototypes until much later it reached production status with Tu-110. By that time it had been upgraded to 12,000 pounds thrust.[97]

Most of the Soviet jet engine designs concentrated on centrifugal compressors focused on mass of the airflow. This resulted in engines with large frontal areas which were difficult to incorporate into efficient fighter designs. It seemed this basic technology would not support supersonic flight.[98]

For the Soviets, the breakthrough came about 1950 with Mikhulin designs based on axial compressors. The first of these was a low-pressure, single-rotor configuration believed to have powered the prototypes of the Mya-4 and Tu-16 bombers which appeared in 1954. While the engine was large compared with Western standards, the technology promised improvements with multiple rotors, higher pressures, and higher heats. The effect would be higher thrust-to-weight ratios, improved fuel consumption, and, especially important in fighter designs, smaller sizes and weights with a much improved thrust-to-frontal area ratio. Pending the development of such engines the design of suitable all-weather area interceptors was frustrated as the 1948 attempts demonstrate.

h. 1948 Attempts at an All-Weather Capability

Among Sukhoi's ill-fated activities was a 1948 attempt at an all-weather interceptor, the SU-15. It featured a curious staggered fuselage arrangement of the production version of the Nene engine, the RD-45. The SU-15 would have been a heavy machine with a radome to house an Air Intercept scanner mounted over a common opening which served both engines. The aircraft would have featured a good 750-mile radius and transonic speed, but unfortunately it disintegrated in one of its first flights.[99]

Lavochkin in 1948 also attempted to create an all-weather fighter. As with the Sukhoi aircraft, it featured two engines, probably RD-45's, mounted in the fuselage. A radome would have been housed inside a large circular intake which served both engines.[100]

Likewise, Mikoyan and Gurevich participated in the all-weather interceptor design activity. The MiG prototype, the I-320, had similar features and performance as the other two aircraft. Of three aircraft the MiG

[96] "Lyulka," *Air Enthusiast*, p. 299.
[97] Inferred by USAF Intelligence, *Air Intelligence Digest*, "Mikhulin," Nov. 1954, p. 21. (CONF.)
[98] Nemecek, op. cit., p. 499.
[99] Green, "Last of Lavochkins," June 1968, pp. 349–350.
[100] "Plane Facts," *Air Enthusiast*, March 1973, p. 140.

was the first to successfully fly. The SU-15 crashed in 1949, the MiG performed successfully in the winter and the Lavochkin flew in February. But the Mikoyan designers also resorted to another approach.[101]

It is likely that none of the three models were passed after it was found that the rather primitive Izumrud radar could be fitted to the MiG-15. The fuselage mounting of two large centrifugal engines in the fuselage was an ungainly, inefficient and expensive arrangement without compensating advantages in range. Further, the short acquisition range of the Izumrud may have made greater demands on maneuverability than either aircraft seemed to offer, especially when compared with the MiG-15. Nevertheless, the SU-15, the La-200, and the I-320 do indicate the order of Soviet priorities. Attention was first focused on the achievement of a world standard day interceptor. Then, and only then, did the focus shift to an all-weather capability. The requirement appears to have been dropped when it was found to be technologically inconvenient; a simpler expedient was adopted instead.

The failures of the SU-15 with the post war purges did cast a long shadow through Soviet aviation history. Sukhoi's post war record, to those who did not appreciate a number of his technical innovations, appeared to be a series of disasters. Judged by a more objective standard, he was the only major designer who had failed to create a jet prototype suitable for series production.

During the post war period when it seems that every sector of the Soviet society required a ritual "cleansing"[102] Sukhoi's was the obvious target among the design bureaus. Although Sukhoi does not appear to have been imprisoned, his design bureau was disbanded in 1949.[103] The long shadow is this. On the Sukhoi drawing boards was a design, the SU-17, which might have been the first totally supersonic Soviet aircraft.[104]

Such was the success of Sukhoi's 1956-version SU-9 and SU-11 that he is sometimes credited for breaking the sound barrier with the earlier design that never flew. Advanced aircraft concepts such as were seen in 1956 might have been available to the Soviets three or four years earlier had it not been for the purge of the Sukhoi bureau.[105]

i. Improvement of the MiG-15

Such was the perceived success of the MiG-15 that alternative fighter designs stagnated at the turn of the decade. Although the Soviets were aware of its failings quite early—the spin proclivity, for example—it was a thoroughly capable aircraft in well-trained hands. Early attention was given to a two-seat trainer version to ease the earlier mentioned difficulties of conversion training. Moreover, the basic configuration accommodated an improved engine and a rudimentary air intercept radar. During 1950, these modifications appeared in two separate adaptations of the basic aircraft: the MiG-15 bis clear weather fighter which featured the improved native-designed VK-1 engine accompanied by a general trimming of weight and the MiG-15P which added the Izumrud radar to the improved single seat model.[106]

The MiG-15, however, remained a poor transonic airframe aerodynamically.

---

[101] Alternate translation to "purge."
[102] Nemecek, op. cit.
[103] Green, "Sukhoi," p. 353.
[104] Assuming availability of Mikhulin engines – an assumption which would have required a somewhat earlier emphasis on smaller axial-flow configurations.
[105] "From Cambodia to Cuba," *Air Enthusiast*, pp. 304–306.
[106] Ibid., pp. 307–311.

j. The MiG-17

In parallel with the above programs, a general reworking of the design was undertaken to extract full advantage of the improved power plant in speed regions near Mach 1. The result was the MiG-17. While changes in the fuselage were minimal—a lengthening by 41 inches—the MiG-17 featured an entirely new wing and modified tailplane. The new wing was larger, thinner, and more swept with parallel but rounded tips, while the tailplane was also more swept. The result was a transonic design which retained the maneuverability of the MiG-15 for subsonic combat.

The MiG-17 evolved to a limited all-weather variant as did its immediate predecessor. The Izumrud radar was fitted along with two beam-riding missiles.[107] The nose was extended somewhat to accommodate the radar equipment. This MiG-17P was available in 1953, but production was limited. By that time, more effective all-weather aircraft were in development.

k. Stagnation of Development

The period from 1950 until 1955 is marked by a dearth of significant interceptor prototypes except for the 1953 appearance of the MiG-17. Several reasons for this may be apparent:

(1) Production of the MiG-15 which continued until 1954 occupied a great deal of Soviet production capacity. This consumption of capacity had been sparked by the Korean War. The transfer of this capacity to the similarly constructed MiG-17 represented a least disruptive means of modernizing the force.

(2) The attention of the aviation industry may have turned to bomber aircraft which were nearing production.

(3) Two technological constraints seemed to prohibit major advances. The first was the lack of an efficient axial flow engine and the second was the size of Soviet second generation air intercept radars. The extent to which these factors constrained an effective all-weather design was apparent in the 1948 prototypes.

(4) On a more speculative point, it had become apparent that other elements of the air defense system, particularly the control and warning system, required attention before better interceptors could be effectively utilized. Likewise, the Korean War had emphasized the necessity of adequate pilot training. This coincides with the evolution of PVO Strany between 1948 and 1954.[108]

(5) The political leadership was satisfied with the Mikoyan-Gurevich product. As in WWII, production focused on great quantities of a standard design once it was proven. The Korean War and the necessity of equipping the newly formed Warsaw Pact forces emphasized the production commitment. It is also apparent that minor changes in the MiG-15 were adopted in favor of the more disruptive change to the MiG-17. The 20-month development cycle observed in the generation between MiG-9 and MiG-15 indicates that such a rework of a basic design as the MiG-17 could have been available in 1950 or 1951 had it been wanted. Instead, development proceeded at a more leisurely pace.

(6) Of ultimate importance, Stalin did not want new designs; he had become committed to Mikoyan.

l. The Decision to Develop the YAK-25

The first all-weather area interceptor of the Soviets, the YAK-25, did not appear until 1955. Its designer explains the stagnation of the design process and claims credit for the innovation. Since his story is fairly

[107] See Chapter IV above.

[108] Barrage aircraft—one which patrols in the air, defending objectives from air attack (Trans). Roughly translated "area interceptor."

complete, concise and essentially correct in its fit with observable facts, it is quoted in its entirety. Possible controverting evidence from other participants—Stalin, Beria, Mikoyan, and Mikhulin—is not available:

> In 1951 the MiG-15 fighter was in series production and used as armament in the Air Force. It was our Army's basic swept-wing jet fighter, and a fine machine.
>
> At that time we were developing several types of new swept-wing fighters, but all our proposals met with Stalin's objection: "We have the fine MiG-15, and I have no intention of creating new fighters in the immediate future. It would be better to continue improving the MiG. . . . "
>
> I was highly upset by the situation, which was arising in our Design Bureau. Behind me there were several hundred people who might lose faith in me as a design team leader. I also understood that if all our experimental works were limited to modernizing existing series aircraft and not creating new more advanced models, this would inevitably lead to a lag in the shortest possible time. And so, day and night I was tormented with the questions of what stand to take.
>
> I felt that we had to create something new in quality. At that period I got close to the engine designer Alexander Alexandrovich Mikulin. I felt then and I feel to this day that he was our foremost and most perspicacious aircraft engine designer. His AM-3 and AM-5 jet engines were for a long while the power source basic to Soviet aircraft.
>
> In 1950 and 51, he and I had the idea of creating an economical light jet engine. Mikulin had formulated the idea that a jet engine with small dimensions would be more effective from the viewpoint of economy, reliability and other aspects. I supported him in this.
>
> Mikulin began work on a light-weight small-size jet engine with a thrust of 2000 kg. I decided to develop an aircraft for this engine which in addition to good, simple flight qualities would have great endurance and flight range—qualities enjoyed by no other jet fighters of that period, either in the Soviet Union or abroad. It was then felt that jet engines were very uneconomical in terms of fuel consumption and therefore although we might talk of fairly long endurance and range for heavy aircraft such as bombers with large fuel reserves, for jet fighters an increase in range and endurance seemed an insurmountable obstacle. With two of Mikulin's engines subsequently designated the AM-5, we succeeded in designing an aircraft which had double the MiG's flight range and endurance. It would require a crew of two, and would carry heavy armament—two 37-mm. cannons with large supplies of ammunition.
>
> For its time, this was an innovative aircraft in the fullest sense of the word. With my idea for this aircraft, I decided to skip the usual steps of going through the Ministry and Air Force, and wrote directly to Stalin. I had no other recourse: I was afraid that my proposal might get bogged down in going through normal channels.
>
> Three or four days after I sent my letter, Aviation Industry Minister M. V. Khrunichev called me. Mikhail Vasik'yevich well understood the difficult, complicated situation and attempted to ease my position, but could not do much.
>
> I went to him at his office. He was alone. He stood up from behind his desk with a kind smile.
>
> "Stalin just called. He got your letter and has read it. He said that your proposal is quite interesting. He is surprised that you can promise a fighter with such range and endurance. He also asked whether it would be possible to use your aircraft as an all-weather barrage[109] interceptor and supports your proposal. He said that you should keep working on your idea, and he'll contact you in a few days."
>
> And in two days Stalin did call in Khrunichev, Artem Mikoyan and me.
>
> In Stalin's office we found Bulganin, Beria and Malenkov. Stalin took my letter from the table and read it aloud.
>
> "Well?" he asked. "Does this mean we can make a fighter with this jet engine that will have great flight range and duration? That's very important. At what expense will you achieve it?"
>
> I explained that the idea might be achieved only if we were able to work together with Mikulin, whose engine would, in combination with several structural features of the aircraft, be a success. Stalin was completely in favor of the idea in principle, but said that we would have to be able to put out such an aircraft in a barrage fighter-interceptor version.

[109] Sukhoi was a nonperson at the time of the conversation. This is a possible explanation of omission of Su-15.

"We need this kind of interceptor, which could stay in the air a long while and search out the enemy not only during the day, but at night as well, and in bad weather. We ordered Mikoyan and Lavochkin to develop such a fighter, but something didn't work out, and their flight endurance is less than you propose."

Not long before this, heavy fighter-interceptors had in fact been developed and tested under the designation La-200 and I-320.[110] I do not know precisely or, more accurately, I don't remember the reasons why both these fighters failed their test flights. However, it's not a questions of what the reasons were—what was important was that the country was lacking a much-needed all-weather night fighter-interceptor.

I replied that Mikhail Vasil'yevich had already given me authorization and that we were working in this direction and would probably encounter no difficulties. It should especially be remembered that the engines in my aircraft were located under the wings and in this way the nose of the fuselage allowed a great deal of area for installing a powerful radar unit which had previously been created by our designers working in radar.

At this point Stalin raised the point of whether this aircraft would be capable of use as a high-speed observation aircraft. I found no objection to this.

Satisfied in principle with these questions, in conclusions Stalin said that he had received an offer from Artem Mikoyan as well, who wanted to use Mikulin's same engines in creating a long-range fighter model based on the MiG-17 series aircraft.

"Well, we'll have both an interceptor and a high-speed observation plan. Yakovlev will make this one, and Mikoyan will give us our long-range fighter," concluded Stalin.[111]

As is the procedure in the Soviet Aviation R&D, Yakovlev returned for formal approval of the "pre-project,"[112] a more or less formal proposal submitted for technical evaluation of the design concept. The pre-project is used to establish the priority for a project and for assigning its place in the overall Soviet system of industrial planning; it differentiates required designs from the ongoing development work of the Design Bureau. It is at this stage that the politics of Yakovlev's design activities were laid bare:

On July 30th [1951] and in the same company we again gathered with Stalin to examine and evaluate placing Mikulin's AM-5 engine in both the YAK-25 two-seat all-weather barrage jet night interceptor with its YAK-25R modification serving as an observation aircraft as well as the fighter which was serving as the basis for the well-known MiG-25 [*sic* MiG-19].

The project was sent to Stalin in short time. He was already familiar with it and, with almost no notes, he indicated that he had no objection.

At this point Beria opened his briefcase and withdrew some sort of document.

"Comrade Stalin," he said, "here is another proposal by the designer Lavochkin."

"What proposal?" asked Stalin irritatedly. "I don't know anything about any proposal by Lavochkin."

To this Beria replied in an intentionally indifferent tone, attempting to emphasize his objectivity:

"He sent it in a long time ago . . . Some sort of unusual interceptor. And it's equipped for night and blind flying. Everything's here on three pages . . . ." And he started to read: "Radar, radio, radio compass, instrument landing system, etc., etc . . . ." The whole list. "He proposes building it on the basis of the La-200."

All the instruments which Beria had listed are basic requirements on any interceptor, including the one I had proposed. But Beria had to play out this entire scene and give Stalin the impression of a long list of equipment only to destroy my proposal and reverse the decision which had been taken—in a word, to stab me.

Stalin blazed up.

"Why didn't you report this to me?" he asked Khrunichev.

Khrunichev at first started to lose his temper, but then he replied that the La-200 had already been rejected once as a complete failure and therefore there could be no basis for using it as the source of a new aircraft. Besides, the entire list of equipment was also on the YAK-25.

[110] Yakovlev, *Target*, pp. 394–396.
[111] Alexander, *R&D*, pp. 17–18.
[112] Yakovlev, op. cit., pp. 396–399.

Stalin wanted to hear none of this, but simply repeated, becoming more heated:

"Why didn't you report it? Why didn't you report it?"

Finally, Mikhail Vasil'yevich succeeded in clarifying that Lavochkin's proposal had been examined in the Ministry and that it had received no approval basically because Lavochkin had planned on using his own unsuccessful fighter, which had already been rejected. Subsequently Lavochkin succeeded in gaining permission to pursue this work, but his aircraft never did materialize.

I was terribly frightened both for my own concern and for Mikhail Vasil'yevich. In those days nothing was worse than being looked upon as a fraud in Stalin's eyes. Meanwhile he, without quieting down, continued demanding of Khrunichev:

"Why didn't you report it?"

It would seem that Khrunichev had purposely concealed Lavochkin's proposal. Finally Stalin understood what the situation was and said:

"We will not go back on the decision we've already made, but we'll look at Lavochkin's proposal separately."

The proposal was accepted, but in signing it Stalin suddenly turned to me:

"And why is this written here at the end: 'Upon construction of the aircraft, to allow you overtime and piecework pay and set aside money as a prize?' Why should you have such an advantage? You know what they're saying behind your back? They tell me your self-seeking."

"They have misinformed you," I replied.

"What do you mean, misinformed?" Stalin again flew into a rage.

"Well, prize money and overtime and piece-work money are at the disposal of all the designers: Tupolev, Ilyushin, Lavochkin and Mikoyan. This is no exception to the rule. On the contrary, the exception to the rule is that our design team has for the last two years not had this privilege, while all the others have had it and continue to."

"And how is this so?" Stalin asked, surprised.

Khrunichev verified that this was in fact so. Then Stalin, still irritated, came back to me:

"I want you to know what they're saying behind your back."

"Thank you for telling me. What complaints have there been against me?"

"They tell me that you have been using your position as Assistant Minister to build yourself the largest factory."

"That's slander. I have the smallest factory."

Stalin turned to Khrunichev:

"Is this so?"

Khrunichev pulled from his pocket a notebook which he always kept on him and in which was written all necessary information concerning the production areas of the different factories, the amount of equipment, the number of workers, etc., and said:

"That's true Comrade Stalin, Yakovlev has the smallest factory."

"They say that you've grabbed a lot of machine-tools."

"That's also untrue. I have fewer machine-tools than any other designer," I replied.

Again Khrunichev verified that I was telling the truth. Mikhail Vasil'yevich quoted the number of machine-tools in our Design Bureau and, for comparison gave the number in Tupolev, Mikoyan, Ilyushin and others' experimental Design Bureaus.

"They say you've gotten hold of laboratory equipment like no one else has."

"That, too, is untrue. I have nothing the others don't have."

And again Khrunichev proved the veracity of my words.

"How can this be so?" said Stalin, gradually calming down. "I had completely opposite information. Strange. . . . "

"It's unobjective and made-up information to weaken faith in me. Incidentally, I anticipated the possibility of such accusations and so doing my eight years of work, first at the Narkomat, then in the Ministry, I have done nothing which might subsequently justify even one of the reproaches which you have been throwing at me."

"And you haven't received any prizes in recent years?"

"That's precisely right, I haven't."

"I don't understand a thing," Stalin voiced his amazement and, to the amazement of those present, turned to Khrunichev and Bulgarin and said:

"Well, if this is so, we have to create conditions for him no worse than for the others. He's done a great deal for our aviation and will do more."[113]

From the 1955 May Day fly-by, U.S. observers reported two new types of fighters. One appeared to be a twin-jet clear-weather fighter capable of supersonic speeds—the MiG-19. The other was identified as a Yakovlev designed all-weather interceptor. Both were displayed in sufficient numbers to indicate they had been committed to serial production.

The YAK-25 featured two engines carried in underwing pods in a configuration similar to that of Sukhoi's early SU-9 and 11 and of the Me-262 which Yakovlev himself had much maligned. Further, the wing bore a striking resemblance to that which appeared on the 1950 Pulqui II design by Kurt Tank. The fuselage featured a large radome which housed a radar much improved over the Izumrud. The remainder of the fuselage allowed sufficient fuel for a much extended range.

Lavochkin did produce the prototype mentioned in the Yakovlev account. The La-200B features a nose radome of similar dimensions to that on the YAK-25. However, he retained the VK-1 centrifugal-flow engines which were fed by intakes on both sides of the radome for the forward engine and a larger lower scoop for the rear engine. Somehow the nosewheel was housed among the lower ducting. Range was extended by two large underwing fuel tanks and two crew members sat abreast. Not surprisingly, the YAK-25 was chosen with the more efficient engine, serviceable installations and stable wheel positioning, not to mention greater speed, range, and altitude. If for no other reason, the La-200B deserved to die from sheer ugliness.

The YAK-25 was committed to series production and eventually some 580 were produced.[114] Meanwhile, Pavel Sukhoi had been reestablished following the death of Stalin in 1953. Already in progress was an aircraft which would fill out the PVO all-weather force.

4. Observations Based on the Evolution of Interceptor Designs

a. Introduction

The foregoing material provides a basis for some generalizations about the nature of Soviet force-posture decisions particularly as they relate to the aviation element of early post war air defenses. Although the generalizations are inherent within the foregoing material, supplemental evidence will be drawn upon to round them out.

[113] See production data, Section III.
[114] Izmaylov (Ed.), p. 631.

b. Perception of Strategic Defense

From the outset, it is essential to disregard the contemporary U.S.-conceived dichotomy between strategic and theater defense. It seems clear that the Soviet aviation establishment in the early post war period conceived of fighters and bombers. Fighters were further broken down into interceptors and ground attack. Among interceptors there was a separate category of "barrage" or area defense aircraft. Otherwise, an interceptor was an interceptor whether it was assigned to PVO Strany or to the forward area. As is conveyed in the strategy chapter, PVO Strany and the integrating concept of air defense operations evolved some 15 years and a world war after the patterns of weapons creation were established. A dichotomy between frontal and defense aircraft evolved as PVO Strany evolved, but that was well after the program of post war aviation modernization was well under way.

c. The Role of Planning

It is clear that there was a plan, such as Yakovlev documents, which governed the development of jet aircraft. Such a plan would have coincided with the decision cycle of the Fourth Five-Year Plan. Despite what may seem to Westerners to be virtual obeisance to "the Communist Party's and Soviet Government's concern and attention for aviation,"[115] a high priority was set for aviation development and a political consensus supported it. Throughout the period of the Fourth Five-Year Plan (1946–1950), either three or four programs were instituted to compete against each interceptor requirement. In addition, a multitude of prototypes continued to be developed in the course of ongoing design bureau activities—these aside from the formalized requirements cycle. It is no coincidence that Stalin's attitude changed to "no intention of creating new fighters in the immediate future" at the same time as the Fifth Five-Year Plan.

It is clear also that this type of long-range plan evolved in the industrial and design establishment. Military participation was negligible except within the Central Committee. Military participation came in the formal requirements cycle which gave priority to certain specific types of aircraft already being developed. In the case of the MiG-19, La-200B, and YAK-25, it is evident that the requirements were formalized between Stalin and the designers, with pernicious participation by Beria and separate perfunctory staffing by the air force.

d. The Role of Institutions

The perception of two categories of aircraft, bombers and fighters, was reinforced by the structure of the Ministry of Aviation. Of ten bureaus, three design-oriented bureaus were devoted to fighters, bombers, and engines. Thus, categories of aviation were conceived in this manner. This division parallels the 1930's institutionalization of bomber design activities in the Zhukovski Academy under Tupolev and of fighter design activities in TsAGI under Polikarpov. Major Designers schooled under either of these two men basically remained working in either one category or the other. Sukhoi was the exception of a Tupolev protégé who worked in fighters. But the exception supports the rule somewhat. His aircraft tended to be heavy fighters more appropriate to ground attack and he mixed fighter and light bomber design activities with a lack of success. Only in the late 1950's did his heavy aircraft come into vogue.

e. The Flow of Information

Although the pre-war centralization of basic research in the TsAGI infers a common downward flow of basic aerodynamic findings, it is clear that the sharing of information did not work very well. Somehow,

[115] Tokaev indicates that it was the Mikoyans' influence that saved him from expulsion from the party in 1937. *Comrade X*, p. 72.

during the development of the MiG-15, Mikoyan and Gurevich knew much more about swept wings than did Lavochkin. One suspects that the MiG bureau had better access to wind tunnels and to German test results. (Alternately, the MiG team might have acquired its own test facilities.) Likewise, Lavochkin appears to have been ill-informed about the capabilities of the Derwent engines he was to work with. Although a partial explanation of the MiG-15 success can be attributed to the theoretical talents of Gurevich, better information also seemed to support the MiG collective's single-minded pursuit of a bold design. The system includes competition for information.

f. Allocation of Engines

One is struck by the manner in which engine allocations prejudiced the success of a particular prototype. The double JuMO configuration had an obvious power advantage over a single-engine BMW-powered design. Likewise the Nene engine's greater thrust and smaller frontal area offered advantages of a similar magnitude over the Derwent engine. Both allocations favored Mikoyan and Gurevich.

g. Intelligence, Risk, and Luck

A great deal was at stake for the Soviets to base their long-range planning for aviation on the assumption that British engines could be obtained. To be sure, back-up programs were under way, but the weight of development effort appears to have been committed to third-generation engines while lengthy negotiations were ongoing. This is risky policy behavior, but the payoff was enormous. In light of the outcome, it was quite a reasonable risk based on good intelligence about British commercial procedures and about British Labor Government politics.

h. Rewards and Incentives

As the Yakovlev account reveals, there was a competition among design bureaus for personnel, equipment, and facilities. There was also a system of materialistic rewards in the form of overtime pay, bonuses, and state prizes which operated in the aviation industry. All of these things flowed from "successful" designs. Successful designs were those which were committed to serial production. There was also a system of negative rewards. It can be represented by Hangar Seven of the internal prison which operated during the 1930's. In the post war years it was represented by the fate of the Sukhoi bureau.

i. Conflict of Objectives

Between the Stalinist criteria which prevailed until 1950 ("the winner will be the one who gives us the best fighter . . . and also deliver first") is a very real conflict. One with a mathematical bent will point out that either delivery time or performance can be optimized. Yakovlev made his reputation by delivering first; Mikoyan made his by delivering best. In the post war period, Mikoyan and Gurevich played the better mixed strategy between these two objectives. Lavochkin also played a mixed strategy, but his timing appears to have been out of cycle.

j. Personal Politics

Soviet wartime and post war fighter aviation was dominated by two men: Alexander Yakovlev and Artem Mikoyan. These two represented the foremost among a very small group of heroes, the Design Bureau Chiefs, after whom aircraft were named. These men were literally "Heroes of Socialist Labor." Among this

group was a collegial relationship supported by a similar education, the same mentors, common work experience, and intramural competition. These men shared a common ethic with the Aviation Engineering Service of the air forces.

One of these men—Yakovlev then Mikoyan—was Stalin's personal advisor on aviation. Their influence extended beyond fighter aviation matters. Yakovlev held a favored position because of his two-hat assignment as Deputy Commissar (later Minister) of Aviation. Mikoyan held a favored position because he was the brother of Anastas Mikoyan, an even closer associate of Stalin generally in charge of the consumer goods area in the post war period. An active area of Anastas' interest was foreign trade; he had been charged with responsibility for foreign aid during the war, and he was later to be foreign policy advisor to Khrushchev.

The Mikoyan relationship worked in at least two ways during post war aviation development. First it clarified the opportunities inherent in British technology to both the design and trade portions of the government. Second it allowed Artem Mikoyan a separate channel to the Politbureau—one that he used for political relief on behalf of others in the aviation establishment as early as 1937.[116] Stalin's preference among designers changed in 1946 after the success of the MiG-9, when Yakovlev resigned his position as Deputy Minister. Thus Mikoyan was in a favored position in the competition for information and resources from the time of the first jet prototypes on. In addition, he used his favored position well. His were the best of the post war designs. Thus, securing himself in this favored position, his design objectives, which emphasized speed and altitude, predominated over alternate design approaches which might have favored range or improved supporting systems. Personal politics helps explain why the MiG-15 was a success and how Stalin came to be committed to improvement of the MiG as the route of aviation development.

k. Design Objectives Versus Requirements

A recent Soviet text for industrial engineers in the aviation industry states the following: "The basic task of the technical preparation of production is the creation of designs . . . whose quality is *not worse than the best world models*, and the period of their development and introduction into series production is minimum" (emphasis added).[117] Yakovlev's personal motto was "Be Ahead."[118] Mikoyan's Bureau slogan is said to be, "Speed and Altitude."[119] Stalin, at the 1947 Tushino Show enjoined the aviation industry to create aircraft which would "fly higher, faster, and farther" than any in the world.[120] This slogan harks back to a speech to the Eighteenth Party Congress (1939) which stated: "We will henceforth fight to increase quantity, improve quality and decrease the cost of our aircraft so that our pilots can fly higher, farther, and faster than anyone in the world."[121] An even earlier precedent is a July 1929 Party Central Committee Decree which includes: "We consider the greatest challenge in building the Red Air Force to be the improvement of its quality as fast as possible to the level of the foremost bourgeois countries . . . "[122] While the list of these slogans can be extended, it is evident that throughout postwar interceptor decisions they represent a set of lenses through which the Soviet aviation industry sees the world and which "color" their perceptions. It is the contention that these perceptions profoundly influenced the menu of weapons from which Soviet plan-

[116] Tikhomirov and Paramonov, p. 152.
[117] Yakovlev, *Target*, p. 357.
[118] Green, "Mikoyan Quarter-century," p. 156.
[119] "Soviet Air Shows," *Air Intelligence Digest*, Oct. 1949, p. 5.
[120] Yakovlev, *Target*, p. 153.
[121] Ibid., p. 147.
[122] AID, "Soviet Bloc AAA: An Interim Solution," April 1957, p. 34.

ners built their post war strategic defensive force. Such a contention goes a long way toward explaining that Soviet interceptor aircraft were *not* designed against the early U.S. bomber threat. Instead, they were designed in technological competition with foreign interceptors.

On the other hand, the 1948 attempt at an all-weather prototype confirms that there was a perceived need among the air forces for an all-weather interceptor and that it had matured to the point of a "requirement." That the requirement resulted in a less-than-satisfactory weapon is evident. An interim solution was arranged, the MiG-15P, and the design process continued without regard to the night and all-weather threat. A more appropriate weapon awaited an engine design breakthrough and Yakovlev's initiative. The 1948 requirement also coincides with the emergence of PVO Strany as an independent force. It is inferred that this type of two-engine, long-range aircraft is what the PVO wanted. Instead, it got the short-range MiG-15P. Either aircraft would have been equipped with a short-range radar. Thus, planning attention in aviation was directed to the engine and the airframe; other element of a weapons system were added on—if it was technically convenient.

C. Antiaircraft Artillery and Surface-to-Air Missiles

1. World War II Experience

During World War II, antiaircraft artillery was the basic element of the static air defense of the important centers of the country. Other related ground-operated systems included antiaircraft machine guns, barrage balloons, and antiaircraft searchlights. The primary systems used by the Soviets were the 25-mm., 37-mm., 76-mm., and 85-mm. antiaircraft guns. These guns were further supplemented by 90-mm. and a few 120-mm. U.S. guns which were supplied under Lend Lease and by captured German 85-mm., 105-mm., and 128-mm. guns.[123] According to Marshal Batitskiy, the medium caliber guns were completely replaced with 85-mm. guns during the war.[124]

In the tactics of antiaircraft artillery general principles were worked out for the construction of a powerful, deep-echelon antiaircraft defense for large objectives with the use of systems of weapons of various calibers, and on the basis of the control of rather large groupings of antiaircraft forces. So that antiaircraft defense would be flexible, and equipped to respond quickly to any changes in the nature of the air enemy's actions, mobile groups were established which included small units of antiaircraft artillery, antiaircraft machine guns, and searchlights. These groups were used for battle with aircraft on their flight routes (operating from ambush), for temporary cover of small individually important objectives, and for strengthening the defense on the exposed operational axes of enemy aircraft. Extensive use was made of armored antiaircraft trains which were assigned the missions of protecting railway communications and objectives primarily in the pre-frontal sector.[125]

The scale of Soviet use of antiaircraft artillery grew steadily throughout the war. For example, the Soviets in 1941 had some 1000 antiaircraft guns defending Moscow. By 1945 the number had risen to over 2,000.[126]

Lessons learned from World War II included the need to increase the range and effectiveness of the guns, to improve the lethality of the antiaircraft shells, and to provide better fire control. In addition, it was

[123] Batitskiy, *Voyennaya Mysl'*, p. 35.
[124] Ibid., p. 36.
[125] Batitskiy, *Voyska Protivovozdushnoy Oborony Strany*, pp. 101–102.
[126] Ibid., p. 327.

also necessary to improve their tactical employment, mainly through the achievement of better concentration of fire.[127]

2. Post-War Development (1945–1955)

During the period from 1947 to 1954, the Soviets introduced three new antiaircraft artillery guns of larger caliber (57-, 100-, and 130-mm.). Gun-laying radars were included in the composition of antiaircraft artillery batteries.[128] In order to improve the concentration of fire, the batteries were equipped with eight guns rather than four as before, and the individual guns were positioned more closely together. In order to increase the defensive depth, antiaircraft batteries were deployed along concentric perimeters around the areas being defended.[129]

Thus, throughout the first decade after the war, the Soviets continued to improve the technical characteristics and tactical concepts of their antiaircraft artillery. At the same time, the Soviets were also working on a new weapons system, the surface-to-air missile, which would take over and greatly expand on most of the role of antiaircraft artillery.

By the end of the war, the Soviets had captured a considerable number of German missile scientists. One group which had been working on surface-to-air missiles was put to work at Scientific Research Institute 88. Under projects R-113, these scientists were directed to design a surface-to-air missile utilizing the design principles of the German World War II Wasserfall missile as a point of departure. The missile was to be effective from 16,000 to 98,000 feet and was to carry a 500 Kilogram warhead. The German scientists worked by themselves in isolation from any Soviet counterparts. They apparently were being tasked to develop specific missile system components, although the project encompassed the total missile system. The work was conducted from 1947 to 1951. Four units were delivered for testing; the first in 1948, the last in 1950. In 1951, the group was disbanded.[130]

In 1951, construction was begun on a network of surface-to-air missile launch sites and associated radar installations surrounding Moscow. This was the SA-1, a missile with an effective maximum altitude of 60,000 feet and an effective minimum altitude of 3,500 feet. The first sites became operational in 1954 with deployment continuing into the next period (post 1955).

Deployment of the SA-1 was limited to the area around Moscow. It apparently was designed to counter the perceived threat of mass bomber formations flying at what was then considered to be a high altitude (i.e., up to about 50,000 feet). The SA-1 lacked mobility, a 360 degree radar capability for each site, and autonomous control for each site. These factors probably led to the decision not to deploy the SA-1 more extensively and to begin the development of the SA-2, a mobile system, probably in the 1950–1952 period.

3. An Evaluation

Antiaircraft artillery, as the Soviets deployed it and continued to modernize it, was a large and costly system. Still, the decision was made to expend the resources on a system which would soon be largely

---

[127] Batitskiy, *Voyennaya Mysl'*, p. 37.
[128] Yakimanskiy, p. 70.
[129] CIA SI 17-56, 1 December 1956, "Contribution of German Scientists at Branch 1 of Scientific Research Institute (NII) 88 to the Soviet Guided Missile Program," pp. 5–6, (S).
[130] Research and Development Associates, "Comparison of U.S. and U.S.S.R. Land-Based Battlefield Air Defense Systems."

replaced. The 130-mm. antiaircraft gun actually began deployment after the first SA-1's had become operational. Concern for defense was such that even new guns were about to become obsolescent within about three years after their deployment. The rationality of the final antiaircraft artillery deployments was even more questionable in light of the problem of defending a target area against the mass destruction capabilities of nuclear bombs.

As the first decade ended, the SA-1 was setting the pattern for the future in which surface-to-air missiles would largely replace antiaircraft artillery and would also assume ascendancy over fighter aviation as the premier arm of the national air defense system.

The story of Soviet air defense missiles and also of antiballistic missiles belongs essentially to the period after 1955. The early developments will therefore be retraced as the post-1955 period is analyzed.

D. History of Early Warning Systems

1. Pre-1945 Developments

The Soviet early warning systems prior to and during World War II were heavily dependent on visual and sonic methods. Radar, although somewhat developed, was not deployed and was used only to a very limited extent. In 1941, the Soviets had, in its completed state, their first known radar. The development for this radar took place at the University of Kharkov and later relocated to the Red Army Signal Labs at Hytischi. At this time, another Soviet group, the Leningrad Development Group, was working on a C-W Doppler operating at about 50 MHz.

The later years of World War II found the Soviets in the position to receive samples and/or significant information concerning nearly all of the major operational radars in the United States and United Kingdom. The sets of primary significance were the U.S. SCR-584 fire control radar, which in turn became the Soviet Son-2; the British searchlight control radar "Elsie"; and the U.S. types SCR-545, 527/627, 582/682, 602.[131] The control or knowledge of these radars proved to be the means for the late wartime and post war Soviet radars.

2. Assessment of Post-War Requirements

The Soviets, as a result of World War II, were well aware of the limitations of their offensive and defensive systems. This, combined with the known offensive potential of the West, dictated that the Soviets attach a high priority to air defense. The Soviets decided that their wartime approach to early warning was clearly inadequate.[132] Indeed, it was necessary to greatly expand the use of radar equipment of various kinds. A particular concern, during World War II, was how to combat massed enemy flights at night under the conditions of the use of radio and radar interference.

In their post war analysis, the Soviets noted that the need for early warning was a lesson which should have been learned from observing the German offenses against Poland, Norway, and France. But it was a lesson which they did not heed sufficiently. This was evidenced by the German surprise air attack on June 22, 1941, in which the Soviets lost some 1,200 aircraft while simultaneously sustaining many losses to all other border air defense forces. In relation to the defense of so vast an area (U.S.S.R.), the efforts of

[131] Ibid.
[132] Batitskiy, *Voyska* . . . , p. 333.

interceptors must obviously be closely coordinated with a highly efficient early warning system. Russia saw this flaw in her defenses and made strenuous efforts to improve the situation. From the evidence which has so far come to light, it is apparent that Soviet planners sought to cover the whole of the U.S.S.R. by a comprehensive air warning organization.

3. Developments After 1945

Throughout the 1945–1955 period, the early warning systems of sonic and visual sighting remained extremely important. This system continued to maintain an active role in the detection, tracking, and primarily the identification of aircraft due to the system's invulnerability to electronic jamming and direct air attack. The short-range limitations of this system were not important enough to phase it out; therefore it continued to serve not only as a secondary means of warning and a supplement to radar systems but also as a gap filler.

Organizationally, in order to establish control, the country was subdivided into regions with each region administratively subordinate to the PVO Headquarters in Moscow. Direct communication links were established between each region and Moscow headquarters.

The responsibility for air defense of each region was placed on the Military Commander of each area.[133] The Military Commander had at his disposal tactical air forces, aircraft artillery, and an air warning system. (Satellite countries are set up on a similar basis even though it appears cruder and less effective.) From 1950 to 1952, there appears to have been considerable expansion and reorganization of the air warning system in both the PVO and the Field Armies. One important change was the increasing use of radar. In conjunction with this, Air Defense Centers were set up at Air Army, Air Corps, and Air Division levels and these ensured a much greater degree of coordination of existing facilities.

Technologically, progress after 1945 was deeply dependent on Western knowledge, acquired by three means: first by lend-lease; second by capture; and third through post war German scientific assistance. One of the most significant events, as far as U.S. knowledge is concerned, was the publication of the MIT Radiation Laboratory series of books, which in effect became the Soviet developmental "Bible" for some time to come. Western knowledge provided the core of Soviet Air Defense prior to 1951.

With respect to lend-lease, the growth of mutual distrust between the U.S. and U.S.S.R. prompted the end of the Lend-Lease Policy to the Soviet Union and others in 1945. However, by this time, the Soviets had enough knowledge to manufacture copies of Western radars, through the assistance of German scientists and engineers. Certain foreign radars were adapted to Soviet requirements and placed into production.

During 1945–1946 and later, we find that Germans were apparently being forcibly evacuated and taken from East Germany. As far as this forced work on radar systems was concerned, these Germans were primarily put to[134] work in the Scientific Research Institute 160, about 22 miles from Moscow. This was primed for the exploitation of German scientists who were prominent in the electron-tube field. Before 1950, the German group had completed the development of X-band and S-band tubes for radar jamming purposes. The department was evidently still engaged in development of jamming the KU-band, which is the region in which practically all U.S. airborne and U.S. ground radar operated. This and other works indicates that the Soviets knew what they needed for effective electronic countermeasures.

[133] SRI, "An Analysis of the U.S.-Soviet Strategic Interaction Process."
[134] "Soviet Electronic Countermeasures," *Air Intelligence Digest*

By 1950, the extension and development of air warning network had been most marked. By then they afforded continuous coverage in fair depth and density for the entire country with the exception of the least vulnerable portions of the national frontier. However, it was obvious that these systems were not confined to the Soviet Union. The zone extended to Eastern Europe, to Poland and likewise to other satellite countries.

The air warning networks had the following characteristics:

(1) Their performance was still unimpressive by Western standards
(2) Restricted range necessitated their use in great numbers to give continuous coverage
(3) Russia's great size permitted radar positioning far in advance of the area to be defended
(4) The system was simply built and easily maintained
(5) Most of the equipment was mobile and extremely easy to conceal (nc high concrete towers; thus recognition was difficult from the ground and almost impossible from the air).

There were three primary sets in use by 1950: RUS-2, Pegmatit, and Dumbo. RUS-2 was a highly mobile ground radar developed early in the World War II period. The complete equipment consisted of two trucks or one truck and a trailer. One vehicle contained the radar equipment and its operators, the other housed the generators. In addition to its high degree of mobility and aptness for concealment, the RUS-2 was a very simple form of radar and already obsolete by Anglo-American standards during the 1945–1950 period. The primary disadvantages of the RUS-2 were its inaccuracy in measurement of range and bearing, its lack of height-finding capability, and its poor range against low-flying aircraft.

The Pegmatit was the first relatively static radar installation; although a trained team should be able to dismantle and reerect it on another site in a matter of days.[135] The radar was generally placed inside of a building or house with an aerial array protruding through the roof or nearby ground.

Dumbo was the third major radar system at this time. The Dumbo radar was first reported in 1946 and represented an improvement over the RUS-2 (1943) in range and accuracy. Although not mobile the set was easily transportable. This set was also easily concealable and was often erected in wooded areas with only aerials clear of the tree tops. Dumbo proved to be the primary post–World War II early warning radar. However, this system was quickly followed by a family of radars characterized by metric frequency, the use of Yagi antenna, goniometric techniques and nearly identical transmitters.

By late 1951 Token, the next radar system to develop, stood out as the beginning of a generation of Soviet-built radars. This generation consisted of two subgroups, V-beam radars, and multisearch radars. By mid 1952, at least 50 V-beam radars, were spread across the U.S.S.R. and surrounding satellites from East Germany to Vladivostok.[136] This radar was obviously inspired by the U.S. AN/CPS-6 V-beam set. Although not provided for or available under the lend-lease program, it was contained in the MIT series. This set was constructed with IAGC and FIC circuitry: basic ECCM features which produced a limited capability against long pulse jamming and jamming with low modulation frequencies.

During the post-1950 period, Scan Odd was developed with German technical assistance. This was the first Soviet AI radar with limited all-weather capability. This set became field operational and was deployed in 1954.[137]

---

[135] "The Use of Radar in Soviet Antiaircraft Defense," Air Ministry Secret Intel. Summary.
[136] Background Intelligence Data for Posture Statement on Strategic Initiatives.
[137] Ibid.

Knife Rest A and GAGE, a Soviet designed EW and surveillance radar mounted on a bunkered building, made their appearance in 1952. The oldest radar in the Soviet inventory with the strict purpose of early warning, Knife Rest A had limited accuracy and detection capabilities, but was inexpensive and easily maintained. Knife Rest A has been found to operate in the 70–80 MHz frequency range. Gage proved to be the first really permanent radar of any significance that was employed by the Soviets as a search finder.

In 1953, a height finder was produced by the Soviets. This radar (Patty Cake) did not follow the usual Soviet development pattern—because it was uniquely Soviet in design—not a copy of Western technology. This, as stated, was contrary to the pattern followed in the V-beam early warning radar (Token) and fire-control radar (Whiff) which were directly derived from Western radar technology. Patty Cake remained the sole Soviet operational height finder from 1953 to 1956. Although the Soviet Union and the Soviet satellites were still using U.S.-made and British-made radars, in addition to the Soviet-made copies of U.S. and British radars.

In 1954, the number of Token radars increased markedly. Soviet technicians were clearly more successful at maintaining them at an operational level than the U.S. had initially anticipated. The difficulties that the United States had expected the Soviets to encounter were based on U.S. experiences with the AN/CPS-6, a similar radar. It was found, however, that the basic design of the Token radar was considerably simpler.

Observations during the 1954 time period showed that the Soviets were developing a radar system that made concurrent use of two sets as a single unit. The most commonly used sets were GAGE (search finder) and Patty Cake (height finder). The advantages of this system, in relation to Token, proved to be:

(1) Less complicated installation
(2) Simpler maintenance and operation
(3) Increased range and height finding capabilities.

The Soviets took this one step further by building radar installations with four radars. These radars were situated in pairs with Gage and Patty Cake comprising each pair. This appeared to represent a movement away from the mobile V-beam, Token, to a static system of radar defense.

By 1955, the Scan Can radar system was developed for use on missile armament. It is believed that this system was developed from Scan Odd. The nodding height finder was also introduced in 1955, apparently to provide reasonably accurate altitude readings on modern manned aircraft.

4. Summary

At the end of World War II, the Soviets found themselves in an outdated position regarding offensive and defensive war systems. They chose to place high priority on development of their defensive system. Development of radar systems was obtained through lend-lease, capture of wartime radars, German scientific assistance, and Soviet developments.

Throughout the 1945–1955 period, the Soviets primarily worked to reduce surprise, increase coordination, and increase the capabilities of their early warning system. The introduction of jet aircraft and tactical bombers increased the necessity for early warning and low altitude capabilities. By the end of 1955, radar systems were deployed and in the development stage to counter these problems.

Although advance raid warning was now primarily dependent on radar, visual reporting was still highly organized in 1955 with 750 visual reporting posts in active operation.[138]

E. History of Civil Defense in the Soviet Union, 1945–1955

1. Introduction

Civil defense in the Soviet Union played a key role in defense measures after the 1920's, but the destruction suffered during World War II and the advent of weapons of mass destruction prompted a new emphasis on Civil Defense shortly after the war.

Reconstruction and other problems surrounding immediate postwar recovery took priority until 1948; thereafter, and especially after the outbreak of hostilities in Korea, new civil defense programs and policies emerged.

Since the Bolshevik Revolution ended in 1917, the Soviets have nurtured the expectation of an impending attack by capitalist powers. During the 1920's, cities and other targets were prepared for protection against chemical and conventional attack. In 1927, OSOAVIAKHIM, a paramilitary training organization, was established with Civil Defense training as one of its prime functions.[139] During the 1930's, as concern over air power and the German threat began to grow, the first nationwide civil defense program was begun. However, it was not until World War II, when old civil defense programs proved inadequate, that shelter construction and compulsory training programs, designed mainly for civil defense workers, actually began.

2. Post-War Developments: General

Immediately after the war, interest in civil defense declined, primarily because of the precedence given to reconstructing the nation's social, economic, and military complex. However, around 1948, reports were filtered to the West from returning German POWs of a shelter construction program in all new buildings.[140] In 1949, basic radio communications designed to improve defense command and control was ordered. A call, in 1950, for "tens of thousands" of instructors preceded the formation of DOSAAF in 1951.[141] This organization, a paramilitary group cooperating with the Army, Navy, and Air Force, replaced OSOAVIAKHIM and became the principal civil defense training group. In the next two years, as DOSAAF took on more responsibilities, mandatory study circles began, followed by a 20-hour compulsory civil defense training program for all members, then numbering approximately 16 to 20 million.[142] The XIXth Party Congress, meeting in 1952, called for "all out" defense measures, to include civil defense. In 1953, an antiaircraft general, Nikolay F. Gritchin, was made DOSAAF chairman, indicating the growing importance of this group in relation to the military, and air defense in particular.[143]

Although the Soviets were aware of the existence of nuclear weapons at the end of World War II, little or no mention was made of these in public literature until 1954, nine years after Hiroshima and five years

[138] "Air Warning System of the Soviet Union," RCAF Intel. Summary.
[139] "Civil Defense of the U.S.S.R.," *Intelligence Review*, p. 15.
[140] Goure, *The Soviet Civil Defense Program*.
[141] CIA, "Civil Defense in the U.S.S.R."
[142] Goure, *The Soviet Civil Defense Program*.
[143] CIA, "Civil Defense in the U.S.S.R."

after the U.S.S.R. exploded its first atomic bomb. The turning point in civil defense thinking occurred at this time when civil defense literature publicly announced a growing concerning with nuclear and bacteriological weapons. This awareness precipitated changes in policy and eventual debate in the late 1950's over the effectiveness of civil defense programs, shelters, evacuation and dispersal procedures, and various other aspects of the existing system. More immediate results involved, in 1955, the assignment of Colonel General of Aviation O. Tolstikov, a First Deputy Minister for Internal Affairs, as head of Civil Defense and the onset of a 10-hour compulsory training program for the adult population.[144]

3. Organization

Civil defense, until 1961, was an integral part of the Soviet Antiair Defense (PVO) and was supervised by the Main Directorate of Local Antiair Defense, or GU MPVO. This controlling body operated under the Ministry of Internal Affairs (MVD) and was responsible for planning and assisting the Council of Ministers in developing civil defense policy and cooperating with the Defense Ministry's Main Directorate of Antiair Defense of the Country. Also, under the jurisdiction of the Council of Ministers was the principal civil defense training organization, DOSAAF.

Subordinate to the GU MPVO were Republic, Region (Oblast), District (Rayon), and City MPVO organizations. Within these areas, the civil defense structure paralleled that of the civil administration and employed administrative and managerial personnel from government and industry in its own commands and staffs.[145] For example, the Council of Workers Deputies of the City maintained responsibility for civil defense in their area. The chairman of their Executive Committee was the Chief of the MPVO in the city, and he directed the program through the MPVO staff. His duties included staff and personnel training, planning, financial and materiel coordination, and organizing civil defense training programs for the population. In addition, the MPVO controlled the services of fire fighting crews, emergency engineers, medical personnel, the sanitary processing and decontamination groups, the security groups, those involved in warning and communications, transportation personnel, shelter and cover service, and various other facilities that could assist in any facet of civil defense.[146]

Several aspects of the city or point concept indicate that the Soviet Union had not yet modified its civil defense structure to accommodate a nuclear threat. The existing system was geared towards a World War II or conventional bomber mode of attack. It was not until the early 1960's that the need for a state-wide, rather than city-wide, system of civil defense was evolved.[147] In addition, there was not, as yet, significant cooperation with the military, indicating that the actual integration with the air defense contingent of the U.S.S.R. had not been fulfilled.

4. Training

Comments on the organizational concept of civil defense between 1945 and 1955 would be incomplete without some attention to the birth and rise of DOSAAF, the paramilitary organization with responsibility for Civil Defense training of the entire population.

---

[144] Goure, *The Soviet Civil Defense Program*.
[145] "Civil Defense of the U.S.S.R.," *Intelligence Review*, p. 16.
[146] Ibid., p. 17.
[147] CIA, "Soviet Civil Defense: Policies and Priorities," p. 13.

Paramilitary organizations have always handled Civil Defense training, beginning in 1927 with OSOAVIAKHIM. In September 1951, DOSAAF succeeded OSOAVIAKHIM as the "Volunteer Society for Cooperation with the Army, Air Force, and Navy" with Colonel General Vasiliy I. Kuznetsov as its head.[148]

Kuznetsov's leadership of DOSAAF was uneventful and he was replaced in 1953 by Lt. Gen. Nikolay F. Gritchin, a former World War II antiaircraft artillery officer. This appointment caused various analysts to note that there may have been increasing emphasis on the cooperation of civil and air defense at this time because of Gritchin's background. In any event, Gritchin initiated a successful campaign to urge new KOMSOMOL recruits into DOSAAF and to integrate DOSAAF with the trade unions and their various enterprises. In July 1954, a plenary session of the Central Committee of DOSAAF was held, emphasizing its roles and calling for a sports competition which would measure such abilities as marksmanship, grenade throwing, and PVKho (antiair and antichemical defense) to be held the next month.[149]

The PVKho section of DOSAAF retained the main responsibility for supervision of civil defense training, beginning with the study circles which originated prior to the formation of DOSAAF. Members of these circles who passed various civil defense examinations were awarded the badge of "Ready for Antiair and Antichemical Defense." In 1948, the stated goal of the mass training program was the preparation of 4 to 5 million persons a year to qualify for the badge. The Soviet press placed considerable emphasis on this program, evidenced in a *Pravda* item noting that in 1951, 21,434 persons from Tadzhik SSR were trained and received the badge and that the number of such trainees was growing "yearly by the hundreds of thousands."[150]

These various reports made civil defense and DOSAAF progress look effective, at least on paper. The three civil defense manuals of 1952, in particular the "Handbook for Exercises," reaped praises of civil defense excellence on "heroic people contributing to Civil Defense during the Great Patriotic War" and to DOSAAF and its work.[151] The contents of the manual included sections on means of attack against the rear and antiaircraft defense, protection against bombs and their consequences, protection against gases, and rules of conduct for the population in antiaircraft defense. However, the outlined procedures did not demonstrate that the Soviets had achieved any profundity in civil defense that could not be achieved in any other country subject to aerial attack. Surprisingly enough, they lacked any significant reference to atomic or thermonuclear warfare and its consequences, a matter which seemingly should have been assuming more importance as the Cold War was taking shape. One of the few references to atomic weapons appeared in the Soviet press in 1947, before OSOAVIAKHIM was disbanded: "The present program of civil defense includes the training and protection of the population against atomic air raids. OSOAVIAKHIM aims only at the discipline of the people; the preparation of such defenses as 'insulation layers' is being left to the scientists. At present, sham maneuvers are held for those people in strategic areas who would have to be moved away rapidly, and personnel are being trained in the detection of radioactivity. The training is similar to that for chemical warfare."[152]

---

[148] "Military Notes: U.S.S.R.," *Intelligence Review*, p. 16.
[149] CIA, "Civil Defense in the U.S.S.R."
[150] "DOSAAF Trains Soviet Civil Defense," *Air Intelligence Digest*, p. 14.
[151] Ibid., p. 14.
[152] Ibid., p. 13.

Whether this statement indicated that the press was merely naive or was printing what it was authorized to print is unknown. As a propaganda move, it could have been intended to reassure the population regarding any knowledge they might possess of nuclear threat. The mention of "scientists" handling problems related to civil defense indicates that the Soviets may have been awaiting technological developments in shelter capabilities before either publicizing a problem they could not yet counter or making any massive changes in the existing system.

Guards Colonel General P. A. Belov became the new commander of DOSAAF in 1955 and perhaps initiated the first drive for better cooperation between the military and the civil defense organs when he stressed the need to use demobilized reserve officers and soldiers for leadership and instruction in areas of civil defense.[153] Eventually, not reserve but high-ranking active duty officers became a part of the directorate. Various sources have mentioned that, after 1955, civil defense was endorsed by the Soviet leadership.[154]

5. Shelters, Evacuation, and Dispersal

Although some sources refer to basement shelters constructed in new apartment buildings as early as 1946,[155] the general consensus puts the year around 1948 when German POWs reported sighting shelter buildings being inspected and supervised in recent construction. It was believed that civil defense officials had authority to conduct these inspections to insure that construction was meeting certain regulations. However, it was also noted that priority was given to shelter protection for industrial, administrative, and economic facilities and to major cities, thus disregarding a greater part of the population,[156] particularly the agrarian community. The most prevalent shelters, those of World War II vintage, were not capable of protecting more than 10 to 15 percent of the population against fallout,[157] and new shelters were designed merely to withstand the collapse of the building. This did not account for the thermal and blast effects of nuclear explosion. The advantage of existing underground structures was demonstrated in 1954 when shelter construction was begun in subways.

The preceding data were partly responsible for spurring the civil defense debates of the late 1950's over the cost-benefits of updating present shelters to withstand nuclear attack.[158] It was not until then that a massive evacuation program was promoted to compensate for both the shortage and inadequacy of the existing shelters. Very little emphasis was accorded to a formal evacuation program prior to 1958.[159] Although one source said there was "fairly reliable evidence" that industrial evacuation plans were updated in 1950, an interview in 1953 with Moscow citizen did not yield any evidence of a city-wide air raid drill during the two-year period the interviewer had been a resident there.

A summary of rules the population was to follow during a "critical situation" involved learning the location of the nearest air raid shelters, and *when none exist* to "prepare trenches, dugouts, and similar facilities,"[160] indicating the inefficiencies of the shelter program. Also, implied is the Soviets' reliance on early warning of attack. Civil defense elements maintained close communications with the "local elements

[153] CIA, "Civil Defense in the U.S.S.R."
[154] "Civil Defense of the U.S.S.R.," *Intelligence Review*, p. 20.
[155] SRI, Soviet Strategy, Objectives, and Force Postures in Response to U.S. BMD, 1968–1980.
[156] Goure, *The Soviet Civil Defense Program*.
[157] CIA, "Soviet Civil Defense: Policies and Priorities," p. 7.
[158] Ibid.
[159] CIA, "Changing Soviet Civil Defense Concepts."
[160] "Civil Defense of the U.S.S.R.," *Intelligence Review*, p. 20.

of the air defense command . . . especially VNOS," the ground observation early warning service.[161] This approach may have been appropriate when bomber attack was the primary threat, but dependence on such a primitive early warning system (which later improved with more advanced radar technology) in order to prepare the population, was hardly an efficient and secure plan.

According to observations during a 1961 trip, which could easily apply to this early period, Leon Goure theorized that the population was indifferent to civil defense, possibly because of the effects of World War II destruction. He noted that the general fear of war and feeling of helplessness against the weapons of war left the people with little confidence in shelter programs. "Mere physical survival was not reassuring when they knew the great damage brought by war: and were still recovering from World War II."[162] If this is true and if the leadership of the Soviet Union considered the civil defense programs as a propaganda tool in boosting the morale and nationalistic altitudes of the population, then they were unsuccessful in attaining this goal.

Uncertainty exists concerning the relationship of industrial dispersal in the Soviet Union and civil defense activities. However, it seems that the reasons for relocation of industry to the Ural regions during the 1930's and from 1941–1945 were attributed primarily to both protection from conventional military invasion and the discovery of new locations of resources,[163] from which air and civil defense would only indirectly benefit. Budgetary considerations alone would make such a transfer impractical except in extreme cases. Although one source assigns to the MPVO the peacetime functions of "town planning" (and thus the ability to *ensure* proper dispersal of plants and provisions for air raid facilities in new building construction),[164] it is doubtful that it was able to do more than recommend guidelines for such purposes.

6. Summary

It would seem that, as the Soviets were recovering from World War II damage and beginning their strenuous drive to gain technological and military parity with the West, they also found time to reassess and begin improvements on other internal programs. Civil defense acquired renewed attention by 1948 and paralleled the growth of air defense in the Soviet Union.

Beginning with lessons learned from World War II, including the effects of German air attack on their homeland and the accounts by returning Soviet military of U.S. bomber damage in Germany, Soviet leaders realized the need for a stronger, more organized civil defense program. Not only did they realize that the ability to protect their military/economic/social complex would be a more difficult mission with the development of new weapons technology, but perception of immediate threats such as the proliferation of the United States' Strategic Air Command, the establishment of NATO in 1949, and the Korean conflict of 1950–1953 (when it was possible to actually witness and assess the new aircraft technology developed since the war) reinforced the Soviet's early views concerning adequate defense. The following changes within the Soviet Union after 1950 had a profound effect on defense posture:

(1) Development of strategic weapons of mass destruction;
(2) Increasing vulnerability due to urbanization and industrialization;
(3) Polarization of the global struggle into an East/West power bloc;

[161] Ibid., p. 20.
[162] Goure, *The Soviet-Civil Defense Program: A Trip Report*.
[163] Cole and German, A Geography of the U.S.S.R., The Background to Planned Economy, p. 75.
[164] "Civil Defense of the U.S.S.R.," *Intelligence Review*, p. 20.

(4) Cold War intensification;
(5) The feeling that civil defense can contribute to the overall military posture of the Soviet Union.[165]

Thus, it could be claimed that the Soviet civil defense program was a result of mere common sense, of the recognition of the need to protect not only the military-industrial segment of the society but also to maintain the morale of the population, now considered a prime factor in effective recovery from mass attack.

Of course, the success of such a vast institution relies heavily on popular support. As stated earlier, considerable apathy has been reported, and one sources mentioned that "pressure is being applied by the Communist party and other groups" to promote membership and participation.[166] The advent of a compulsory training program in 1955 probably came as a result of little success with "voluntarism." Therefore, again it must be that the program at least looked "good on paper," but to the extent it was successful is not known. By 1955, with the acknowledgement of nuclear weapons, civil defense appeared to be more heavily endorsed by "those who can make a difference"; also, the impressive leadership status of such organizations as DOSAAF, and Tolstikov's appointment as Chief of Civil Defense in 1955 implied a trend toward greater integration with the military and air defense components.

A quote from a 1953 article states: "Today, the Soviet Union is reasonably well prepared in civil defense matters to cope with air attack."[167] The key words here seem to be "air attack," because Soviet civil defense preparations were certainly keyed to a World War II–type of aerial threat through 1958. Even the publicized awareness in 1954 of a nuclear threat did not immediately change civil defense thinking, although it precipitated greater military/political concern with civil defense and the eventual transition of the system from a civilian-administrated/city-oriented program to a military-directed/nationwide institution.

[165] Goure, *Civil Defense in the Soviet Union*.
[166] "Civil Defense of the U.S.S.R.," *Intelligence Review*, p. 20.
[167] Ibid., p. 15.

Appendix A

Concepts of Air Defense Before 1945

A. The U.S. Heritage of the Interwar Period

1. Early Premises

U.S. concepts for air defense during the 1920's were strongly influenced by various developments in U.S. national policies, the perception of the threat and technological advances. These were supported by "lessons" drawn from World War I operational experience and subsequent developments.

U.S. national defense policies rested on the premise that attack by a potential enemy was unlikely. Indeed, during the decade of the 1920's, Army and Navy planners found it difficult to determine *any* enemy or enemies who might be *capable* of threatening the United States. After the 1922 Washington Disarmament Treaty and the termination of the Anglo-Japanese alliance, the United States seemed to have little to fear either from hostile air attack launched from carriers (because of tonnage limitations in the Washington Treaty of 1922) or from land-based aircraft (because of their inherent range limitations). As a consequence, the conclusion was general that the United States was in no danger from air attack. This conclusion was not reinforced by prevailing service doctrine but still became the conventional wisdom.

2. Origins of Air Force Doctrine: Early Air Defense Concepts

Air officers in the Army were convinced from the end of World War I that the best defense was a good offense. Many who held this view felt that the Army General Staff was primarily interested in the "defensive use" of aircraft and had neglected the "fighting side." General Mitchell carried on an extraordinary effort for a separate aviation department while arguing the need for a defined role for an expanded Air Service in the Army. Mitchell's paper entitled "Tactical Application of Military Aeronautics," proposed in January 1920, defined the principal mission and secondary employment of aeronautics. "The principal mission of Aeronautics is to destroy the aeronautical force of the enemy and after this, to attack his formations, both tactical and strategical, on the ground or on the water. The secondary employment of Aeronautics pertains to their use as an auxiliary to troops on the ground for enhancing their effect against hostile troops."[1]

Based upon a visit to France, Italy, Germany, Holland, and England in the winter of 1921–1922, Mitchell advocated unity of "air command." The air commander, he wrote "should control not only the observation aviation but also all antiaircraft weapons, searchlights and barrage balloons."[2]

Two years later, General M.M. Patrick, who had headed the Air Service with the AEF in France, proposed a reorganization and expansion of the Air Service within the War Department to give the Air Service

[1] Futrell, *Ideas, Concepts, Doctrine: USAF*, pp. 32–33.
[2] Ibid., p. 37.

a status analogous to that held by the Marine Corps within the Navy Department. He wrote on 19 December 1924, "I am convinced that the ultimate solution of the air defense problem of this country is a united air force . . . . Future emergencies will require at the very outset . . . the maximum use of air power on strategic missions . . . ."[3] Such views were disputed by some critics.

In early autumn of 1925, the Secretaries of War and Navy jointly requested President Coolidge to support a board to study the best means of developing and supplying aircraft in U.S. national defenses. The President appointed a board, The Aircraft Board, headed by Dwight W. Morrow. After extensive hearings, this board published a report on 25 November 1925 stating: "We do not consider that air power, as in some of the national defense, has yet demonstrated its value—certainly not in a country situated as ours—for independent operations of such a character as to justify the organization of a separate department."[4]

The board concluded that the United States was in no danger from air attack and stated that the "belief that new and deadlier weapons will shorten future wars and prevent vast expenditures of lives and resources is a dangerous one, which, if accepted, might well lead to a more ready acceptance of war as the solution of international difficulties."[5]

Over the next decade, advances in aircraft range, speed, and altitude persuaded the Air Corps to urge upon the War Department the development of interceptor aircraft with at least 20 percent greater speed than proposed bombardment planes. In addition, the Air Corps recommended steps to provide a ground observer corps and aircraft warning and reporting unit in the United States and its overseas possessions.

While the Air Corps was seeking a better interceptor capability, it was also urging an improvement in early warning systems.

Detection research had progressed deliberately after World War I. By the 1930's, increased concern for defense (i.e., a growing U.S. desire for effective warning of a hostile approach either by sea or air) caused existing programs of visual and sonic research to broaden and include other radio-optical research for detection. That area showed promise and progress. Both the Army and the Navy reported success in detecting and tracking aircraft by reflected infrared rays. The Army, in 1926, had detected an aircraft, and, in 1932, the Navy had tracked a blimp using reflected IR means. The Army's Signal Corps experimented in tracking ocean liners in the early 1930's using a thermo locator. From a location at Fort Hancock, the Mauretania was tracked to a distance of 23,000 yards in 1934. A year later, the Normandie was tracked to 30,000 yards and, a few months later, the Aquitania to a distance of 18,000 yards through a fog.[6] Radio location soon took over, however, from heat locating and ranging.

May 1937 is often cited as a principal turning point in Army technical history, based upon the successful demonstration of a short-range AA radio locator, the SCR-268, developed for searchlight control.[7] Designed to locate aircraft at night in range, elevation, and azimuth accurately enough so that searchlights would instantly illuminate them when they were turned on, the SCR-268 was a mobile item of equipment. Designed for AA use, it did not provide continuous tracking and could not be brought to bear against low-flying aircraft. With relatively limited range, the SCR-268 provided only about five minutes' warning.

---

[3] Ibid., p. 43.
[4] Ibid., pp. 48–49.
[5] Ibid., p. 49.
[6] Terrett, *The Signal Corps: The Emergency*, pp. 38–39.
[7] Ibid., p. 46.

Although it was obviously not immediately useful for interceptors, the new locator was impressive enough to prompt the Army Air Corps to seek development of an early warning radio locator to provide warning at ranges up to 120 miles. Following further development and testing during 1938, the SCR-268 mobile radar for AA was standardized and put into production in the winter of 1939. Concurrently, development of early warning radars for the Air Corps progressed until the SCR-270 was established as basic equipment for the purpose. With these developments, the United States, as well as the British and the Germans, had radar for air defense when World War II began.[8]

In addition to these developments in the doctrine and technology of early warning and interception, the Army fostered improvements in antiaircraft artillery.

3. U.S. Army AAA Developments

AAA developments during the 1930's in the U.S. Army advanced to the degree that appropriations permitted. In 1938, the 90-mm. gun development project was completed and by 1940 was standardized as a replacement for the 3-inch AA gun M-3 which had been adopted in 1928. The 3-inch gun began to phase out as the 90-mm. AAA gun was adopted as standard in February of 1940. By the fall of 1940, the 90-mm. requirement called for more than 1,000 guns; yet during 1941 only 171 complete units were produced. The 37-mm. AA gun was adopted as standard in 1939 but this automatic weapon was just getting into production in 1940, when 170 were produced. By January 1941 this weapon was being produced at a rate of 40 per month. In the following month the 40-mm. Bofors AA gun was approved for standardization, although it took more than a year to get production rolling on the Americanized version of the 40-mm. AA gun.[9] The caliber .50 AA machine gun remained a low-altitude defense weapons from its adoption as standard during the early 1920's.

The U.S. Army AAA regimental organizations at the time were of two basic types: mobile and semi-mobile. Mobile regiments consisted of two battalions; the first battalion (guns) contained three gun batteries, each having four 3-inch guns and one searchlight battery of 15 searchlights. The second battalion was made up of automatic weapons, with those batteries of 37-mm. automatic weapons each having eight 37-mm. guns with one .50 caliber machine gun battery or, as was the case earlier, four .50 caliber machine gun batteries. The semi-mobile regiment consisted of three battalions; the first two battalions were gun battalions, each with the armament of the mobile battalion; the third was an automatic weapons battalion of four batteries.

At the outbreak of World War II in September 1939, the U.S. Army included seven skeletonized active AA Regiments, plus a number of National Guard and Organized Reserve AA Regiments, in the inactive forces.

4. Expansion Program

Keeping pace with increased performance of military aircraft, AAA developments influenced U.S. Defense planning. In addition to greater interest in AAA, in June 1939, the Army began an "Aviation Expansion Program" which authorized a three-fold increase in the combat strength of the Air Corps. That branch planned to attain within two years an overall strength of 24 groups—including seven pursuit

[8] Ibid., p. 127.
[9] Green, et al., *The Ordnance Department: Planning Munitions for War*.

interceptor groups. As the war in Europe developed, the U.S. Army Air Corps looked more closely at air combat operations in that theater for their implications concerning air power theories which stemmed from Douhet's thesis that airpower and command of the air would enable the destruction of an enemy nation. Increasingly the Army Air Corps argued that the air defense of the United States was best served by having strong offensive air capabilities. The best defense was a strong offense.

U.S. air officers generally agreed in the fall of 1939 that the Luftwaffe had substantiated American theory in its essentials because, although German air operations in Poland were mainly in support of ground fighting, the Luftwaffe had established control of the air by destroying the Polish Air Force on the ground on its air fields. German victories over British and French forces in the west further underscored the theory and increased pressure for meeting U.S. bomber requirements. Recommendations for increases in U.S. long-range bomber forces were pressed with the view that, rather than investing heavily in interceptors for defense, strong U.S. bomber forces could carry destruction to an enemy homeland or destroy his air power.

Development and success of the B-17 and B-18 gave rise to the Air Corps Tactical School 1938 teaching: "The possibility for the application of military forces against the vital structure of a nation directly and immediately upon the outbreak of hostilities in the most important and far reaching development of modern times."[10]

5. U.S. Air Defense Planning and Organization for CONUS

Thus, as early as 1938 U.S. planning had to include the possibility of attack on the continental United States. Because of the prospect that this possibility would involve air attack, air officers became more deeply involved in U.S. defense planning. "Indeed, they tended to feel that the problem was exclusively theirs and to attach slight importance to collaboration with ground troops. . . ."[11]

An Air Defense Command was organized on 26 February 1940, with headquarters at Mitchell Field, Long Island, New York, under GHQ, Air Force. It was a planning body with authority to organize combined air-ground operations but it had no territorial responsibility over either aircraft or antiaircraft artillery. Directly subordinate to the GHQ Air Commander, the Air Defense Command's organization and operations were greatly influenced by lessons from the Battle of Britain and the growing autonomy of the Army Air Corps. The Air Corps, for example, established an intermediate echelon between its wings and the GHQ Air Force in 1940 by dividing the United States into four air districts. Ostensibly organized for training and administration, these districts were later proposed to have, within each of them, a bombing command and an air defense command, the former to conduct offensive operations, the latter defensive operations, "within the theater of the Air District."[12] In other parts of the Army, it was held that the air districts should not be identified as theaters of operations.

In March 1941, the War Department ordered the establishment of four defense commands in the United States—Northeastern, Central, Southern, and Western. Each defense commander would be responsible for planning all measures against invasion of the area of his command. The commanding general of each of four armies was designated as the commanding general of the defense command within which his head-

[10] Futrell, op. cit., p. 84.
[11] Greenfield, et al., *Army Ground Forces: The Organization of Ground Combat Troops*, p. 116.
[12] Ibid., p. 117.

quarters was located and the Army staffs were used as the staffs of the defense command. This same War Department order replaced the previously announced four air districts with four numbered air forces. Each air force included a mobile echelon comprising a bomber command and an interceptor command, the name chosen to replace the "air defense" command. The four air forces remained directly under GHQ Air Force and were not subordinate to the defense commands.[13] The directed organization appeared somewhat similar to the basic British structure which had been set up for UK air defense under the RAF.

By June 1941, the Army Air Forces became an autonomous element in the War Department and direct responsibility for Army aviation matters was given to the Chief, Army Air Forces. Within his staff, the Air War Plans Division was charged with preparing "overall plans for the control of the activities of the Army Air Forces."[14] In effect, the AAF would make aviation plans for the numbered air forces in the defense commands. But the War Department order of 17 March 1941 establishing the defense commands stated explicitly: "When the War Department, to meet an actual or threatened invasion activates a Theater of Operations (or similar command) in the United States . . . the commander of the theater (or similar commander) will be responsible for all air defense measures in the theater."[15]

This same order provided that antiaircraft artillery, searchlights, and barrage balloons be attached to interceptor commands during operations.[16]

How these ground elements would be controlled, however, was not clear. Experience in the Battle of Britain had shown that tactical coordination was needed and that rapid, reliable communications and intelligence were essential, among other reasons, to clarify responsibilities and to avoid possible harm to friendly aviation. In the summer of 1941, the AAF proposed that the fire of all AAA be controlled by regional officers of the interceptor command. This was deliberated through the spring-summer of 1941, first, by an Air Defense Board made up of the Chief of Coast Artillery, Chief Signal Officer and the Commanding General of the GHQ Air Force which concluded that an exception should be made for combat zones. This view was personally contested by General McNair (first commander of Army Ground Forces) who pointed out that coordination of air defenses was just as necessary in the combat zone as elsewhere. He urged unity of command for all air defense forces and suggested that all antiaircraft units should be assigned or attached to interceptor commands.[17]

6. Early Air Defense Doctrine

During the following months, the AAF prepared a draft Field Manual, entitled "Air Defense," which included doctrinal concepts which integrated pursuit/interceptors, AAA, barrage balloon units, and Signal air warning units into a coordinated air defense establishment. This draft manual which drew heavily on British air defense experience in the Battle of Britain, distinguished for the first time between the term "air defense," which was a direct defense against enemy air operations and "counter air force operations," which were said to be not properly within the scope of air defense. While not officially approved and published,[18]

[13] Ibid., p. 119.
[14] Futrell, op. cit., p. 100.
[15] Greenfield, op. cit., p. 123.
[16] Ibid.
[17] Ibid.
[18] FM 1-25, *Air Defense*, was finally published by the War Department on 24 December 1942, but it was substantially revised from this draft.

this draft manual strongly influenced U.S. air defense training and organization. Much of its substance was incorporated into War Department Training Circular No. 70, 16 December 1941, which implicitly reflected some of the lessons drawn from the attack on Pearl Harbor and the need for unified command as it stated: "All antiaircraft artillery and pursuit aviation operating within the same area must be subject to the control of a single commander designated for the purpose." Two days later, War Department Training Circular No. 71, 18 December 1941, set forth the concept of "antiaircraft commands" to operate under the "command" of interceptor commanders.[19]

In addition to these concerns with the proper organization for air defense, the Army Air Forces newly established Fighter Command School in the summer of 1942 also contributed to the evolution of air defense doctrine. The Air Defense Directorate of that school set about to develop air force doctrines, tactics and techniques of air defense, to test air defense equipment and operational procedures and to recommend measures for the organization of air defense for the Unites States and overseas theaters.

7. Organizing AAA Combat Units

The concept of an arm of one of the Army's branches to be configured for operational employment as part of a larger integrated fighting force was new and pointed up the growth of specialization and new techniques and interdependence of U.S. combat forces. Within the Army Ground Forces the Coast Artillery Corps, which was traditionally responsible for ground-based air defense, confronted a number of problems in meeting demands of a great and rapid expansion. Gradually a new antiaircraft branch emerged within the Coast Artillery Corps and the new element exceeded the importance of the coast defense functions.

The requirement for operational air defense units grew amazingly, and the antiaircraft operational function became increasingly technical. As an indication of growth, during the three years after the fall of 1940, when the President declared a national emergency and U.S. defense efforts accelerated, Infantry increased by 600 percent; Field Artillery by 500 percent; but Antiaircraft Artillery jumped by 1750 percent.[20] Only a small part of this expansion resulted from the call to active service of Antiaircraft Artillery units from the National Guard and original reserves. Thus, there was an immediate and difficult job of organizing, training, and equipping substantial numbers of AAA units.

To build required, new AAA units became an important, pressing task. No other ground areas had to ship units—organized, trained, and equipped for combat – as rapidly as antiaircraft. In the early phases of the defense buildup and initial period of the war the demand for AAA was exceptionally heavy both in overseas theaters and bases and in the defense commands in the United States. Units had to be put together and deployed quickly. The effort was built on the base of available active units which, by 30 June 1941, included 43 mobile AAA Regiments, 6 semi-mobile Regiments, 13 separate AAA Battalions, and 1 Barrage Balloon Battalion.[21]

As an early step to facilitate rapid organization and training, the AAA regimental structure was replaced by designating the battalion as the fundamental unit, making it self-contained tactically and administratively. In addition, the number of different kinds of units was reduced. As the Army moved to eliminate the

[19] Greenfield, op. cit., p. 126.
[20] Ibid., p. 418.
[21] Cibula, *History of the Antiaircraft Command.*

AA regiments, a new tactical organization, the group, was set up to provide a means of having a flexible composition of AA battalions. As groups would have a number of battalions, varying with the situation, so would brigades constitute a varied number of groups with attached battalions. At the same time, the Coast Artillery designation of AAA units also was dropped.

As part of a major reorganization of the Army in March 1942, the Antiaircraft Command was set up within the Army Ground Forces and made responsible for readying any required AA forces needed for operations. Many handicaps attended the organization and training of new units by the Antiaircraft Command. Combat experiences were not available to pre-test or guide the effort. There was no proven doctrine and much to learn from on-going operations. To regularize training policies was difficult in the face of heavy demands for more complete training.[22]

8. Lessons from the Battle of Britain and American Combat Experience

The Battle of Britain clearly influenced U.S. thinking about coordinated air defense. The British experience impressed itself in various ways on U.S. organization and operations. First, that experience seemed to discredit the U.S. concept that a hostile air force could be destroyed on the ground. The RAF not only showed that a well-dispersed air force was a difficult bombing target, but also argued that it was effective and efficient to destroy hostile aircraft in the air by fighter attack. Second, fighter tactics used by the RAF were proved effective because of electronic early warning and fighter control established on the recommendations of a special committee for the scientific survey of Air Defense under the chairmanship of Sir Henry Tizard, Rector of the Imperial College of Science and Technology.

U.S. Army Air Corps observers attributed severe losses taken by the Luftwaffe in the Battle of Britain to the firepower volume of British fighters, poor rear defenses of the German bombers, vulnerability of dive-bombing tactics, large formations, and poor air discipline. Yet the growing significance of radar was implicit in the basic report of the RAF victory submitted by General Spaatz on 29 February 1941 when he said: "A numerically inferior air force has been phenomenally successful in stopping the unbroken chain of victories of the world's strongest air power." That same month, General Arnold, while commenting on U.S. air defense deficiencies, wrote: "During daylight in good weather, when pursuit aviation is present in strength in an area, it can pretty near bar the air to the bomber."[23] (Within a few years, senior U.S. air officers would claim that bombers could overwhelm any defense.)

The British experience soon stimulated conceptual planning for a U.S. continental warning system. From the spring of 1941, GHQ Air Force had responsibility for organizing and training for air operations and defense against air attack in the continental United States. Many other War Department agencies were actively engaged in different aspects of the development of U.S. air defense capabilities. Under the AF GHQ, the Army Air Force organized interceptor commands to carry out air defense operations. It was anticipated that these commands would exercise operational control of AAA units of the Coast Artillery Corps and air warning units of the Signal Corps.

---

[22] During 1942, the SCR 268 was the only gun-laying radar available for AA units although it had not been designed for that purpose. Since these radars were also needed overseas, very few were available for units in AA training center in the United States. Target practice against airborne targets was difficult because of limitations on availability of Air Force aircraft for tow target missions. AA Command pioneered expedients such as the rocket target and other training devices.

[23] Futrell, op. cit., p. 97.

"When war came [radar warning] sites had been picked for thirteen radar stations along the East Coast and eight of the stations were approaching completion."[24] On the West Coast at the outbreak of war 10 radar sites were scheduled to be set up to provide coverage of the 1200 miles between Seattle and San Diego.[25] Each radar chain was to be complemented with ground observers; the East Coast was to have 4,000 ground observer stations and 2,400 were supposed to be active along the Pacific coast.

But, while progress had been made, the air defense system of the United States was still in a formative stage when the war broke. There was no GCI (Ground Controlled Intercept) capability and it was "not until late 1943 that the continental defenses were generally equipped with VHF radio and a workable system for controlling interceptions at night."[26] While radar siting activity was "feverish" during 1942 and 1943, by the fall of 1943, the danger of air attack had decreased to the point that the numbered Air Forces which had been assigned to the defense mission were then reassigned to the control of the Army Air Force.

Early in 1942, the Army was reorganized into three principal elements: Army Ground Forces, Army Air Forces, and Army Service Forces. None was directly responsible for air defense combat operations. Under the Army Ground Forces, the Antiaircraft Command was given the mission of organizing, training and equipping AAA units for assignment to operational commands. In addition, AA Command was responsible for developing AA materiel and equipment. Major General Joseph A. Green, then Chief of Coast Artillery, headed the AA Command and his headquarters were staffed by personnel from the Office of the Chief of Coast Artillery. From April 1942 to September 1945 the AA Command trained and sent overseas 451 separate AAA units; the balance of a total of 613 AAA combat units were trained for use within the continental U.S. Under the Army Air Forces, four numbered air forces based in the U.S. not only organized and trained air units but shared air defense activity at home. The Army's Chief of Ordnance and Chief Signal Officer had significant roles in the procurement, delivery, and maintenance of air defense equipment under the Service Forces.

Since operational activity in continental air defense never actually involved active combat, the growing overseas experience of U.S. units increasingly affected organizational and training activity in the zone of interior and also influenced equipment developments for air defense. From the Philippines, Panama, the Antilles, Alaska, and the Central and South Pacific reports of operations during 1942 began to build a varied body of operational experience which was looked upon as a validation and extension of existing U.S. doctrine, organization, and equipment for air defense.

Because it was the first major air-ground offensive in World War II, operations in North Africa beginning in November 1942— with new theories being expounded and tested there and greater emphasis given to armored warfare—soon gave rise to demands for more effective close air support and air defense tailored to the needs of mobile, widely dispersed combat formations. These demands also led to concepts of increased centralization of air power.

General Montgomery wrote in January 1942 that the greatest asset of air power was its flexibility and maintained that this flexibility could be realized only when air power was centrally controlled by an air officer who maintained close association with the ground commander. The following month General Spaatz

[24] *History I Fighter Command, 1941–1944*, p. 104ff, cited by Sturm, et al., *The Air Defense of the United States*, p. 21.
[25] Ibid.
[26] Ibid., p. 22. GCI involved U.S. commitments to air defense improvements for many years after the war. Considerable effort and money have gone into improving the potentials of GCI, including adding to the speed and altitude of interceptors, and to the lethal- has been given to improving the coverage and sophistication of ground based radar nets. Yet the war time role of GCI was n[illegible] to possible theaters.

organized the Northwest Africa Allied Air Force and gave it command over a Strategic Air Force, a Coastal Air Force and a Tactical Air Force. Writing to General Arnold the next month, General Spaatz said: "the air battle must be won first . . . Air units must be centralized and cannot be divided . . . among several armies or corps. . . . When the battle situation requires it, all units, including medium and heavy bombardment must support ground operations."[27] Within a few months, the Army Air Forces published Field Manual 100-20, *Command and Employment of Air Power*, which said:

> The inherent flexibility of air power is its greatest asset. This flexibility makes it possible to employ the whole weight of the available air power against selected areas in turn; such concentrated use of the air striking force is a battle-winning factor of the first importance. Control of available air power must be centralized and command must be exercised through the Air Force commander. . . . Therefore, the command of air and ground forces in a theater of operations will be vested in the superior commander charged with the actual conduct of operations in the theater, who will exercise command of air forces through the air force commander and command of ground forces through the ground force commander.[28]

Published by the War Department, but without the concurrence of the Army Ground Forces, FM 100-20 was greeted with mixed reactions. In the Army Ground Forces, it was viewed with "dismay" and described as the "Army Air Forces' Declaration of Independence." Among U.S. air officers, too, there was some reserve; for example General Orvil Anderson considered the division of air power, as represented by a tactical air force, to be wrong and it was suggested that the Air Force had "swallowed the RAF solution to a local situation in Africa hook, line and sinker without stopping to analyze it. . . ."[29]

In effect, relatively new and essentially untried principles were being applied on the battlefield to the needs of the war. Trial and error experience in the field did not offer American schools adequate time for thoughtful development of doctrine. Nevertheless "trained" units had to be deployed with the latest "doctrine." With incidental changes, the previously developed draft on air defense, which had originated in the Army Air Forces in October 1941, became War Department Field Manual 1-25 on 24 December 1942. But little actual operational experience could validate the manual.

In North Africa, the Luftwaffe remained active and contested with the several allied air forces for local air superiority. The demands for air defense capabilities, therefore, intensified and the rate of growth for antiaircraft units continued high throughout 1943. This continually expanding requirement for AAA combat units not only consumed programmed manpower, but increasingly sophisticated and varied technical demands developed as a result of combat experience and the growing capabilities of improved weapons, ammunition, and material.

Within the Army Ground Forces, AAA was viewed primarily as a "defensive" capability, required and useful only so long as U.S. air power could not provide air superiority. Air defense requirements for resources were of less concern to the AGF which felt that the AAA represented priority and specialized requirements for support in men, equipment and facilities. AAA was useful and worthwhile if it supported ground combat forces but otherwise air defense artillery was of lesser interest.

Command arrangements in overseas areas governing air defense frequently were deficient for coordination of operations; long periods of inaction limited operational proficiency because of lack of arrangements and facilities for continued training. AAA units needed target practice and this entailed Air Force support, to

---

[27] Futrell, op. cit., pp. 121–122.
[28] Ibid., pp. 122–123.
[29] Ibid.

fly the tow-target missions. Such conditions fostered a proposal for the transfer of the AA Command to the Army Air Forces. The issue first came to a head in February 1943. Originated within the War Department General Staff, by the G3, General Edwards, who was an Air Corps officer, the proposal was supported by General Arnold, Commanding General, Army Air Forces.[30] The main reason for the proposal, according to the memorandum setting it out, was that AAA and fighter aviation should be trained together because they should operate as a team in combat.

General McNair, the AGF commander, agreed with the need for training of AAA units with Air Force units but he also believed there was a need to train AAA units with mobile ground units, despite the fact that few ground troops had, up until that time, engaged in mobile operations.[31] He could not see how branch or unit training of AAA, a necessary preliminary to combined training of any kind, would be improved by a transfer of the Antiaircraft Command to the Army Air Forces.[32] The Operations Division of the War Department General Staff agreed, and the proposal for AAA to be shifted to the AAF was dropped.

By the summer of 1943, however, the issue surfaced again.[33] Reflecting the growing significance of AAA as part of active air defense operations overseas, a substantial body of antiaircraft officers were assigned to duty at various Air Force headquarters throughout the world. Their assignments ranged from instructing at the School of Applied Tactics at Orlando, Florida, to flak analysis for operational Air Forces overseas. Many AAA units were actively committed to air field defense. AAA officers on duty with the Air Force had a kind of functional headquarters in the office of the Special Assistant for Antiaircraft to General Arnold, headed at the time by Major General Homer R. Oldfield, who was named to the post after having served for several years as the Commanding General, Panama Coast Artillery Command. In that assignment, General Oldfield had commanded the antiaircraft defense of the Panama Canal with more than 600 operational positions manned in an extensive deployment throughout Panama for defense of the canal.

In September 1943, General Oldfield was named to head a War Department Board to survey the antiaircraft problem, following the shooting down of U.S. aircraft by friendly antiaircraft in the Sicilian Campaign. That board submitted a number of findings, including the following:

(1) Air commanders, in the defense of fixed installations in the theaters of operations, should exercise command over their supporting antiaircraft units,
(2) Air commanders should control the allocation of all antiaircraft units,
(3) Army Ground Forces regarded AAA as a defensive weapon,
(4) Combined training of AAA had been bad, and
(5) The dissemination of technical knowledge and training doctrine in the theaters had been inadequate.

War Department Memo, 9 February 1943, subj.: "Integration of AAA with AAF," cited by Greenfield, op. cit., p. 420.

In the North African campaign, the utility of self-propelled AAA had been demonstrated effectively and spurred the requirement for this special type of automatic weapons battalion. One AAA unit in the initial landings had been equipped as a self-propelled battalion for test of the concept. Organized with a headquarters and, each consisting of two platoons, one an automatic weapons platoon, the other a machine gun platoon. AAA SP battalions were standardized in 1943 to provide the AW platoon with nine M-15 gun carriages, consisting of one manually operated 37-mm. gun coaxially mounted with two air-cooled .50 caliber AA machine guns. The M-15 was a lightly armored, half-track carrier. The machine gun platoon was equipped with eight M-16 carriages; each consisting of four air-cooled .50 caliber AA machine guns on a power-operated revolving turret mounted on a lightly armored half-track carrier. Subsequently, each platoon was organized to have an equal number of M-15 and M-16 mounts.

Memo, General McNair for G3, WD, 19 February 1943, subj.: as above, cited by Greenfield, p. 421.

OPD Memo for G3, WD, 23 February 1943, same subject, cited by Greenfield, Ibid.

As a remedy, the Oldfield Board recommended the transfer of antiaircraft training to the Army Air Forces.[34] The War Department disregarded the Board's recommendation.[35]

9. Contribution of the SCR-584

By the summer of 1943, improved gun-laying radars, the SCR-584 and SCR-545, were being reproduced in quantity to equip AAA gun units. The SCR-584, a microwave development, proved to be an outstanding piece of equipment and came into great demand because the SCR-268 was increasingly vulnerable to German jamming. Everyone wanted the SCR-584. The Air Force commanders in North Africa complained that their 268's were being jammed and could not satisfactorily direct either searchlights or night fighter operations.

U.S. AA searchlight units had been trained in cooperative tactics with fighter aircraft; one searchlight in each platoon was designated as an orbit beacon and the U.S. standard 60-inch searchlight, with a beam of 800 million candle power, capable of illuminating targets to 19 miles under normal atmospheric conditions, had been adapted to spread the focus of the beam. While decreasing the intensity of the beam and lessening effective range by this focus change, the wider beam made it ideal for use against high speed targets at close range as well as being useful against night-time parachute attack and raids and providing artificial "moonlight" for friendly night operations or surveillance.

With the advent of the SCR-584, however, field commanders increasingly called for AAA which could defend effectively against hostile air attack by day or night. Air Force commanders and principal staff officers saw the improved AAA capability as lessening demands for night fighters and for airborne intercept radars. Such factors helped to sustain continuing requirements for more AAA units.

10. Strategic Factors and Related Influences on AAA Developments in World War II

Despite the popularity of AAA units for defense, strategic factors soon brought a decline in their training and overseas deployment. Toward the end of 1942, estimates of the limits of U.S. capacity to produce materiel and ceilings on the manpower available to the Army had come sharply into view. Limitations on shipping capacity were also felt as the submarine menace continued. These, combined with the evolution of changed Allied strategic concepts, constrained the fuller development of the ground army.

From 1 April 1942 to 2 September 1945, 451 separate AA units were trained and shipped overseas by the AA Command. Included among them were: 80 AAA Gun Battalions, 176 AW Battalions, 18 Searchlight Battalions, 6 Airborne AAA Battalions, and 83 additional separate AA units, such as airborne AA MG batteries, AW batteries and operational detachments. Such units were largely organized, trained and equipped during the period that manpower and logistical limitations in the Army were becoming of great concern. Indicative of this, the proposed organizational structures (TO&Es) for these kinds of units were critically reviewed by the War Department in late 1942 to justify the personnel and equipment needed to carry out the AAA mission. As a result of this review, the organization of AAA units, as proposed by the AA Command, was cut from 10 to 15 percent in personnel and equipment. Still, the War Department requirement for AAA

[34] Memo, Major General Oldfield and others for G3, WD, 27 Sept. 1943, subj.: AAA, cited by Greenfield, Ibid.
[35] WD Memo, WDCSA 351.17 (13 Oct. 1943), Gen. McNarney for Gen. McNair, 13 Oct. 1943, same subject., cited by Greenfield, Ibid.

units in 1943 continued to rise. At the end of 1942, AAA troop strength in the Army approximately 7 percent; the following year, the same percentage held true.

By the end of 1942, however, the basic outline of U.S. strategy seemed pointed to an even greater development of air power for offensive purposes, substituting for defensive AAA resources. The strategic factors included the following:

a. Allied Strength

By late 1942, it appeared that the Soviet had passed from a strategic defense to the offense. Massive ground forces (400 divisions by 1945) engaged the bulk of German ground forces and helped to neutralized Japanese forces along the Manchurian Border.

b. Allied Naval Strength

Naval successes by this time enabled the employment of U.S. forces at advantageous times and places.

c. Increasing Allied Air Power

Reduced effectiveness of the Luftwaffe and increasing effectiveness of Allied air would permit employment of ground forces under conditions of favorable, local air superiority. In this light, and because of shipping constraints, U.S. strategy began to allocate a larger proportion of U.S. resources to naval and air power and to support of U.S. allies. AA equipment furnished the U.S.S.R., for example, included more than 250 90-mm. guns, 5,500 40-mm. guns, 2,200 multiple mount AW, including 100 self-propelled M-15 sets, and many different radars, and, of particular importance, 49 SCR-584 sets.[36] The War Department therefore revised its 1943 mobilization troop basis to emphasize a basic preferences for light, easily transported units having offensive combat capabilities. This emphasis promoted a lighter, flexible, more interdependent ground army with its main strength in infantry, backed by significant fire support and with armored divisions designed to exploit breakthroughs. Such an emphasis on the ground offensive meant that the proportions of armored and AAA units in the ground army would gradually be reduced. While more than 800 AAA battalions had been planned, in October 1943 the War Department reduced the planned figure to 575 and checked what had been a continuing AA expansion.[37] By the spring of 1945, AAA constituted less than 4 percent of the strength of the Army. At the same time, it was 11.5 percent of the strength of the Army's ground combat forces.[38]

Other undulations also affected the organization, training, and equipment of AAA units during World War II. For example, by the end of 1943, every item of primary armament and equipment — guns, radars, automatic weapons, and searchlights—then being issued to AAA units either did not exist at the time of Pearl Harbor or had been considerably modified and improved. (A comparable situation existed among Army Air Forces units.) To realize these improvements and modifications, however, required a great variety of tests and a considerable analysis of suggestions, devices, and prototype equipment. While a number of advanced developments were contemplated, the basic strategic approach formalized by the War Department in late 1942 may have tended to slow or impede development of AA guided missiles during World War II.

[36] Jones, *The Roads to Russia*.
[37] Greenfield, op. cit., p. 423.
[38] Ibid., pp. 203, 395.

The 120-mm. AA gun (M1) was standardized by 1944 as a result of development begun in 1939 for a gun with greater range than the 90-mm. gun. A need for guided missiles to reach very high flying aircraft or high rockets, such as the rumored German "V" weapons, however, was stated by Headquarters AA Command in 1943. The 120-mm. gun was a high-velocity weapon with a muzzle velocity of 3100 fps, able to fire a 50-pound projectile to 56,000 feet using semi-fixed ammunition and employing a power-operated ammunition tray and rammer. Excessive barrel wear was anticipated and this fact, together with technological progress, prompted a stated need for an AA missile.

11. Guided Missile Development

In January 1944 the Antiaircraft Artillery Board outlined the military characteristics for a controlled antiaircraft rocket projectile and recommended that AA Command initiate a development program using those characteristics. The Commanding General, Army Ground Forces quickly forwarded these recommendations to the Commanding General, Army Service Forces, and on 9 February 1944 requested that a project for the development of an antiaircraft rocket weapon with associated control mechanism and directing radar be initiated immediately and be given the highest priority.

The development of the missile itself would be an Ordinance responsibility; but the guidance package would be electronic and therefore a concern of the Signal Corps. The latter took the stand that until Ordnance determined the kind of missile and its flight characteristics, work on a control system would not be pursued, "due to limitations of personnel."[39] Thus, in April 1944, the Signal Corps saw the project "to be desirable for LONG range investigation but one which the Signal Corps should not attempt at the present time. . . ."[40] When the German V-1 and V-2 weapons began to hit the UK in the summer of 1944, U.S. research in rockets and guided missiles quickly accelerated.

In the meantime the Army also began other projects to meet future requirements. In May 1944, Army Service Forces awarded the California Institute of Technology a contract involving an estimated $3,900,000 for research and development work on long-range rocket missiles, ranjets, and launching equipment. The resulting "ORDCIT" Project was to focus on propellants, control mechanisms, and materials involved in missile design, as well as aerodynamics. The overall aim of the program was to gather research information on which to base the design of future missiles.

Later in 1944, the Ballistic Laboratory at the Aberdeen Proving Ground, which was assigned responsibility for all external ballistic missile work in connection with guided missile development, successfully performed the necessary tracking and computation of trajectories for testing the first missile developed by the California Institute of Technology.

While these development activities got under way, a struggle grew within the Army concerning control over the development of missile weapons.

In an attempt to clarify areas of responsibility, on 2 October 1944, Joseph T. McNarney, the Deputy Chief of Staff, issued a policy directive to the Commanding Generals, Army Ground Forces, Army Air Forces and Army Service Forces. That directive established responsibility for research and development in the field of guided missiles as follows:

---

[39] Thompson and Harris, *The Signal Corps: The Outcome*, p. 464.
[40] Ibid.

(1) Army Air Forces would have research and development responsibility, including designation of military characteristics, for all guided or homing missiles dropped or launched from aircraft.

(2) Army Air Forces also would have research and development responsibility for all guided or homing missiles launched from the ground which depended for sustenance primarily on the lift of aerodynamic forces. The Army Air Forces and Army Ground Forces would designate military characteristics when and as these affected their interests.

(3) Army Services Forces had research and development responsibility for guided or homing missiles launched from the ground which depended for sustenance primarily on missile momentum. The Army Air Forces and Army Ground Forces would designate military characteristics when and as these affected their interests.[41]

12. Continued Utility of AAA

A revolution in AA gunnery, stemming from the introduction of radar, helped to make very substantial contributions to the toll of enemy aircraft attacking areas defended by AA guns. In addition, by their volume of fire, AA guns forced aircraft to take evasive action which reduced the effectiveness of air attack. Concentrations of guns forced bombers to seek altitudes above effective zones of AA fire, and bombers flying above 20,000 feet lost considerable bombing accuracy.

U.S. AAA proved particularly effective against the German "long-range" bombardment weapon, the V-1. This relatively small, automatically controlled, jet propelled monoplane carried a ton of high explosives at a speed between 300 and 400 mph at altitudes from 600 to 10,000 feet for 250 miles.[42] The V-1 missile attacks against the United Kingdom began during the night of 13 June 1944 and ended 29 March 1945.[43]

V-1 activity against the United Kingdom occurred in three periods. The first from 13 June to 5 September; the second, when the V-1 was air-launched, from early September to mid-January 1945; and the third, from 3 March to the end of the month. A combined U.S.-British air defense, including fighters and AAA, was setup against this new weapon.

At the start AA guns were formed in an inland belt between the Channel and London, the prime target of attacks. AAA was restricted from firing whenever RAF aircraft were over the area. Their success was limited. Soon the defense shifted, based on a desire to destroy V-1's over the ocean. To lessen the danger to personnel and property from falling V-1's and to eliminate mutual interference between AAA and fighters, the defense was realigned after a month. AAA was moved to the coast and set up in a 5,000-yard belt along the Channel coast which permitted guns to fire 10,000 yards out to sea. The fighters were to intercept further out in the channel and beyond the belt of guns. Over the gun belt fighters were restricted; they had to fly over 8,000 feet in that area and AAA guns could fire up to 6,000 feet. Following this, and with the proximity fuze available and authorized for use, AAA quickly reached a high order of effectiveness against the V-1.

On the continent, the capture of Antwerp and the opening of port facilities there saw the rapid growth in importance of that city as an Allied supply base. Germany made a determined, large-scale effort to neutralize Antwerp and its port facilities beginning on 24 October 1944 and maintained nearly continuous V-1 attacks against the area until 30 March 1945. Of nearly 5000 V-1 missiles launched by the Germans against Antwerp only 211 (4.3 percent) fell within the area which was designated to be vital. AAA provided the principal defense against the V-1 attacks on Antwerp. About 12,000 personnel participated in the AA defenses.

---

[41] Letter, C/S USA, to CG AGF, et al., subj.: "Guided Missiles," 2 October 1944.
[42] General Board, ETO, *Tactical Employment of AA Units, Including Defense Against Pilotless Aircraft (V-1)*, Report No. 38.
[43] Welborn, *V-1 and V-2 Attacks Against the UK*, Tech. Memo ORO-T-42, p. 1.

In the early days of the Antwerp defense, the effectiveness of the defense was degraded considerably by restrictions placed on AA fire in order to protect friendly flight activity. A number of airfields in the vicinity of the city complicated control and protection of friendly aircraft from AA fire. Because of adverse weather in the fall season, visual recognition was difficult and to eliminate the mutual interference problem, a "Inner Artillery Zone" (IAZ) was established. Friendly aircraft continually violated the IAZ; during the period 26 November–11 November 1944 available records reportedly indicate 375 friendly aircraft in 129 flights violated the prescribed zone.[44] Nevertheless, while large amounts of AA equipment, ammunition, and personnel were required, the AA defense of Antwerp essentially made the V-1 obsolete as a tactical weapon.

In the various theaters of operations, AA units provided defense against air attack on friendly forces and installations both in the combat zone and in the rear areas. Allocation of AAA for the defense of specific units or vital areas was established on the basis of priorities directed by the U.S. forces or area commander. No AAA units were assigned as organic or integral elements to other combat organizations; generally AAA units provided air defense protection and, on occasion, especially during later stages of the war, ground fire support to U.S. ground combat forces. But no organic AAA was provided U.S. divisions.

13. Anomalies in Command and Control Air Defense Resources

In the European theater the requirements for U.S. AAA units were derived from British organizational allocations of antiaircraft artillery. This situation stemmed from a combination of factors that included U.S. deference to British sovereignty and experience, U.S. adherence to the British pattern of action, and the functional air defense planning and operational responsibility among U.S. forces being vested with U.S. Army Air Forces. In turn, this raised a question concerning the control of organically assigned AAA units. If AAA units were not specifically assigned to a parent unit or organization, functional command of a "coordinated" air defense might require an Air Force command of these units.

Several anomalies were apparent in the general situation, reflected by the allocation of U.S. AAA units in the ETO in October 1944. At the time, AAA units either were assigned or attached as follows:

	Armies					
	First	Third	Ninth	6th Army Group	12th Army Group	IX ADC
Gun Battalions	5½	5	7	1	1	7
Automatic Weapons	17	13	11	2	2	20
Searchlight	—	—	—	—	—	3
Self-Propelled AW	6	6	3	1	2	—

Noteworthy is the fact that the Army group and Army elements had: 19½ gun battalions versus 7 for IX Air Defense Command; 45 AW Battalions versus 20; and all 18 self-propelled AW battalions were with the operational combat forces. Yet none of these AAA units was organic to any of these field forces.

[44] *The Flying Bomb: The Defense of Antwerp and Brussels*, par. 33–40; U.S. Army Hq Antwerp X, "Infringement of IAZ, 26 November–11 December 1944" (Air University Archives, 539.667B, Folder 33) cited in Chapter 4, *Air Defense Historical Analysis*, U.S. Army Air Defense School, p. 148.

As the flow of Allied operations moved east, these field forces were increasingly dependent upon AAA for effective local defense yet could neither effect nor cause the reassignment of any AAA units under the IX Air Defense Command to help provide air defense protection. In contrast, Air Force units under IX Air Defense Command could be reassigned, and be relieved from responsibility for any active air defense role. This actually happened. With a reduced threat, fighters were withdrawn from IX AD Command and only AAA was actively committed to the air defense mission. Accordingly, it was questioned whether IX AD command, the principal theater element for air defense had either been tested for or demonstrated then current air defense "doctrine."

The Air Force Commander in the ETO, with responsibility for the U.S. air defense mission (CG, Ninth Air Force), could deputize a subordinate Air Force command (IX Air Defense Command) to discharge the air defense responsibility and either authorize or direct that command to disengage Air Force units which were assigned air defense missions. Theoretically, at least, the situation could have developed that an Air Force commander could carry out air defense missions with only AAA units, thus exclusively using ground based air defense systems to provide the protection of rear areas. This appeared to violate the "doctrine" of coordinated, integrated air defense and rankled further because AAA units believed the air warning service in the IX Air Defense Command inadequately performed its air defense mission, being used more to control tactical air operations. At the same time, the Air Force component commander could also limit the use of AAA assigned to Army field forces by asking for augmented or more intensive ground-based air defense efforts for the defense of airfields located forward of army group rear boundaries.

Essentially, the Air Force element could dictate the scale of the AAA allotment needed for rear areas, citing the factors of British experience and the need for an Air Force command over any AAA resources committed in order to coordinate the several means being employed for air defense. With the authority that attended that responsibility, the Air Force commander could also scale down the commitment of air resources given to the task while limiting the transfer of ground AA units critically needed by ground force commanders in the field.

In Europe, all Air Force capabilities were considered to be available for support of the surface campaign. "Although the Ninth Air Force stood ready to maintain friendly air superiority, it was routinely committed to interdiction and close support operations."[45] Thus, Allied air resources, without being obliged to extended, static commitments for air defense because of the general decline of the Luftwaffe and the availability of AAA for protection, were free to pursue offensive operations against the enemy, including counter-air operations against airfields.

Nonetheless, it remained evident that air defense from AAA units was still valuable and significant in protecting forward areas against air attack. Anzio, Remagen, and Bastogne all provided apt illustrations of that fact. Between 18 and 23 December 1944 at Bastogne, for example, the U.S. 406th Fighter-Bomber Group was responsible for close air support to the 101st Airborne Division. The group flew 529 close air support sorties into the area; out of 60 operational P-47's at the beginning of the period, the group lost 17 shot down and had more than 40 damaged by German AA in the area.[46]

In a two-week period in March 1945, the Remagen Beachhead became the most heavily defended vulnerable area since Normandy. Normally, on a single day, 67 jet aircraft attacks were made on the bridge

[45] Futrell, op. cit., p. 162.
[46] Ibid.

which was defended by U.S. AAA. A total of 142 German aircraft were destroyed by AAA fire and 59 probably destroyed there from 8 March to 21 March 1945.

14. Interest in New, Improved Air Defense Weapons

As the war drew near its close, interest in the potential of new defensive weapons grew and greater expectations of effectiveness took hold with the prospects of maneuverable defensive missiles or projectiles. Gun developments had proved capable of handling high-speed targets and, with improved fire control, the defense could contemplate the prospect of jet aircraft without undue concern. The Army had begun work in 1944 on an improved fire control system, the M-33, to link a computer with guns, a tracking radar, plotting boards and communications equipment. (As developed, the M-33 system could compute, for the 90-mm. and 120-mm. guns, firing data for targets with speeds up to 1,000 mph.)

In February 1945, Bell Telephone Laboratories was given a contract, co-sponsored by the Office, Chief of Ordnance and the Army Air Forces, to explore the possibilities of a new antiaircraft defense system to combat future bombers invading friendly territory at such speed and altitude that conventional artillery would be unable to defend against them effectively. Bell completed a research plan to develop a practical weapon system of this type six months later. The plan promised such a system within a few years. To have a system available by the time an enemy could have high-speed, high altitude bombers in operation, it was recommended that the equipment be derived insofar as possible from devices, methods, and techniques already known and understood. By this time, however, the AAF had pulled out of the joint effort. The proposed project was named Nike and marked the beginning of the development of a series of missiles bearing that name and which eventually led to the antiballistic missile system known as Safeguard.

At about the same time the Army Ground Forces Equipment Review Board submitted a report on postwar equipment for the Army. Among its findings the Board concluded that high velocity guided missiles, preferably of the supersonic type capable of intercepting and destroying aircraft flying at speeds up to 1,000 miles per hour at altitudes up to 60,000 feet or of destroying missiles of the V-2 type, should be developed at the earliest practicable date.

Air defense remained a subject of high level attention for a variety of reasons. Prominent among them was the violent and growing use of Japanese suicide air attacks in the closing campaigns in the Pacific. Beginning as a reaction to U.S. landings in Luzon, the Japanese attacks, later known as Kamikaze attacks, grew in frequency and intensified. In effect, they proved very costly, decimating Japanese air strength but posing serious problems for U.S. leaders. While causing only relatively minor damage to U.S. ships at Luzon, the Kamikaze attacks on Okinawa in April 1945 helped the Japanese to sink 20 U.S. ships and to damage 157 others. Most of the sinkings (14) and damages (90) resulted from the suicide attacks. During May and June, these attacks continued. In all, Kamikaze attacks accounted for 26 of 28 U.S. ships sunk and 164 of the 225 ships damaged at Okinawa.[47] Destroyers, cruisers, battleships and carriers were all hit; some of the large ships suffered great damage and loss of life.

The Japanese objective sought to disable the U.S. fleet offshore to disrupt supply. In addition, Japanese air attacks were directed against U.S. airfields. During the operation Japan launched nearly 900 air raids. Nearly 4,000 Japanese aircraft were destroyed in combat including 1,900 Kamikaze planes. The intensity

[47] Appleman, *Okinawa: The Last Battle*, pp. 362–364.

and serious threat of Kamikaze attacks helped to promote a crash program for a shipborne air defense guided missile.

15. The Termination of World War II

Barely three years after denouncing the Japanese air attack on Pearl Harbor, President Roosevelt in early 1945 contemplated an "intensive bombing" campaign against the Japanese homeland to destroy Japan and its army. Admiral William Leahy, the President's wartime chief-of-staff, recorded in his diary in February 1945: "The President [Roosevelt] said that with the fall of Manila the war in the Pacific was entering a new phase and that we hoped to establish bases on the Bonins and to make plans for additional bombing of Japan . . . he hoped by intensive bombing to destroy Japan and its army and thus save American lives."[48]

The following month, the most destructive bombing raid in history took place when U.S. B-29's raided Japan and, according to the U.S. Strategic Bombing Survey, killed at least 83,000 people, injured 102,000 others and left 1,000,000 homeless.[49] Within six months, General LeMay's Twentieth Air Force could deliver 8,000 tons of bombs per raid.[50] During July 1945, LeMay's B-29's dropped 40,000 tons of bombs on Japan.[51] Navy carrier aircraft strikes against the home islands added substantially to that total. And, as part of the deliberate preparation to the planned invasion that was scheduled later that year, U.S. military power being redeployed from Europe to the Pacific would include the B-17's and B-24's that had been pounding Europe with mass bombing attacks. The U.S. capacity to bomb Japan was growing on a vast scale. Despite the fact that many primary targets in Japan were so badly burned they no longer represented useful targets, the U.S. program of putting 1,051,000 tons of bombs on Japan during 1945 moved ahead on schedule.[52]

Nonetheless, a unique "rain of destruction from the air, the like of which had never been seen on the earth" and "utter destruction" of Japan was spoken of by the United States in the summer of 1945 unless the Japanese surrendered immediately.[53] Propaganda leaflets dropped on Japan said: "You should take steps now to cease military resistance. Otherwise we shall resolutely employ this [atomic] bomb and all our other superior weapons to promptly and force fully end the war."[54] U.S. leaders clearly wished to avoid an invasion of Japan.

President Truman wrote in his memoirs that "General Marshall told me that it might cost half a million lives to force the enemy's surrender on his home ground."[55] Secretary of War Henry L. Stimson, soon after the war, recalled: "As we understood in July, there was a very strong possibility that the Japanese government might determine upon resistance to the end, in all areas under its control. In such an event the allies would be faced with the enormous task of destroying an armed force of five million men and five thousand suicide aircraft, belonging to a race which had already amply demonstrated its ability to fight literally to the death."[56]

---

[48] Leahy, *The Leahy Papers*, "Diary of William Leahy, 8 November 1947."
[49] Craven and Cate, *Matterhorn to Nagasaki: June 44 to August 45*, p. 617.
[50] Miller, *Men of the Contrail Country*, p. 39.
[51] Knebel and Bailey, *No High Ground*, p. 2.
[52] Arnold, *Global Mission*, p. 595.
[53] Truman, *Memoirs: Year of Decisions*, p. 422.
[54] Knebel and Bailey, op. cit., p. 170.
[55] Truman, op. cit., p. 416.
[56] Stimpson, "The Decision to Use the Atomic Bomb," *Harpers*, Feb. 47, p. 102.

Vannevar Bush had no doubt about the desirability of using the atomic bomb; he reportedly "knew it would end the war."[57] And, while a number of scientists opposed the use of the bomb only a relative minority of U.S. government officials opposed its use.[58]

Thus, the terrible retribution of Hiroshima and Nagasaki in early August 1945 when U.S. strategic aircraft delivered atomic weapons there, appeared as a capstone to the war which began for the United States as a result of a Japanese air attack. In effect, there seemed to have been demonstrated the overwhelming potential of strategic forces wielding nuclear weapons. The image portrayed was colored and given added dimension by other events and technical milestones of World War II. Taken together, there was projected a new security environment which would profoundly challenge conventional wisdom and "operational experience." This challenge elicited little recognition or response as the United States sought a transition from war to peace and failed to arouse notable interest even as the country's leaders began an exhaustive inquiry into the questions of Pearl Harbor where surprise air attack had brought America into the war.

The Pearl Harbor investigation saw lessons in that bitter experience centering on the need for better coordination among U.S. armed forces and improved intelligence. But the question of measures to defend against surprise attack by air were essentially ignored. Nonetheless, air and missile defense were a central security issue for the next twenty-five years. In the face of technological changes and advances in offensive capabilities operational procedures, tactics, techniques, and command and control procedures for air defense had to be adapted and fitted to the bounding development of new weapons and their projected potentials. Changes in the established pattern and structure of air defense concepts was inherent in the situation at the end of World War II.

B. Growth of Soviet Air Defense

1. The Interwar Years (1918–1941)

The origins of Soviet air defense can be traced to the first years of the regime when the Soviets had to defend against air attacks by the forces of foreign intervention and internal counterrevolution. During this period (1918–1920) small numbers of antiaircraft batteries and fighter aircraft were assigned to the defense of important centers such as Petrograd and Moscow. Because of the limited means which were available, the air defense had an "objective" or "point" character. The tactical approach of the time had the combat units of antiaircraft artillery spread out around the objective in such a fashion as to improve the mutual cover of a firing zones of adjacent batteries. Machine guns were placed on the roofs of buildings in order to do battle with low-flying enemy planes. Fighter aircraft assigned to defend an objective, as a rule, were based at the edge of the city and carried out combat operations up to the zone of antiaircraft artillery fire.[59]

The detection of enemy aircraft was the responsibility of a special air observation service which included nets of visual observation posts spread around the defended points to distances of 100–200 kilometers. Observers at these posts, upon visually or by sound detecting enemy aircraft, reported the information immediately to the air defense headquarters and the nearest airfield. The command of the air defense forces was concentrated in the heads of the chief of the air defense point. But because of inadequate

[57] Giovannitti and Freed, *The Decision to Drop the Bomb*, p. 324.
[58] Feis, *The Atomic Bomb and the End of World War II*, pp. 190–191.
[59] Batitskiy, *Voyennaya Mysl'*, p. 28.

communications the air defense commander could provide only initial direction. After which each unit commander acted independently in accordance with his own situation. Some centralized control did exist during battle, particularly in the linking of individual antiaircraft batteries in groups with each battery having its own sector of defense.[60]

Such were the origins of the Soviet national air defense system. The system is frequently identified as Soviet PVO. The term "PVO" is an abbreviation for two Russian words, "Protivovozdushnaya Oborona," which literally mean "Antiair Defense." Another term which is frequently encountered in transliteration from Russia is "PVO Strany," meaning "Air Defense of the Country," or, more conveniently, "National Air Defense."

In 1930, the Soviet air defense system began to come into much sharper focus. On 15 April 1930, a directive of the Revolutionary Military Council of the U.S.S.R. called for the Headquarters of the Red Army to prepare a national air defense plan and to present it to the Council of Labor and Defense for approval.[61] Specifically the plan was to encompass the following:

(1) identification of the most important state regions and points and specification of the means for their defense;
(2) presentation of measures which would secure the uninterrupted operation of industry during wartime;
(3) determination of measures of passive (local) air defense.

The commanders of military districts were then called upon to develop district air defense plans within the framework of the general air defense plan. The directive from the Revolutionary Military Council indicated that direct control of the air defense service in the districts was the responsibility of the chief of air defense of a district who was also designated an assistant chief of staff of the district.[62]

Within the Headquarters of the Red Army there was a Sixth Section which had been formed in 1927 and which handled matters of national air defense. This section was then upgraded in 1930 to the level of a directorate. It developed the General Plan for National Air Defense for 1930–1933.[63] Another document which was produced was the "Regulations on the Air Defense of the U.S.S.R." Under these regulations population centers and state installations of strategic, economic, or political importance which had to be defended against possible enemy air attack were designated air defense points or objectives. An air defense point encompassed all objectives located within its territory. The points were further distinguished according to whether they were to support the operations of the active army or were in the interior of the country.[64]

In accordance with the new regulations the air defense service of a point was organized and conducted on the basis of the involvement of all local military and civilian organs and also of public organizations. All resources were responsive to the chief of air defense of the point.[65]

During the period 1930–1932, the Headquarters of the Red Army organized and conducted several exercises in order to work on problems of the tactics of the air defense of the major centers and rear area objectives of the country. In the military districts special exercises were conducted with respect to the air

[60] Ibid., p. 29.
[61] Batitskiy, *Voyska Protivovozdushnoy Oborony Strany*, p. 43.
[62] Ibid.
[63] Ibid.
[64] Ibid.
[65] Ibid., p. 44.

defense at major points, the protection of rail movement against air attack, and the employment of barrage balloons. This latter step coincided with the formation of the first barrage balloon regiments.[66]

The gradual improvement of Soviet air defense continued apace until 1937 when the Soviet Government, noting the increasing danger of hostilities in Europe, implemented a new series of measures to strengthen air defense. Air defense corps were organized for the defense of the largest centers of the country, including Moscow, Leningrad, and Baku. These corps contained antiaircraft artillery divisions (the first such divisions had been formed only a few years earlier), antiaircraft search light regiments, observation, warning, and communication regiments, barrage balloon regiments, and machine gun regiments. Air defense divisions of similar but scaled-down composition were formed for the defense of certain other centers such as Kiev. The results of these and similar unit creations was to bring all air defense forces except fighter aviation together in combined arms formations. The fighter aviation which was assigned to the defense of the major centers of the country was subordinated to the air force commanders of the military districts. The basing of fighter aviation was accomplished under general air defense plans within a radius of 20–100 kilometers from the defended objectives. Fighter aviation participated in all general air defense exercises. In case of war, the fighter aviation was to come under the operational control of the air defense corps and division commanders for the performance of joint operations.[67]

As World War II drew nearer and then erupted in the West, additional changes were made. Practical experience was gained in the war against Finland and this was reinforced by observation of the pattern of operations in the West. The territory of the Soviet Union was divided into air defense zones (which coincided geographically with the military districts). In turn the zones were divided into air defense districts, and air defense points were identified within the districts. The zones were headed by air defense commanders who at the same time were deputies to the military district commanders.[68] At the national level, air defense was further upgraded with the establishment of the Main Directorate of Air Defense of the Red Army in accordance with a Defense Commissariat directive of 27 December 1940. The head of the main directorate was directly subordinate to the People's Commissar of Defense of the U.S.S.R.[69]

On the doctrinal side Soviet air defense concepts were put into a structured and balanced framework which contained the following basic points[70]:

(1) The massed employment of all air defense forces and means in order to combat enemy air action through the close coordination of all arms of air defense, avoiding the one-sided development of any single arm of air defense at the expense of the others;

(2) The grouping and concentration of air defense forces in those areas which were in the greatest danger of enemy air attack;

(3) The consistent implementation of the principle of the massed employment of air defense forces for the defense of the strategically most important points and objectives of the country;

(4) The maneuvering of air defense forces during the course of combat operations in accordance with the specific situation in order to reinforce the most threatened approaches and objectives;

(5) The close cooperation of National Air Defense Forces with the ground forces in accomplishing air defense in the frontal area.

---

[66] Ibid.
[67] Ibid., pp. 46–47.
[68] Ibid., p. 47.
[69] Ibid., p. 48.
[70] Ibid., p. 52.

2. Experience During World War II[71]

The Soviet Union's air defense forces began deployment and the taking of combat positions in a situation where the German had already initiated an invasion and where enemy air attacks were being mounted against major objectives in the border air defense zones. While the antiaircraft artillery units located along the western border were fully deployed and had taken their firing positions by the morning of 22 June 1941, many units located in the heartland were in camp and began moving out to defense objectives at a considerably later date. The Moscow alert batteries were combat-ready by about noon on 22 June. By that evening 102 out of 137 available batteries had taken their firing positions. The entire Moscow system was ready to repulse enemy air attacks by the morning of 23 June.

Full deployment of the air defense system to a combat-ready status took a considerably longer time. For example, the 18th separate Antiaircraft Artillery Battalion, which had the mission of defending the railroad bridge across the Dniester River near the city of Rybnitsa, did not reach its deployment position from camp until the sixth day after the war began. The aircraft warning service battalions stationed at the border continued their deployment during the first 2 days of the war with arriving reserve personnel. The second-line aircraft warning service battalions were not fully deployed until 25 June. As a whole, the antiaircraft defense of objectives located in zone up to 500–600 kilometers from the border, as well as Moscow and Baku air defense, was essentially deployed and ready to repulse an attack from the air by the evening of the second day of the war.

During the initial phase of the war the most important task of Soviet air defense forces was defense of major population and industrial centers; this involved utilization of the bulk of available fighter aircraft and medium and small-caliber antiaircraft artillery. Defense of lines of communication on the front occupied a secondary position during the initial phase. In addition to performing their immediate missions of repulsing mass enemy air strikes against airfields, personnel, cities, and lines of communication, air defense troops were compelled to take part in action against enemy tank and mechanized units. The brunt of the effort was handled by antiaircraft artillery, since fighter aviation was weakened by losses sustained during the initial days of the war.

The Germans were making a desperate effort to disrupt rail operations in the vicinity of the front. During the course of 1941 the Germans conducted approximately 6,000 air strikes against rail objectives. In spite of this effort only 1,504 raids (or 25 percent) succeeded in disrupting rail traffic as long as 6 hours.

At the end of 1941 major changes were made in the air defense system. By decision of the State Defense Committee a commander of National Air Defense Forces designated, and corresponding control entities were established: an Air Defense Fighter Aviation Directorate and Headquarters, and office of the Chief of Antiaircraft Artillery, etc. The air defense forces were removed from the jurisdiction of the military districts (fronts) and placed under the Commander of National Air Defense Forces and his command elements, with the exception of the forces defending Leningrad, which were left under the command of the Commander of Troops of the Leningrad Front. At the same time the previously existing air defense zones were replaced by the Moscow and Leningrad corps and a number of air defense divisional regions.

[71] The following account is based on an article by Soviet authors Dzhordzhodze and Shesterin, who summarize a much more detailed account by Marshal P. F. Batitskiy, op. cit.

The fighter aviation corps and divisions detached for air defense missions were operationally subordinate to the Commander of National Air Defense Forces, and locally to the corps and division air defense region commanders. Soon thereafter, at the beginning of 1942, aviation regiments and divisions engaged in air defense were placed entirely under the Commander of Territorial Air Defense Forces. In accordance with an order issued by the People's Commissar of Defense of the U.S.S.R., 56 airfield service battalions were assigned during this period to support air defense fighter aviation. These battalions were placed under the commanders of the corresponding fighter aviation corps, divisions, and detached regiments. This signified that one of the basic air defense arms—National Air Defense Forces Aviation—was organizationally constituted, but also that conditions had been created for organizing unified control of all air defense forces and securing more effective coordination of these forces.

The heaviest fighting involving air defense forces in the summer–fall campaign of 1941 was in the defense of Moscow and Leningrad. Actions in the defense of these cities essentially constituted air defense operations, as a result of which enemy air power sustained heavy losses. The following figures indicate the scale of these operations. From July through December 1941 a total of 18,000 German sorties were recorded in the coverage areas of the air defense forces defending Moscow and Leningrad. The troops of two air defense zones (Northern and Moscow) took part in action against enemy aircraft; these operations included the participation of more than 1,800 medium and small-caliber antiaircraft guns and 600–700 fighters. In the course of these actions air defense forces destroyed more than 1,700 enemy aircraft.

An important place in improving national air defense was occupied by matters pertaining to change in the organizational forms of the air defense troops, since these forms exerted a direct influence on combat activity, and on the efficiency of utilization of available manpower and hardware. This was linked in large measure with the over strategic situation, with the nature of enemy air and ground actions, as well as the nation's economic potential for the establishment and equipping of new air defense units. At the beginning of 1942 the Moscow Front and the Leningrad Air Defense Army were established on the basis of the former Moscow and Leningrad air defense corps. Development of an enemy air threat against the Baku oil fields led to the establishment of the Baku PVO Army.

Further development of air defenses and the art of employment of air defense forces came with changes in the character of the war. The Soviet Army, after the Battle of Stalingrad, retook two-thirds of the enemy-occupied territory. This fact had a definite influence on the character of air defense. It was reflected first and foremost in the maneuvering of units in the wake of the advancing forces, in organization of closer coordination with front and army air defense as well as change in the structure of national air defense control.

In June 1943, another reorganization took place in the air defense forces. This reorganization consisted essentially in the following. Two air defense front directorates were established—Western and Eastern. The Office of the Command of National Air Defense Forces was abolished, and supervision of the activities of the air defense fronts and zones, weapons planning and supply was transferred to the Red Army Commander of Artillery. The following elements were established under that commander: Air Defense Forces Central Headquarters, Air Defense Fighter Aviation Central Headquarters; Air Defense Main Inspectorate; Air Defense Forces Combat Training Directorate; Aircraft Warning Service Center. The fighter aviation defending Moscow was unified into the First Air Defense Fight Army.

As the gap increased, however, between the units of the advancing Western Air Defense Front, which were moving ahead in the wake of advancing forces, and the units of the Eastern Front, which had remained

in place, the drawbacks of this reorganization became more and more obvious. While the Western Front, which was operating along the front lines, was heavily engaged against enemy aircraft, the troops of the Eastern Air Defense Front were rather idle, in view of a lack of regular enemy air operations.

Another reorganization took place in the spring of 1944: the Western Air Defense Front was changed into the Northern Front, while the Eastern Front was changed to the Southern Air Defense Front; this eliminated the above-mentioned drawbacks of the previous organization. At the same time a Transcaucasian Air Defense Front was established, based on the Transcaucasian Air Defense Zone.

After the Battle of Kursk the Germans lost their control of the air, which resulted in a change in the basic utilization of their air power. The Germans almost totally stopped bombing objectives deep in the rear areas, shifting their main efforts to action along the line of the front. In some cases the German command was able, by maneuvering units, to concentrate heavy air power to carry out major missions. For example, the Germans were successful in maintaining a fairly high level of air activity in the Ukraine and Belorussia in 1944, as well as on the approaches to Berlin in the winter of 1944–1945. An indicator of German air activity during this period is the fact that in February 1945 alone the Germans flew 18,000 sorties to prevent the crossing of the Oder River by the forces of the First Belorussian Front and to provide support for counterattacks by German ground troops.

In addition to maneuvering its available air power, the German command began employing other air attack weapons to destroy objectives in the front area: radio controlled bombs and aircraft, heavily loaded with explosives. The explosive force of such an aircraft exceeded that of a simultaneous strike by 10 to 12 bombers. For this reason they were employed chiefly against major crossing points, railroad junctions and other important objectives in the area of the front.

Protection of lines of communication along the front became particularly important in the third phase of the war: the Germans considered disruption of these lines of communication to be one of the principal missions of their air power. Large-scale strikes were employed. For example, in the winter of 1944, 1,200–1,450 combat aircraft were concentrated in the zone of action of the Ukrainian fronts; this comprised 53–56 percent of total German aircraft on the Soviet-German Front.

The Soviet command had concentrated more than 2,000 antiaircraft guns, 1,650 antiaircraft machine guns, approximately 450 fighters, and 300 antiaircraft searchlights for the purpose of protecting rail objectives in the south. The Soviet command countered massed utilization of enemy air power with massed utilization of air defense forces. As a result, in 1944 German aircraft succeeded in flying only 1,161 raids on rail objectives, while in 1943 the figure had been approximately 7,000. There were also considerably fewer cases of rail traffic disruption. There were 1,039 disruptions in 1943, while in 1944 there occurred only a few brief stoppages in a few rail traffic areas.

In addition to protecting lines of communication and immediate rear area objectives, the air defense forces were called upon to carry out other missions in close coordination with other armed forces branches. They took part in encirclement operations, provided protection for friendly troops in attack position and protected crossing areas, airfields, and supply trans-shipment facilities. Air defense forces were continuously redeployed behind the advancing forces in connection with occupation of new areas and entire countries. This was a distinctive feature in air defense forces utilization in the third phase of the war. For example, in order to strengthen the defense of rail centers and other important objectives in the area of the First and Second Ukrainian Fronts, two fighter divisions and more than 40 antiaircraft artillery regiments were rede-

ployed in May–June 1944 from the rear areas of the Southern Air Defense Front to the front. In the summer and fall of 1944 five air defense corps were moved from the heartland beyond the Soviet borders to protect objectives in the vicinity of the front. The continuous redeployment of air defense capabilities did not cease until the war came to an end.

The changes in the grouping of National Air Defense Forces manpower and equipment, the continued Soviet Army advance westward, and the movement of new air defense units behind the advancing troops caused certain control difficulties. The Southern and Northern air defense fronts proved unable to maintain efficient control over their units, which were dispersed over a large, deep area. In connection with this, in December 1944 the Northern and Southern Air Defense fronts were transformed into the Western and Southwestern air defense fronts respectively, while a new, Central Air Defense Front, with headquarters in Moscow, was established to control the units protecting objectives in the deep rear areas.

Development of the air defense system took place on a foundation of steady technological advances and the equipping of the Armed Forces with increasingly sophisticated weaponry. Important qualitative changes occurred, for example, in air defense fighter aviation. By 1944, there were mostly new types of aircraft (LA-5fn, LA-7, YAK-3, YAK-9). Radar came into extensive use for intercept vectoring. The equipment and weapons of the other arms of National Air Defense Forces also underwent improvement and modernization during the course of the war.

With these organizational changes, the basic principle of employment of air defense forces as a whole did not undergo major changes during the war. Antiaircraft defense remained essentially point defense, which was dictated by the technical level of available resources. At the same time improvement in the quality of air defense weapons and combat equipment particularly fighters, improvement in utilization techniques, the adoption of radio communications for control purposes, and improved communications reliability made it possible gradually to transition to new principles of PVO organization, from the defense of individual objectives to defense of entire areas and zones.

The development of the concept of zone defense can be illustrated with the example of the Moscow air defense during the first year of the war. In particular, the fighters defending Moscow were at the same time defending a number of cities and objectives in the Moscow industrial region. Deployment of radar facilities on the distant approaches to Moscow (the Rzhev, Sychevka, Vyaz'ma line) and the redeployment to that area of a number of air regiments greatly enlarged the Moscow air defense boundaries and made it possible to intercept any aircraft at some distance from Moscow. Fighters based in the immediate vicinity of Moscow were used to repulse major air attacks on objectives in the Moscow industrial region. In addition, the deployment of aircraft warning observer posts a considerable distance from Moscow and the establishment of a solid-coverage aircraft spotting zone, and organization of reliable control and warning communications which cover the entire area were testimony to the fact that the air defense system of such a major center as Moscow had developed beyond the framework of defense of a separate, although very important objective.

This air defense principle did not become the basic principle of the overall national air defense system. Examples of this type of defense, however, did occur even after the Battle of Moscow. Fighter units based within a radius of up to 200 kilometers from Kursk were used to repulse mass German air attacks on Kursk (June 1943), in spite of the fact that they had the mission of defending other objectives. In 1944, fighter regiments protecting the cities of Kiev and Zhitomir were used to repulse night air attacks on the Korosten'

Rail Center. During the defense of lines of communication along the front in 1943–1944, fighter units were assigned to protect not only major rail centers, bridges, and river crossing areas, but also entire main rail lines.

This experience demonstrated the feasibility of employing fighter aviation for the purpose of simultaneous protection of many objectives located within fighter effective radius of action. This principle made it possible to utilize the maneuver capabilities of fighter aircraft vigorously and fully, when necessary concentrating large numbers of fighters in a threatened area to repulse enemy air attacks. This utilization of fighter aviation became possible because of qualitative improvements and the extensive adoption within the air defense system of radio and radar equipment for fighter control and guidance.

Appendix B

A Chronology of American Air and Ballistic Missile Defense Systems

1944

2 October	Army issues directive to AGF, AFF, and ASF (the McNarney letter) allocating responsibility for R&D.
	AAF has responsibility for all guided or homing missiles dropped or launched from aircraft.
	AAF also has responsibility for all GM and homing missiles launched from ground that depend on the lift of aerodynamic forces. AGF and AAF will designate characteristics when and as they affect their interests.
	ASF has R&D responsibility for all GM and homing missiles launched from ground which depend for sustenance primarily on missile momentum. AGF and AFF designate characteristics of interest.

1945

31 January	A letter from Office, Chief of Ordnance to BTL authorizes negotiations for a formal study of an antiaircraft guided missile.
8 February	Project Nike-I is initiated.
May	AAF signs its initial development contract for P-86, formerly Navy XFJ-1.
20 June	Army Ground Forces Equipment Review Board (Cook Board) submits its report on equipment for the postwar Army. "High velocity guided missiles, preferably capable of intercepting and destroying aircraft flying at speeds up to 1,000 miles per hour at altitudes up to 60,000 feet or destroying missiles of the V-2 type, should be developed at earliest practicable date."
July	BTL furnishes written report AAGM Report (Study of an Antiaircraft Guided Missile System). Signal Corps formally establishes Air Defense Fire Distribution System (ADFDS) Project 414A which will lead to development of AN/FSG-1 (Missile Master).
August	With the ending of World War II, early warning radar stations still operational in CONUS are inactivated.
14 August	Subcommittee Number 4 of the Guided Missile Committee recommends the services include in their R&D programs studies covering:
	(a) A system for control of SAM missiles against simultaneous attacks from all directions.
	(b) An effective short range SAM to replace the 40-mm.
	(c) A guided missile for defense against other supersonic GM and aircraft.

(d) An experimental program to determine the optimum warhead characteristics of surface-to-air missiles.

28 August — AAF makes initial design request for a propeller driven interceptor to replace the P-61; the request ultimately results in development of the jet-powered F-89.

13 September — Ordnance Technical Committee initiates a project for development of SAM based on military characteristics outlined by Antiaircraft Artillery Board in March 1945.

18 October — Patch Board submits its recommendations for an AAA organization which will effectively counter a future air threat incorporating rockets and guided missiles as major weapons.

November — The idea of a jet-powered interceptor as a replacement for the P-61 is accepted by AAF; military characteristics for the plane approved.

1946

4 January — CG, AGF in letter to CG, ASF requests a high priority study on defense against the V-2 and similar GM.

February — Boeing begins design studies for GAPA Project, a ram-jet vehicle capable of reaching an altitude of 60,000 feet at a range of 35 miles at supersonic speed. This will lead to development of Bomarc.

13 February — Army Deputy Chief of Staff requests major commands to review McNarney instructions of 2 October 1944 and recommend modifications to obtain most efficient performance.

27 February — CG, AGF in response to Army DCS 13 February letter recommends:

(a) The GM Committee of JCS Joint Committee on New Weapons be disbanded.

(b) A joint Army-Navy GM Board empowered to coordinate and guide or control GM development for Armed Forces be organized without delay.

(c) A revised directive on the development of GM within the Army be published.

(d) A directive be published establishing the division of responsibility between AAF and AGF for operational employment of GM. This would give seacoast defense, surface-to-air, and surface-to-surface to AGF.

March — AAF awards contract to GE for the study of interceptor weapons for ballistic missile defense. The first program of its kind and is designated the Thumper Project. It will parallel the University of Michigan Wizard Project initiated the following month.

Six manufacturers submit designs in interceptor competition, most are for jets, a few are for conventional planes. One of four Northrop designs is accepted (ultimately the F-89).

27 March — HQ ADC activated at Mitchel Field, New York.

April — AAF awards University of Michigan a contract to study possibility of developing supersonic missile capable of reaching 500,000 feet (Project Wizard).

17 April — AGF submits to the GM Committee a summary of its program which includes requirements for both an antiaircraft GM with a range of at least 50,000 yards and an interceptor GM with a range of at least 100,000 yards, for engaging very high altitude supersonic missiles of the V-2 type.

14 May — WD Circular 138 stipulates the AAF, ADC will provide for the air defense of CONUS and will control and train such AAA units as may be assigned to it. AGF and AAF to cooperate in developing AAA tactics, deciding on types of weapons required, and

drawing up manning and equipment documents for AAA units. AAF will recommend to WD the means, including AAA, required for defense.

25 May — ASF, in connection with the Proposed National Program for guided missiles, outlines existing ordnance projects: ORCIT, HERMES, Nike-I.

29 May — The WD Equipment Board (Stilwell Board) establishes the following requirements:

(a) An antiaircraft missile capable of destroying aircraft traveling 1,000 miles per hour at altitudes up to 60,000 feet at a horizontal range of 50,000 yards.

(b) An interceptor guided missile with a range of 100,000 yards, capable of intercepting aircraft and guided missiles of the V-2 type traveling at speeds greatly in excess of the sonic.

4–6 June — At an Air Board Meeting, the decision is taken to propose integration of antiaircraft artillery into the Army Air Forces.

14 June — CG, AGF sends CG, AAF an AGF study of the air defense problem proposing:

(a) Division of the air defense mission.

(1) Local air defense to AGF.

(2) AAF defenses beyond reach of ground weapons.

20 June — P-86 letter contract of May 1945 superseded by definitive R&D contract; three prototypes to be built.

26 August — CG, AGF informs Army CoS that a point has been reached in the development of certain missiles at which assignment of operational responsibility is possible. AGF position is that any missile launched from the ground is the responsibility of the Ground Forces as a part of their logical mission.

September — AMC dissatisfied with XP-89 mockup; many changes suggested.

18 September — In a summary sheet this date, WD expresses its agreement with AAF that air defense mission should be unitary but withholds decision as to the future role of guided missiles in air defense. It announces the AAF ADC will be integrated, incorporating AAA elements. ADC will ensure that assigned AAA units are trained in the ground combat role, and AGF will continue to provide technical training.

26 September — Army Ordnance, In OCM 31055, establishes the priority of the Nike-I System as 1-A.

7 October — Army CoS rescinds the McNarney Directive of 2 October 1944 and directs CG, AAF assume responsibility for R&D activities pertaining to GM and associated items of equipment.

15 October — AGF requests authority to establish military characteristics of those missiles of which it is the ultimate user and recommends an early decision on operational responsibility for guided missiles.

20 December — With P-86 prototypes still under construction, the first production order for 33 planes is issued.

1947

13 January — As a result of WD decisions in the field of R&D of GM, AGF undertakes a study to determine policy, particularly with respect to operational employment and concludes that AGF should be assigned responsibility for operational employment of all ground-launched missiles.

February — Fifteen YP-84A's delivered to AAF.

21 May	First postwar AC&W organization, the 505th AC&W Group, is activated at McChord AFB, Washington.
20 June	Army Ordnance Department establishes, as part of the HERMES Project, development of a two-stage missile with the code name Bumper.
July	AGF and AAF agree on air defense procedures prior to designation of overall theater commander.
25 July	Congress passes the National Security Act of 1947 creating three separate services, making permanent the JCS organization and creating the National Military Establishment.
19 August	CG, AAF and CG, AGF disagree over GM development priorities.
September	In extension of National Security Act of 1947, the JCS formulate a functions paper which defines Army and Air Force roles and missions.
15 September	The National Security Act of 1947 becomes law. Paragraph 3, Section IV, includes the following matters agreed between AGF and AAF with respect to SAM GM: (a) Security missiles designed for employment in support of Army tactical operations will be assigned to the United States Army. (b) Missiles designed for employment in area air defense will be assigned to the USAF.
18 September	The USAF is established.
23 October	A flight of 48 Soviet TU-4 (Bull) bombers is observed in the U.S.S.R., establishing a presumptive capability to bomb the continental United States by flying one-way missions.
21 November	USAF CoS approves Plan Supremacy for construction of an elaborate postwar radar network. The plan is withdrawn in 1948 in favor of a more modest initial program.
17 December	USAF grants ADC authority to use fighter and radar forces of SAC, TAC, and ANG in an emergency. The ANG would constitute a major source of air defense units.

1948

	Testing of the pilot model 75-mm. AA gun, Skysweeper, is begun.
February	An Air Defense Policy Panel recommends that AAA be integrated into the Air Force.
11–14 March	Secretary of Defense rejects demand for integration of AAA into USAF at Key West Meeting with JCS. The Army will organize, train, and equip AAA units and provide them "as required" for air defense.
16 March	CG, AFF recommends that existing agreements concerning employment of GM be reworded to indicate that USAF has primary interest in the command and employment of air-launched GM and the Army in ground-launched GM.
21 April	Secretary of Defense order assigns primary responsibility for air defense of CONUS to USAF.
13 May	The Bumper missile is fired successfully for the first time.
9 June	The Committee on GM of the Research and Development Board recommends that SAM be the responsibility of Army Ordnance if designed to be launched from the ground.
8 October	GOR for new all-weather jet interceptor issued. Early availability given precedence over capability against aircraft more advanced than Tu-4.

25 October — The first air defense division organization, the 25th Air Division, is established at Silver Lake (Everett) Washington.

16 November — The 26th Air Division, the first division on the East Coast is activated at Mitchell Field.

1 December — The Continental Air Command (CONAC) is established with Headquarters at Mitchell AFB. ADC and TAC made into subordinate "operational" headquarters.

1949

Army and Air Force Authorization Act of 1949 authorizes the Secretary of the Army "to procure materials and facilities, including guided missiles, necessary for the maintenance and support of the Army."

January — Army establishes a formal requirement for a SAM system to combat ballistic missiles.

13 January — ADO for "1954 Interceptor," to have a capability superior to that anticipated for Soviet intercontinental jet bombers, is issued. Coordinated development of the plane as an integrated system is planned.

February — A Panel on Air Defense recommends to General of the Army, Omar Bradley, Chairman, JCS, that an AAA staff section be added to HQ ADC and that ADC be given operational control of AAA units allocated to air defense by JCS.

19 February — Chief, AFF, establishes a requirement for a long range, surface-to-air GM capable of intercepting and destroying missiles of the V-2 type.

1 March — The six numbered air forces of CONAC are relieved of air defense responsibilities which are assigned to Eastern and Western Air Defense Liaison Groups.

21 March — Congress approves a permanent postwar radar net for CONUS and Alaska. The President signs a bill authorizing the Secretary of Air Force to construct a "permanent" aircraft control and warning system for CONUS and Alaska.

24 March — AFF states its position on GM responsibility as follows:

(a) The Air Force has paramount interest in the command and employment of air-launched guided missiles and units.

(b) The Army has paramount interest in the command and employment of ground-launched GM and units.

1 April — The 25th and 26th Air Divisions are transferred to ADC.

May — $48 million contract issued for modification of F-89 and 48 production models of F-89A.

Procurement of F-86D recommended.

16 May — Secretary of Army recommends to Secretary of Defense that operational responsibility for all land-launched guided missiles be assigned to DA and that a National Military Establishment research and development program for GM be jointly undertaken and supported with each service being assigned primary cognizance for RED as follows:

(a) Army — Land-launched SAM and SSM.

(b) Navy — Ship-launched SAM and SSM.

(c) Air Force — AAM and ASM.

31 May — F-86 enters service.

8 August	The Joint Strategic Plans Group, in a "split" paper, advises JCS on the assignment of responsibility for major categories of GM. View "A," which the Group recommends for approval, assigns all land-launched missiles to Army, ship-launched to Navy, and air-launched to Air Force. View "B" advises postponing a decision on the basis that the missile art has not yet advanced sufficiently to make determination possible.
26–29 August	USAF detects a nuclear detonation "somewhere on the Asiatic mainland."
19 September	27 more F-89A's ordered.
23 September	President Truman announces an atomic explosion has taken place in the U.S.S.R.
October	Procurement order for F-94 raised to 288 following Soviet atomic explosion; later raised again to 368.
7 October	Initial procurement order for F-86D issued: 2 prototypes and 122 production models.
29 October	Congress appropriates $85.5 million for construction on a "permanent" aircraft control and warning system for CONUS and Alaska.
17 November	In JCS 1620/12 the JCS conclude that "it is impracticable at this time to assign the several services, in accordance with their assigned functions, responsibility for the entire guided missile field. As a general rule, GM will be employed by the Services in the manner and to the extent required to accomplish their assigned functions. Development in certain categories has progressed to the point where the fields of their normal employment may be recognized." GM supplanting antiaircraft artillery are assigned to the Army as are surface-launched GM which supplant or extend the capabilities of artillery.
December	Construction is ordered on 24 priority radar stations of the "permanent" aircraft control and warning system of CONUS and Alaska.
December	The missile tracking portion of the Nike ground system is successfully tested at White Sands Proving Ground.
December	F-86D chosen as backbone of interceptor force.
8 December	The 32nd and 28th Air Divisions are activated at Stewart and Hamilton AFB.
16 December	30th Air Division activated at Selfridge AFB.
22 December	F-86D makes first flight. During late 1949, the F-86A has been replacing the P-80 and P-84.
27 December	Eastern Air Defense Force publishes rules of engagement for Fourth Army.

1950

January	Joint Defense Planning Committee informs CONUS armies that joint agreements with air forces will be drawn up on the basis provided by the rules established 27 December 1949 by Eastern Air Defense Force. However, CONAC disapproves, especially the EADF/Army position that aircraft should be fired upon unless identified as friendly. CONAC assumes that no AC&W system, current or future, can undertake to warn AAA when friendly aircraft enter its area. The CONAC position, never abandoned, is that AAA must be in constant "hold fire" status until released by the air commander to fire at a particular aircraft. This controversy will be ended by the Collins-Vandenberg agreement of 1 August 1950.
January	CONAC Operations Plan 1-50, "Air Defense of the United States" is issued to Eastern and Western Air Defense Forces. It contains a listing of targets to be defended by AAA.

	HQ USAF, authorizes around-the-clock air defense operations over the Atomic Energy Commission works at Hanford, Washington. HQ USAF, assigns units of the Air Defense Forces equal personnel priority with SAC and overseas units.
March	Construction of the "permanent" aircraft control and warning system begins.
March	Battery C, 518th AAA Battalion (120-mm. gun) becomes operational at Hanford, Washington. The remainder of the BN arrives on site 1 May.
	An ad-hoc interservice committee recommends sixty critical locations to be defended by AAA. The Army and Air Force finally agree on twenty-three which are to be defended by a federalized Army National Guard Force.
	Army Ordnance initiates development of a tactical Nike system (Nike-I).
	ADA study of AAA C^2 problems concludes that a AAA command is essential. This study is under review when South Korea is invaded.
May	Provisional HQ, Albuquerque Air Defense Sector, is established by USAF, ADC, at Kirtland AFB, New Mexico, to exercise operational control over the radar and fighter forces defending the Los Alamos and Sandia areas.
May	F-94 enters service.
15 May	AFF directs its Board Number 4 to study and formulate military characteristics for countermeasures against air-to-surface and surface-to surface missiles.
1 June	The Lashup radar network of 44 radar stations is completed. This network is to operate with World War II radar equipment until the "permanent" AC&W system is completed.
	The first Canadian-U.S. Emergency Air Defense Plan is approved.
	CONAC is formally authorized to establish a Ground Observer Corps.
25 June	North Korea invades South Korea.
27 June	Around-the-clock operations begin in United States air defenses.
July	Air Force puts electronics and control system for "1954 Interceptor" under development contract.
1 July	Army Antiaircraft Command (ARAACOM) is established with HQ in Washington, D.C. per DA, CO 20, 29 June 1950.
	CAA establishes Air Defense Identification Zones (ADIZ) in vital areas of the United States.
11 July	MG Willard W. Irvine is directed to assume command of ARAACOM and "to support the CG, CONAC, on basis of joint agreements between DA and DAF pertaining to policies and procedures for joint air defense of CONUS." When so directed by the JCS or in case of air attack on the United States, CG, ARAACOM, is to assume command of AAA units allocated to air defense.
15 July	CONAC recommends that 20 squadrons of the Air National Guard be called to federal service to buttress the air defense system.
19 July	The three armed services issue regulations establishing Air Defense Identification Zones.
August	F-94B begins to reach operational units.
1 August	A Memorandum of Agreement signed by General J. Lawton Collins, CoS, Army and General Hoyt S. Vandenberg, CoS, USAF, provides for joint decision at departmental

	level on targets to be defended by AAA, mutual Army/USAF agreement on locations of defenses (except that tactical dispositions are to be determined by AAA commanders), Army staff representation at each echelon of USAF command structure charged with air defense, and operational control of AAA by USAF division commanders "insofar as engagement and disengagement of fire is concerned."
7 August	A provisional Southern California Air Defense Sector is established with headquarters at Fort MacArthur, California, and given operational control of radar and fighter forces in the area.
14 August	AFF Board Number 4 informs Chief, AFF that DA has no projects to fulfill the requirement for an AMM and recommends that it be directed to prepare military requirements for search and tracking radar. Also, that certain Signal Corps projects in radar search and tracking research be provided funds and be pursued to completion.
18 August	Description of "pure interceptor" for 1954 issued for design competition.
24 August	President Truman authorizes interception and engagement of unidentified aircraft anywhere in the United States.
September	Public Law 778 gives the Civil Aeronautics Authority (CAA) power to regulate civil air traffic in peacetime.
	In reply to a proposal by LTG Whitehead, CG, CONAC, to establish a third Air Defense Force, LTG Norstad, Acting VCoS, USAF, suggests deferring change until current consideration by the JCS concerning a unified command for air defense reaches a conclusion.
1 September	Eastern and Western Army Antiaircraft Commands are established with HQ at Stewart AFB, New York, and Hamilton AFB, California. USARAACOM G03, 28 August 1950.
20 September	27th Air Division is activated at Norton AFB, California, to replace provisional Southern California AD Sector.
28 September	First production model of F-89 delivered.
8 October	31st Air Division activated at Fort Snelling, Minnesota. The seventh division of CONAC is without area responsibility in EADF and will be reassigned to Central ADF on 20 May 1951.
November	A revision of DA Ops Plan for 1950 (DA-OP-US-1-50) includes a list of 23 targets, listed in alphabetical order, to be defined "to the extent appropriate units are available." The list has been jointly prepared and is the first approved list of vital objectives.
1 November	HQ ARAACOM, is moved from Washington, D.C. to Mitchel AFB, New York where it initially serves as the AAA element of CONAC staff.
December	By Executive Order, the CAA is empowered to require filing of flight plans by civilian aircraft operating within coastal, domestic, or international boundary ADIZ's. This gives the air defense system its first real control over peacetime air traffic.
December	The Committee on Guided Missiles of the Research and Development Board recommends that fiscal support for air defense be increased to permit initiation of new projects to fill serious gaps. A homing-all-the-way missile is specifically recommended. The HAWK Project is initially to be limited to development of a short-range, SAM to be effective against aircraft and guided missiles attacking at speeds up to 600 knots and from altitudes of 30,000 feet to 1,000 feet at 10 miles range and 500 feet at 6 miles range.

1 December	CG ARAACOM, assumes responsibility for planning all AAA defenses within CONUS.
6 December	CG CONAC requests authority to call up 15 Air National Guard squadrons to federal service and to place 23 other squadrons on call.

1951

January	Airframe proposals for "1954 Interceptor" submitted.
1 January	ADC is reestablished as a major command of USAF with HQ Ent AFB, Colorado. Eastern and Western ADF, air divisions and other organizations with primary missions related to air defense are reassigned from CONAC.
5 January	34th Air Division activated at Kirtland AFB replacing the provisional Albuquerque Sector.
8 January	LT General Ennis C. Whitehead is appointed CG of the reestablished Air Defense Command.
10 January	General Collins, Army CoS, directs G-3 to prepare a study of "Preferential Treatment of Selected National Guard (AAA) Units" with a view to future employment of state-commanded AAA units.
10 January	Director of Guided Missiles for the Secretary of Defense, Mr. K. T. Keller, informs Secretary of Defense that immediate acceleration of production processes for Nike-I is necessary in order to get the missile system out of R&D into the tactical weapon stage at the earliest practicable date. The objectives of this effort are: (a) Production of 1,000 missiles by 31 December 1952. (b) Production facilities capable of producing 1,000 missiles per month by 31 December 1952. (c) Production by 31 December 1953 of sufficient ground support equipment for twenty tactical battalions. (d) Production facilities by 31 December 1953 capable of producing ground support equipment for three tactical battalions per month.
15 January	HQ, ARAACOM is moved to Colorado Springs, Colorado. The office of the CG is at Ent AFB, the remainder of the staff is located initially in the Antlers Hotel.
23 January	CONAC receives authority to call 15 National Guard Squadrons into federal service and to place other squadrons on call as requested 6 December 1950.
1 February	15 ANG fighter squadrons are federalized and assigned ADC.
19 February	The first production contract is initiated for Nike-I. A letter order is issued to the Western Electric Company effective until such time as a definitive contract is written.
March	341 F-86D's on order; number increased to 979 two months later. First F-86D delivered and tested. Plane targeted for production before fire control and engine systems proven.
1 March	Central Air Defense Force is activated at Kansas City. 29th Air Division is activated at Great Falls, Montana.
2 March	Another six ANG fighter squadrons are federalized.
15 March	MG Maxwell D. Taylor, Army G-3, requests that Chief, National Guard Bureau, assure prior G-3 approval of further allocations of nondivisional Army National Guard AAA

	gun battalions, in order to preclude their federal recognition in locations far removed from planned vital objectives of air defense.
19 March	33rd Air Division activated at Tinker AFB, Oklahoma.
29 March	Committee on Guided Missiles approves Hawk as a SAM project for Army and requests that the Technical Evaluation Group study and make recommendations on optimum conduct of the program.
4 April	ARAACOM forwards the first master deployment plan: "Operations Plan for Antiaircraft Defense of the United States (AA-OP-US-1-51)."
10 April	CG, ARAACOM, assumes command of all AAA units allocated to CONUS air defense—six AW, nine 90-mm. and eight 120-mm. battalions plus four Bde and seven Gp HQ, eight AAA Ops Det and 15 Signal radar detachments.
24 April	Central ARAACOM established with HQ at Kansas City, Missouri. Organized 1 May 1951.
May	DA approves conversion of ARAACOM's AW battalions to Skysweeper by end of 1953.
	McDonnell XF-88 wins long-range escort fighter competition over six rivals; procurement delayed.
June	F-89 delivered to operational units.
	176 F-94B's accepted in FY 1951.
	Ten federalized Army National Guard gun battalions are assigned to ARAACOM—the first accession of such units during the Korean action.
14 June	AFF forwards to DA the Army military characteristics for a low-altitude, short-range, SAM guided missile.
20 June	Secretary of Army requests AFF to study a report published by Boeing and University of Michigan entitled "Preliminary Study of a Missile Defense System" and comment on the extent to which Bomarc fulfills the Army's requirement for an antimissile missile.
22–24 June	The first nationwide joint air defense exercise is conducted.
July	Convair gets prototype development contract for "1954 Interceptor." Republic and North America also receive contracts for their designs; soon afterward, Republic program terminates, North American design (F-103) kept only as "experimental aircraft."
1 July	35th Air Division is activated at Kansas City, Missouri. This is the eleventh division in ADC.
18 July	Secretary of Defense notified Chairman, R&D Board of his desire for Army to proceed with the Hawk Project and that funding is approved.
1 August	An exchange of notes constitutes formal United States Canada agreement for building the Pinetree radar net extension in Canadian territory.
25 August	LT General Benjamin W. Chidlaw succeeds LT General Whitehead as ADC commander.
28 August	ARAACOM conducts its first unilateral exercise; 75 percent of its batteries occupy tactical positions for seven weeks until 18 October. *The exercise, planned to last only 30 days, is extended because of intelligence indications.*

September	When it becomes clear that the "1954 Interceptor" with the specified characteristics will not be ready by 1954, the construction of an interim version (F-102) by Convair is automated.
September	HQ, 35th Air Division is moved to Dobbins AFB, Georgia.
5 September	Secretary of Defense notified Secretary of Army that Army is authorized to proceed with implementation of Hawk Program.
October	ARAACOM 25 percent Rotation Program initiated. All AAA battalions within six hours' travel of tactical sites are required to maintain one battery on-site at all times. Major Commanders are authorized to order deployment of other batteries under specified emergency conditions.
18 October	AFF, after reviewing Boeing–University of Michigan study of Bomarc missile, concludes that the missile will only partially fulfill Army antimissile requirements. AFF withdraws a Board 4 recommendation that Army give no consideration to support of Bomarc project, but agrees that the missile would only partially meet the need for a defense missile and would not affect the Army's responsibility in air defense in the foreseeable future.
30 November	ARAACOM submits to DA its first deployment plan for SAM.
	ARAACOM submits to DA its plan for the exploitation of ARNG antiaircraft potential.
	Designation of McDonnell Voodoo changed from F-88 to F-101.
December	The President orders procedures established for the control of electromagnetic radiations in an emergency.
31 December	ARAACOM includes 6 Bde HQ, 13 Gp HQ, 13 AAA Ops Det, 6 AW battalions, 24 90-mm. battalions, 15 120-mm. battalions, and 23 signal radar maintenance units.

1952

	F-86D program delayed because of difficulties in fire-control and engine system.
	F-89 has seven accidents, resulting in eight fatalities, in first six months of 1952.
January	180 F-94B's were accepted in first seven months of FY 1952.
	Convair's original letter contract for "1954 Interceptor" expanded to include start of production engineering and tooling program. Convair later authorized to proceed with building of two YF-102 prototypes and seven production aircraft for 1954.
15 January	McDonnell accepts F-101A contract.
18 January	ADC proposes a requirement for small, unmanned radars (gap fillers).
1 February	HQ 25th Air Division is moved from Silver Lake to McChord AFB, Washington.
15 February	HQ 32nd Air Division is moved from Stewart AFB to Hancock Field, New York.
	ARAACOM resubmits its 30 November 1951 plan for SAM deployments.
26 February	DA authorizes ARAACOM to coordinate planning for utilization of ARNG units.
	USAF withdraws delegated responsibility for development of ground-based electronic countermeasures against missiles from Army. Tendered by USAF on 18 February 1948 and accepted by Army on 3 April 1948.

10 March	The first Multiple Corridor System for identification of traffic arriving from overseas is placed in operation outside San Francisco.
31 March	Chief of Ordnance directs Picatinny Arsenal to study the feasibility of an atomic warhead for the Nike-I missile.
April	DA approves an ARAACOM recommendation concerning allocation of 32 Nike-I battalions to 14 defended areas within the United States.
	DA approves ARAACOM's basic concept for the integration of ARNG units into the Air Defense System.
	Phase-out of ARAACOM's 47 assigned ARNG AAA gun battalions is begun. By end 1952, 27 battalions, three brigades, seven groups, and eight operations detachments will be phased out and Active Army units activated in their stead.
1 April	The Multiple Corridor Identification System is made an integral part of the 28th Air Divisions' Identification System.
10 April	In early tests of warheads, a Nike-I destroys a maneuvering B-17 drone at a range of 17 nautical miles and an altitude of 10,000 feet.
10 April	ADC and ARAACOM draw up a "Mutual Agreement for the Air Defense of the United States." AAA units are to pass to the *operational control of appropriate USAF commanders* when deployed to tactical positions, but such control is to be exercised through local AAA Commanders. Defended areas are to be determined by mutual agreement between DA and USAF. ARAACOM's responsibilities include ascertaining ADC's AAA requirements and attempting to fulfill them, preparing detailed plans, providing AAA advisors, and prescribing conditions of readiness. ADC is responsible for all identification, prescribing alerts, establishing gun-defended areas—to be "prescribed as soon as practicable" and, establishing in coordination with ARAACOM, the basic rules of engagement.
17 April	On the basis of reported unknowns ADC declares an actual command-wide condition of Air Defense Readiness. This is a first.
24 April	Complete system test of Nike-I is concluded with round 92 whose live warhead instantly destroys a large bomber.
28 April	Major General John T. Lewis succeeds Major General Irvine as CG ARAACOM.
9 May	Office, Chief of Ordnance requests BTL to make a study of the feasibility of an anti-aircraft guided missile carrying an atomic warhead using the Nike-I ground guidance system.
27 May	The original construction program for the "permanent" aircraft control and warning net is completed.
Summer	F-89F program cancelled.
	In view of the possibility of future wars resembling the Korean War, the development of a cheap mass-produced lightweight tactical fighter is suggested within the Air Force.
2 June	Separate AAA staff sections within HQ ADC and its major subordinate command headquarters are abolished in favor of coordination between counterpart staff elements of collocated HQ at appropriate echelons.
19 June	Assistant, Chief of Ordnance informs Assistant, Chief of Staff, G-4, that the following studies are being conducted:

(a) A study of the relative effectiveness of atomic warheads against bomber formations.

(b) A preliminary study of an antiaircraft GM carrying an atomic warhead using the production Nike-I ground equipment.

(c) A preliminary study of the feasibility of adapting the Corporal missile to a surface-to-air missile with an atomic warhead.

20 June — Undersecretary of the Army, Mr. Karl R. Bendetsen, in a memorandum states that USAF is undertaking an overall campaign to usurp the Army's responsibility in the entire GM field and takes the position that the Army should undertake to secure assignment of responsibility for all ground-launched guided missiles regardless of range, provided they do not require manned aircraft to launch, guide, or home. The Army G-3's position does not go as far with respect to the ICBM but considers that in the SAM field the Army must be responsible for research, test, procurement, and operations of those systems required to protect Army ground installations in a theater of operations. To avoid duplication of effort, the Army would also provide such weapons for the zone of interior.

1 July — The Federal Civil Defense Agency (FCDA) takes over operation of Civil Air Raid Warning net.

14 July — AFF Arms Board recommends that 15.61 percent of the Army's M-Day combat troop strength be allocated to nondivisional AAA.

15 July — Plan for Security Control of Air Traffic is signed by the Secretaries of Defense and Commerce.

22 July — The first production-line Nike-I makes a successful flight.

10 September — The first Bomarc test launching takes place at Cape Canaveral.

3 October — All F-89's grounded pending correction of major structural defects.

17 October — In a letter to Lincoln Laboratory, the Assistant Chief of Ordnance describes the lack of defense against ballistic missiles carrying atomic warheads and requests the laboratory to investigate and evaluate possible methods of defense utilizing and extending Projects Wizard and Thumper, considering defense against large missiles of the 50–400 mile range and ICBM.

20 October — At a conference sponsored by DA, G-4, it is decided that the antimissile system for the Army should be pointed toward the development of a system for use in a theater of operations. AFF is tasked to supply the following information:

(a) The relative priority of competing characteristics appearing in currently approved military characteristics for the Army's antimissile requirement.

(b) The minimum acceptable altitude coverage necessary for an interim antimissile surveillance radar.

(c) A description of the types of missiles with flight paths that could be encountered in a theater of operations before 1960.

1 November — The first hydrogen bomb is exploded at the AEC Eniwetok Proving Ground.

31 December — President Truman approves a National Security Council policy statement calling for a strengthening of continental defense.

1953

January — 2,500 F-86D's on order, of which fewer than 90 have been accepted.

1 February	The 29th and 34th Air Divisions are reassigned from Western to Central Air Defense Force. The 29th Air Division area is expanded to include North and South Dakota and Nebraska.
	Work on the development program for Nike-I-B is initiated by Western Electric who estimates that the system can be experimentally demonstrated in approximately three years.
16 February	ARAACOM region boundaries are changed to conform with ADC boundary changes of 1 February.
18 February	ADC promulgates instructions to all commanders to employ simultaneous engagement as necessary to effect maximum destruction of the attacking force. This follows testing in Western ADF which demonstrates the feasibility especially with the M-33.
March	The AW battalion at Castle AFB, California is converted to Skysweeper. The other three battalions in ARAACOM will be converted in October 1953.
3 March	Military characteristics of Nike-I-B (Hercules) are established.
9 April	Ordnance Technical Committee formally establishes a Hawk RED Project.
10 April	USAF adopts the Lincoln Transition System later to be renamed the Semi-Automatic Ground Environment (SAGE) System instead of the rival Air Defense Integrated System (ADIS) sponsored by the University of Michigan.
30 June	USAF reports only 66 active F-89's out of 164 first-line aircraft.
6 July	DA publishes criteria for designating ARNG AAA units as Special Security Force units.
22 July	The Continental Defense (Bull) Committee appointed by the National Security Council reports that continental defense programs, current and future, are inadequate.
27 July	An armistice is signed in Korea.
12 August	A thermonuclear explosion takes place in Russia.
21 August	USAF approves, in principle, as an interim measure, establishment of Inner Defense Areas (IDAs) around those targets in the United States which have effective AAA defenses. This has long been ADC and ARAACOM's recommendation, except that both considered IDAs to be necessary over the long as well as short term. IDAs differed from Gun Defended Areas in that all weapons would be used for defense.
25 September	The President approves a statement calling for increased emphasis on continental defense.
July	F-89 procurement accelerated in second half of year.
October	First YF-102A delivered.
	Last AW battalion phased out of CONUS Air Defense.
1 October	Secretary of Defense issues a revision of "Functions of the Armed Forces and the Joint Chiefs of Staff" commonly known as the "Key West Agreements."
	The first airborne early warning squadron is activated at McClellan AFB, California.
8 October	The Canada–United States Military Study Group recommends establishment of a Mid-Canada Line of early warning radar along the 55th parallel.
28 October	A Nike-I missile is fired for the first time by a tactical unit, Battery A, Package Number 2, 1st Guided Missile Group, at Red Canyon, New Mexico.
3 November	Canada agrees to construction of Mid-Canada Line.

9 November	DA publishes a policy directive for the AAA defense of CONUS, including provision for ARNG participation.
December	Second YF-102A delivered.
17 December	The first Nike-I-Ajax missile unit is moved on-site at Fort George G. Meade, Maryland: the 36th AAA Battalion, later to be redesignated 1st Battalion 562nd Artillery.
21 December	The first meeting of the Joint ADC-ARAACOM Planning and Coordination Committee results in the creation of a new, jointly approved objectives list.
24 December	USAF and United States Navy reach agreement on the seaward extension of radar for the contiguous system and Distant Early Warning (DEW) Line.
31 December	Phase-out of the 47 federalized ARNG AAA battalions assigned ARAACOM is complete.
	Ninety-one percent of ARAACOM units are on-site. Conversion to Nike-I will reduce the figure to 80 percent in the first quarter of 1954.

1954

	Tests in early months of the year indicate that YF-102 will be subsonic and will have a combat ceiling below 50,000 feet.
January	The Joint Strategic Plans Committee of the JCS is directed to prepare terms of reference for a joint air defense command.
11 January	USAF approves construction of five sea-based radar platforms known as "Texas Towers."
	USAF approves low altitude gap-filler radar program.
22 January	JCS agree to the establishment of a joint command for Continental Air Defense.
February	First flight of XF-104.
19 February	Air Force requirement for a two-place long-range jet interceptor outlined.
24 February	The President approves the recommendation of the National Security Council that a Distant Early Warning (DEW) Line be built.
March	All six Skysweeper battalions replacing the AW battalions are on-site.
25 March	ARNG on-site participation in AAA defense of CONUS is begun with deployment of Btry A, 245th AAA Bn (120-mm. gun) in New York City defense.
May	F-101 moneys delayed pending second flight test (expected in 1955); mass production postponed as a result of relaxation of tension following Korean armistice. "Fly-before-you-buy" policy instituted.
1 May	U.S.S.R. displays a jet bomber for the first time.
June	Following a controversy within the Air Force, decision to build the F-104 with a more powerful engine is made in mid-1954.
	Air Research and Development Command recommends the F-101 to fill USAF requirement for two-place long-range interceptor (stated on 19 February).
	263 F-94C's assigned to ADC.
2 June	The Canada–United States Military Study Group recommends that the two governments agree in principle to establishment of the DEW Line.

28 June	Raytheon is awarded a contract for design, development, and test of a complete Hawk weapon system.
1 August	Airborne early warning operations are begun off the West Coast.
2 August	JCS direct establishment of the Continental Air Defense Command (CONAD) as a joint command under the JCS.
September	52 out of 55 ADC squadrons equipped with all-weather interceptors; 38 of them have the F-86D.
1 September	HQ CONAD is established under command of General B. W. Chidlaw who is given operational control of ADC, ARAACOM, the Navy forces of the contiguous radar coverage system and augmentation forces of all services when made available during periods of emergency.
	NAVFORCONAD is established at Ent AFB, Colorado under command of RADM Albert K. Morehouse.
28 September	Development is initiated for a T-46 cluster warhead for Nike-I-B.
1 October	Major General Stanley R. Michelsen succeeds LT General Lewis as CG ARAACOM.
7 October	AFF indicates a requirement for a surface-to-air missile system capable of defeating a ballistic missile of all classes. The requirement will be restated by AFF successor CONARC on 12 November 1955.
8 October	9th Air Division is activated at Geiger Field, Washington, the 12th to be assigned to ADC.
8 November	Secretary of Army informs Secretary of Defense that studies performed in the Nike-I-B Program have concluded that the Nike-I System can be modified to control the Nike-I-B (Model 1810) missile at extended ranges in excess of 50 miles and up to 80,000 feet altitude without affecting the ability of the system to fire unmodified Nike-I missiles.
19 December	First flight of F-102.

1955

14 January	The first Nike-I-Hercules flight test missile is launched.
10 February	CoS Army directs CG, ARAACOM to initiate a study of possible substitution of civilian or reserve component personnel for military personnel.
March	BTL initiates a feasibility study for a weapon system to replace Nike-I and Nike-I-B about 1965. Emphasis is placed on defense against long-range ballistic missiles.
14 April	A Nike-I missile is accidentally launched by Btry C, 36th AAA Bn during an alert drill at Fort Meade, Maryland. Fragments of the missile fall in Barbersville, near Laurel, and on the Baltimore-Washington Parkway.
5 May	Agreement is reached with Canada reflecting establishment of the DEW Line in Canadian territory.
31 May	Eastern Army Antiaircraft Command is discontinued. Personnel are assigned the 1st AAA region.
	General Chidlaw retires. Major General Smith becomes acting Commander, ADC; LT General Michelsen becomes acting CINCONAD pending the arrival of CONAD and ADC designated Commander General Earl E. Partridge.
June	Construction begun on land portion of DEW Line.

21 June — The Technical Advisory Panel on Aeronautics concludes that the existing antimissile program lacks cohesiveness and direction and recommends that a special high level task group be appointed and responsibility be vested in a single service with a higher level of support.

29 June — First successful Nike-I-B firing takes place at White Sands Proving Ground.

Secretary of Defense states his conviction that the earliest practicable atomic capability for the Nike-I System can be achieved by priority development of the atomic warhead for Nike-I-B.

July — Army critically evaluates Project LAMPLIGHT, exhaustive study conducted by MIT, which omits the missile defense problem as "outside the LAMPLIGHT field of study" and "currently in the hands of a special committee of the USAF Scientific Advisors Board."

ARAACOM initiates a program request to improve the AN/TPS-1D. From this came the AN/FPS-36, -54, -61, -69, and -71 series of radars.

5 July — Chief, R&D, DA directs Chief of Ordnance to modify the requirements of BTL study concerning weapon systems to replace Nike-I and Nike-I-B so as to focus on the ICBM as the prime target of the Nike-I-Zeus.

14 July — ARAACOM submits comments to DA on the feasibility of "integrating reserve troops with Regular Army troops in a dual (Nike-I) Battery."

16 July — CONARC in a letter to G-3, DA concurs with AA&GM School's objection to the 50 mile range limitation of Army SAM:

(a) Maximum effective engagement of enemy aircraft.
(b) Destruction of enemy aircraft carrying nuclear weapons at a safe distance from the defended area.
(c) Improvement of antiaircraft effectiveness compatible with the increase in enemy aircraft speeds.
(d) Exploitation of the flexibility of antimissile missile in the antiaircraft role.
(e) Maximizing the surface-to-surface capability of Army antiaircraft guided missiles.

20 July — General Earle E. Partridge assumes command of CONAD and ADC.

August — ARAACOM submits to DA its own concept of military characteristics for an antimissile defense weapon.

16 August — The first HAWK missile is successfully fired at White Sands Proving Ground to determine flutter and drag characteristics of the missile airframe.

September — HQ 7th AAA Group is activated at Thule AFB, Greenland. It is assigned to First Army and attached to Northeast Air Command for operational control.

8 September — The 85th, 58th, and 37th Air Divisions are activated at Andrews AFB, Wright-Patterson AFB, and Truax Field, Wisconsin, respectively. These activations bring the total number of divisions assigned ADC to 15.

9 September — The number of Nike-I batteries deployed (136) equals the number of gun batteries (90-mm. and 120-mm.).

22 September — Nike-I becomes the dominant weapon of ARAACOM as conversion of the 602nd AAA Battalion of the Baltimore Defense increases Nike-I-l batteries to 140 and reduces gun batteries to 132.

8 October	The 20th Air Division is activated at Grandview AFB, Missouri, the 16th to be assigned ADC.
December	F-102A scheduled for production.
	DA authorizes the United States Army member of the Canadian–United States Permanent Joint Board on Defense to seek Canadian Army participation in the overall defense of Detroit. Under consideration is the relocation of two Nike-I batteries to Canadian sites, to be manned by Canadian personnel, in order to provide a balanced defense of Detroit.

1956

	Performance tests on lightweight, "ideal body" F-102A conducted in early 1956. F-102A becomes operational in mid-1956.
February	First flight of F-104A.
26 December	First flight of F-106A. The two-place F-106B first flies on 9 April 1958. In FY 1957, the F-106 goes into quantity production, while F-102 production is closed out.

Appendix C

A Chronology of Soviet Air and Ballistic Missile Defense

1941

First known Soviet Radar completed.

1943

Soviets receive significant information or samples concerning most of the operational radars in the United States and United Kingdom, including the U.S. SCR-584 fire control radar, which became the Soviet SON-2, the British "Elsie," a search light control and other U.S. types including the SCR-545, 527/627, 582/682, 602.

Development of RUS-2 radar.

1944

June	Reorganization of PVO Troops; Eastern and Western directorates established; Office of The Commander of Territorial PVO Troops abolished; supervision over the activities of the PVO fronts and zones, weapons planning and supply—transferred to the Red Army Commander of Artillery.
Spring	PVO Western and Eastern fronts eliminated, PVO Northern and Southern fronts established; improved control resulting.
	(Late) Soviet VRD3 (jet) bench testing begun.
	(Late) Capture of German jet engines.

1945

	Emphasis on Civil Defense lessens.
February	Stalin orders designs based on German jet engines.
8 May	Cancellation of Lend Lease Policy; decision reversed after strong protest by Soviets.
19 August	Recancellation of Lend Lease Policy—no reversal.
August–November	Flight tests of Me 262.
	Pre-prototype approval of native jet designs of 4 contenders.
October	Ground tests of YAK-15, wind tunnel testing.
December	Decision not to produce Me 262.

1946

	Reorganization of armed forces—unified defense establishment under the Ministry of Armed Forces; previously had Commissariats. Dumbo, early warning radar, the first post–WWII system, quickly followed by a family of radars characterized by metric frequency, the use of Yagi antenna, goniometric techniques and nearly identical transmitters. The Ministry of the Communications Equipment Industry (MCEI) organized. Included production of radar, radio-engineering equipment, telephone and telegraph apparatus, electro-vacuum equipment, storage batteries and electro-carbon articles.
March	Aviation industry mission to Germany.
March–April	Validation of MiG-15 requirement.
2 April	Stalin confirms aviation ministry plan for jet development.
24 April	First flights of MiG-9/YAK-15.
18 August	SU-9 first flight.
19 August	Aviation day MiG/YAK prototypes fly at Tushino.
29 August	Stalin orders 20–30 jet aircraft in 80 days.
September	La-150 first flight.
September	British permit export of 10 Nene jet engines.
7 November–December	30 aircraft delivered for October Revolution Parade.
	MiG-9 committed to production.

1947

25 February–May	State trials of YAK-15.
May	YAK-15 ordered to production with Lyulka RD10 engine.
March	Last of 25 Nene and 30 Derwent British jet engines received.
April	La-150 M first flight.
June	YAK-23 first flight.
2 July	MiG-15 predecessor flies.
August	YAK-15 U (tricycle gear version) passes state tests.
30 December	First flight of MiG-15.

1948

	Subordination of National Air Defense Forces to the Artillery Commander of the Soviet Army eliminated.
June	Ministry of Armed Forces establishes a Chief Directorate of Air Defense and establishes National Air Defense Forces as a distinct type of troops. Civil Defense interests renewed; self-defense leaders reported in training. Plans emerge for training 4 5 million in Civil Defense.
	Electronic experiments on the SA-1 for development of guidance subsystem.

March — MiG-15 to production.

Three designs of all-weather, radar-equipped, transsonic aircraft are unsuccessful, the SU-15, MiG I-320, and Lavochkin 200A.

1949

IZUMRUD AI radar modified for MiG-15.

German POWs report basement shelter construction program; basic radiofication of U.S.S.R. ordered, training of CD instructor(s).

MiG-15 bis modification with Soviet VK-1 engine.

Sukhoi design bureau closed; had begun SU-17 supersonic design.

Phase out of MiG-9 production.

1950

Industrial evacuation plans updated; call for "tens of thousands" of instructors.

Initiation of an Adcock-type radio direction finder; series provided HF/DF monitor coverage between 1.5 and 15 MHz.

January — MiG-17 first flight.

Trials of 2-seat MiG-15 with AI radar.

February — Claim of Mach 1.0 for MiG-17.

MiG-15 bis—to production with VK-1 and improved cannon.

November — German scientists tasked to study guidance problems of the SA-1.

1 November — First combat with F-51D Mustang in Korea.

8 November — First all-jet combat.

1951

Border Air Defense Line established; organizational part of the air defense system; Marshal of Aviation, K. A. Vershinin, named Commander of Border Air Defense Line Forces.

Token, V-beam radar, built by the Soviets; a major accomplishment; based on the U.S. AN/CPS-6 V-beam set, not released under the Lend Lease Policy but documented in the MIT Series reports.

SCAN ODD developed with German engineering assistance; the first Soviet radar with limited all-weather capability.

DOSAAF established.

Czechs and Polish licensed to manufacture MiG-15.

30 July — "Pre-project" approval of YAK-25 and MiG-19 design efforts.

MiG-15 bis to Korea.

Series production of MiG-17 as day interceptor.

1952

Colonel General N. N. Nagornyy named Commander of National Air Defense forces.

Production of a height finder, Patty Cake; not typical of Soviet Radars as it was an original design.

Early warning and surveillance radar on a bunkered building, GAGE; first static radar of significance employed by the Soviets; never achieving widespread deployment nor production in great numbers.

KRUG—the only Soviet ground-based Wallenweher wide aperture HF/DF system known to be in use; considered best of its kind; designed through German assistance.

Compulsory DOSAFF study circles begun; Civil Defense manuals published.

1 July — SA-1 prototype system tested.

November — SA-1 initial system test begun.

1953

Site construction for the SA-1 SAM system started; first site operation in 1954.

Antiaircraft General (Gritchin) made head of DOSAAF; 20-hour compulsory training program for DOSAAF members.

5 March — Stalin dies.

July — Sukhoi receives Hero of Soviet Labor; his bureau reinstated.

Border Air Defense Line Forces joined to National Air Defense Forces. Marshal Vershinin named Commander of National Air Defense Forces with Marshal of Artillery N. D. Yakovlev his first deputy.

1954

First Civil Defense publications mentioning atomic, bacteriological, and chemical weapons; Central Committee session of DOSAAF held, emphasizing its roles.

SCAN CAN deployment initiated; first Soviet AI system to use missile armament exclusively, developed from SCAN ODD.

May — Position of Commander-in-Chief of National Air Defense Forces established. Marshal of the Soviet Union, L. A. Govorov, named to the position.

1955

May Day—YAK-25 all-weather fighter and MiG-19 supersonic fighter are first observed.

First compulsory training program for adult population (10-hour); Tolstikov appointed Head of Civil Defense; Belov head of DOSAAF; beginning emphasis on using military as trainers and instructors.

Appendix D

Figures

Figure 8—Soviet and American Air Defense Systems

Soviet and American Air Defense Systems

I. Early Warning and Target Acquisition Systems

II. Aircraft and Air-to-Air Missile Systems

III. Artillery and Surface-to-Air Missile Systems

IV. Civil Defense Systems

V. Command, Control, and Communications Systems

Figure 9—U.S. EW/GCI/ACO Radar

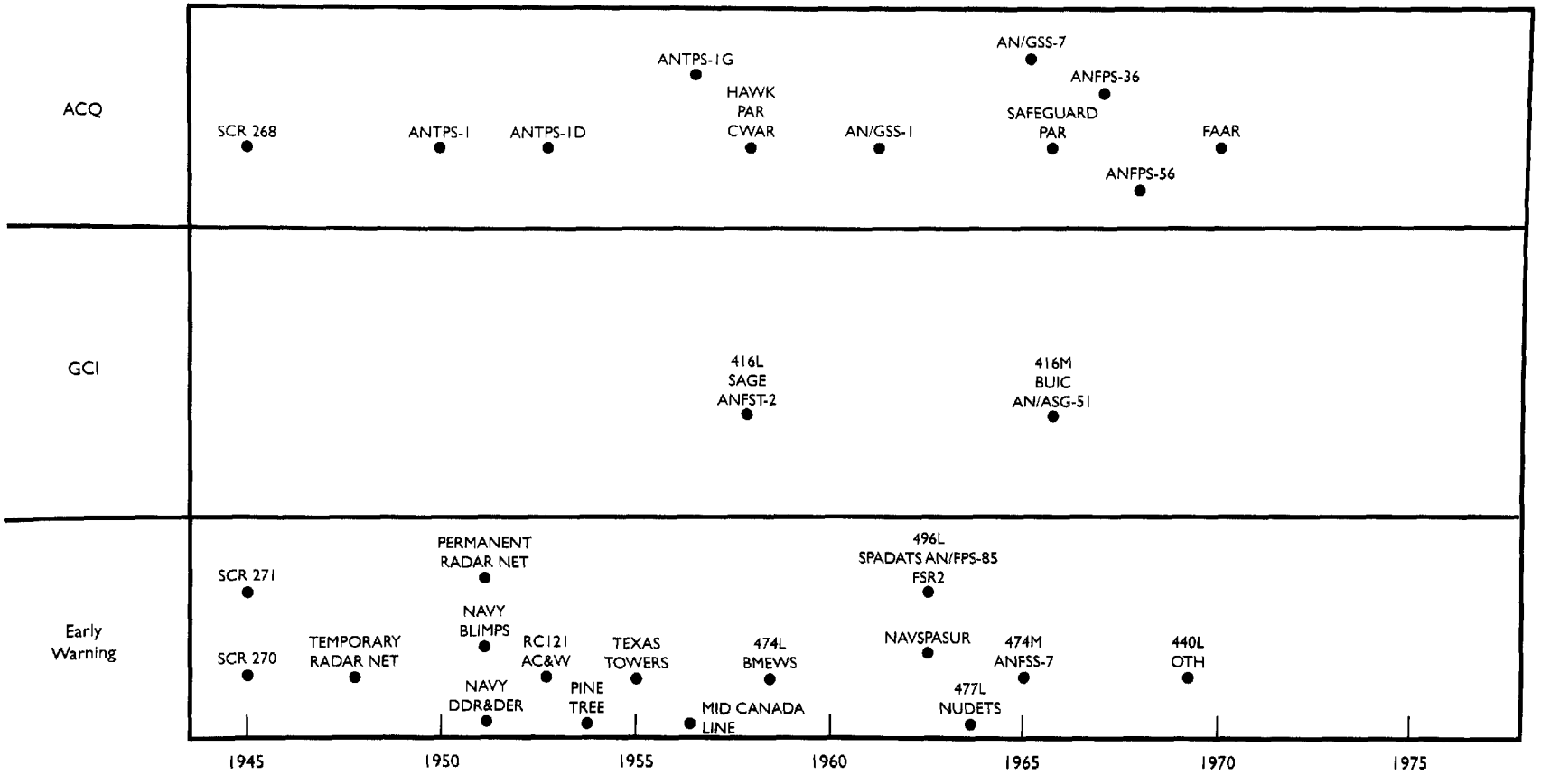


Figure 10—U.S. Fighter Aircraft Development

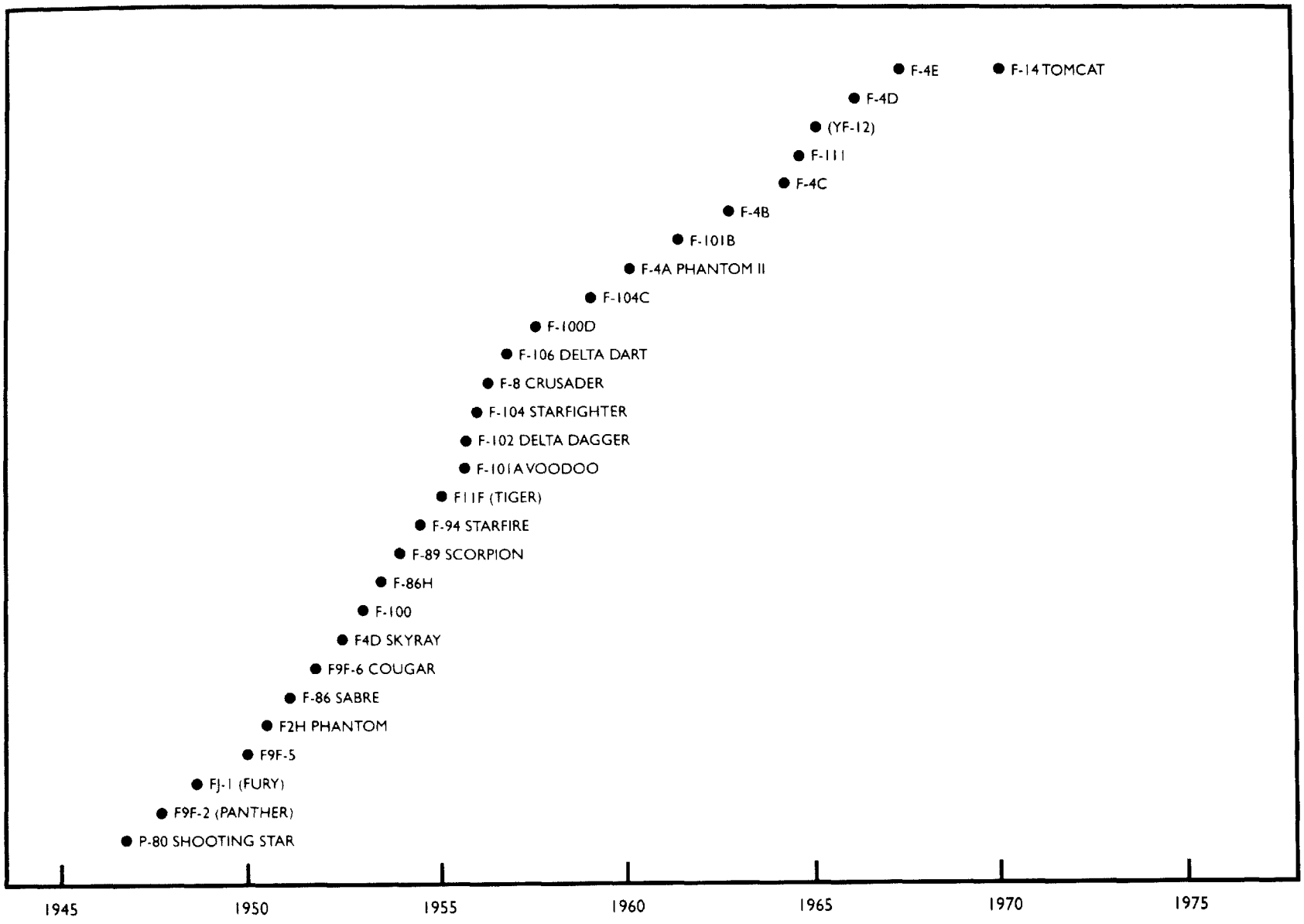


Figure 11—U.S. AAA and Surface Air Defense Missile Systems Chronology

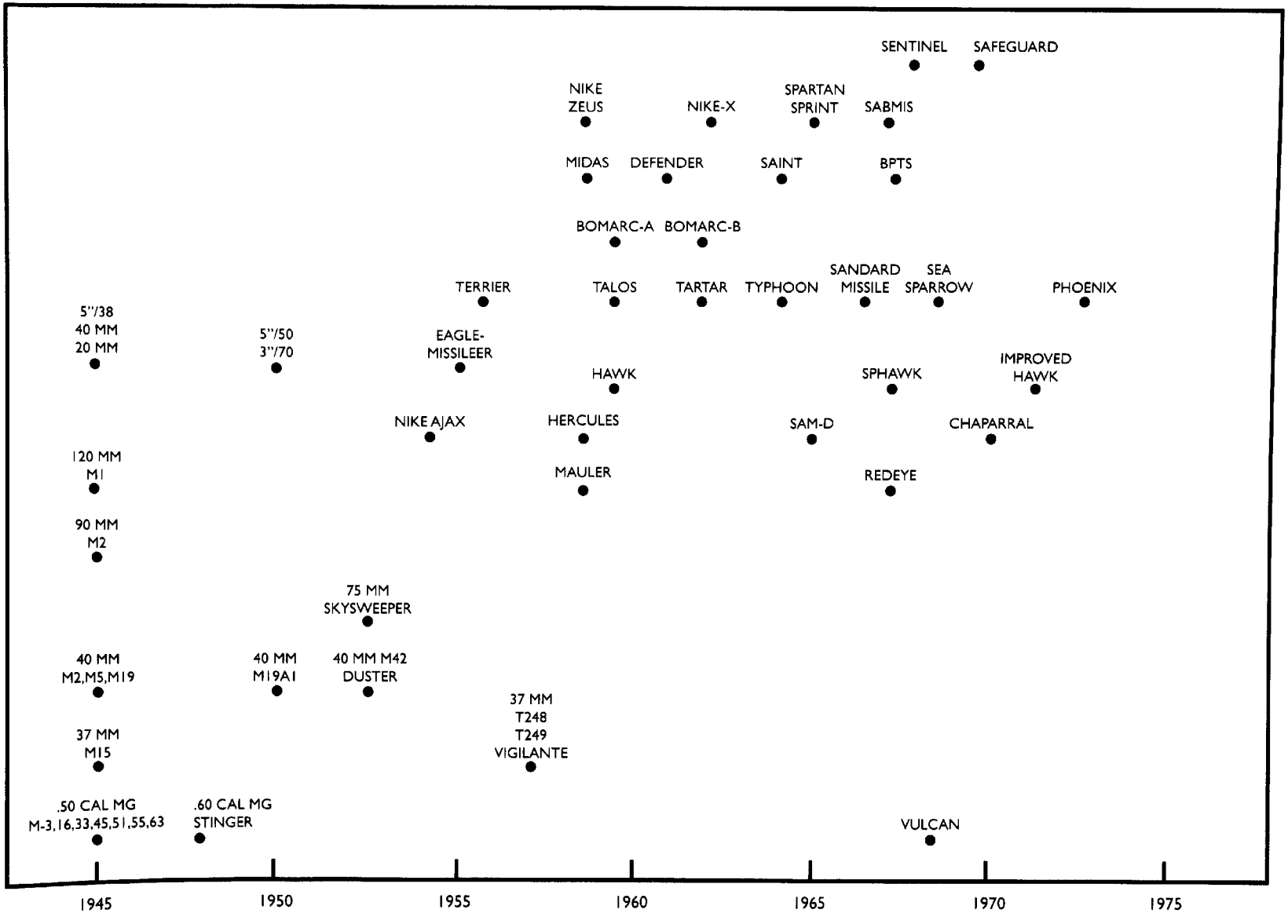


Figure 12—U.S. Civil Defense Key Characteristics

1945–1950

- WARTIME OCD ABOLISHED
- WD STUDIES AND PLANS
- NSRB ACTIONS
- FWA RESPONSIBILITIES

1950–1955

- NSRB CD PLAN
- FCDA, OEM ESTABLISHED
- ODM RESPONSIBILITIES

1955–1960

- ODM, FCDA OCDM
- PL 85-606 INSTITUTED

1960–1965

- OCDM OEP
- CD TO SEC DEF
- ASD (CD) ESTABLISHED
- DAGR, DHEW RESPONSIBILITIES
- $250M CD APPROPRIATION
- OCD TO OSA
- CIV MIL STRENGTHENED
- FALLOUT SHELTER PROGRAM

1965–1970

- PRESIDENTIAL SUPPORT
- CD WITH GEN NUC FORCES
- SHELTER PROGRAM CONTINUES

Post 1970

- MEASURED CD REDIRECTION
- CD REMAINS STATE ORIENTED
- CDPA ESTABLISHED
- ASSIST TO STATE AND LOCAL GOVERNMENTS

Figure 13—Abbreviated Chronology, USAD C³

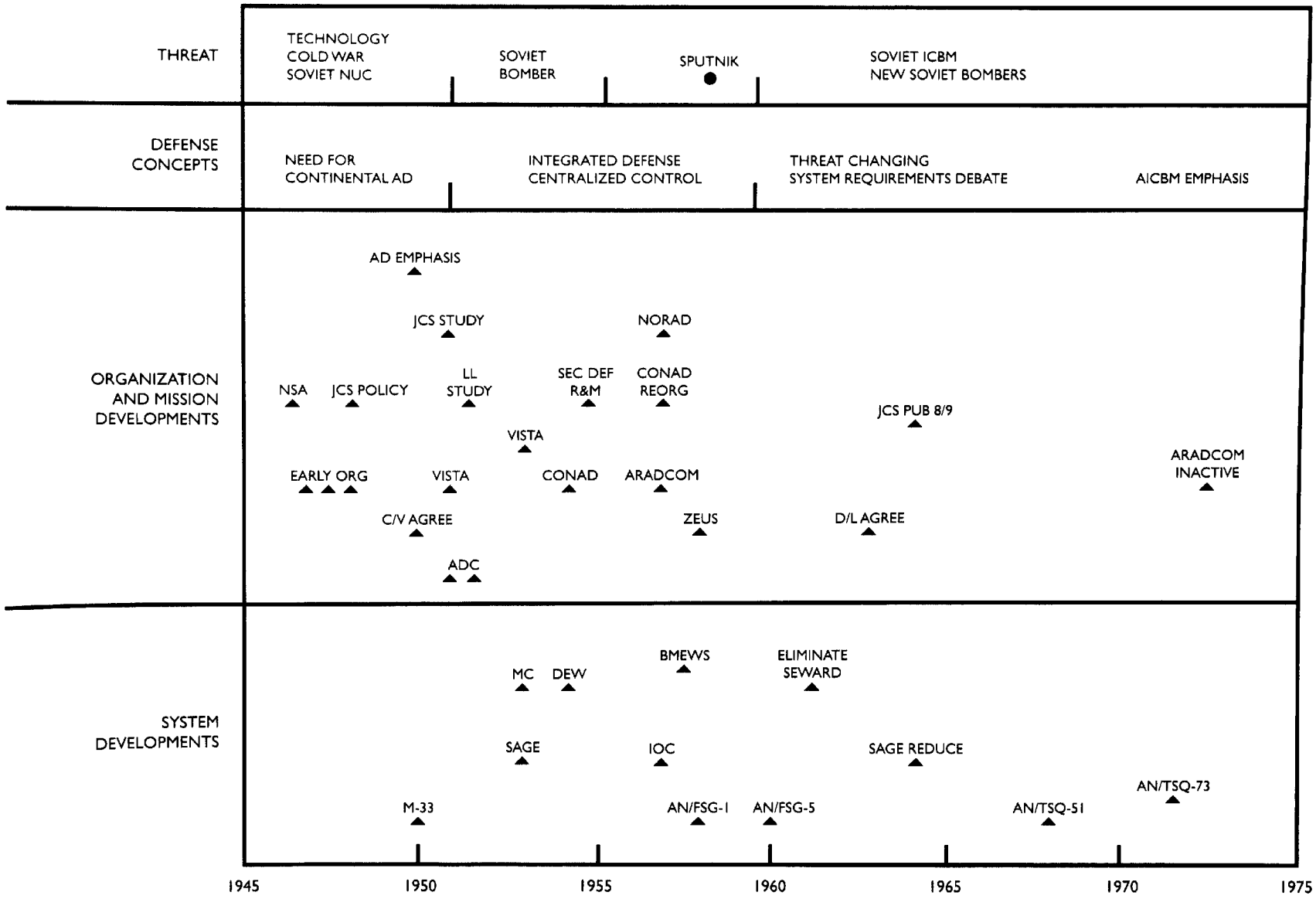


Figure 14—U.S. Air Defense Deployments by Year

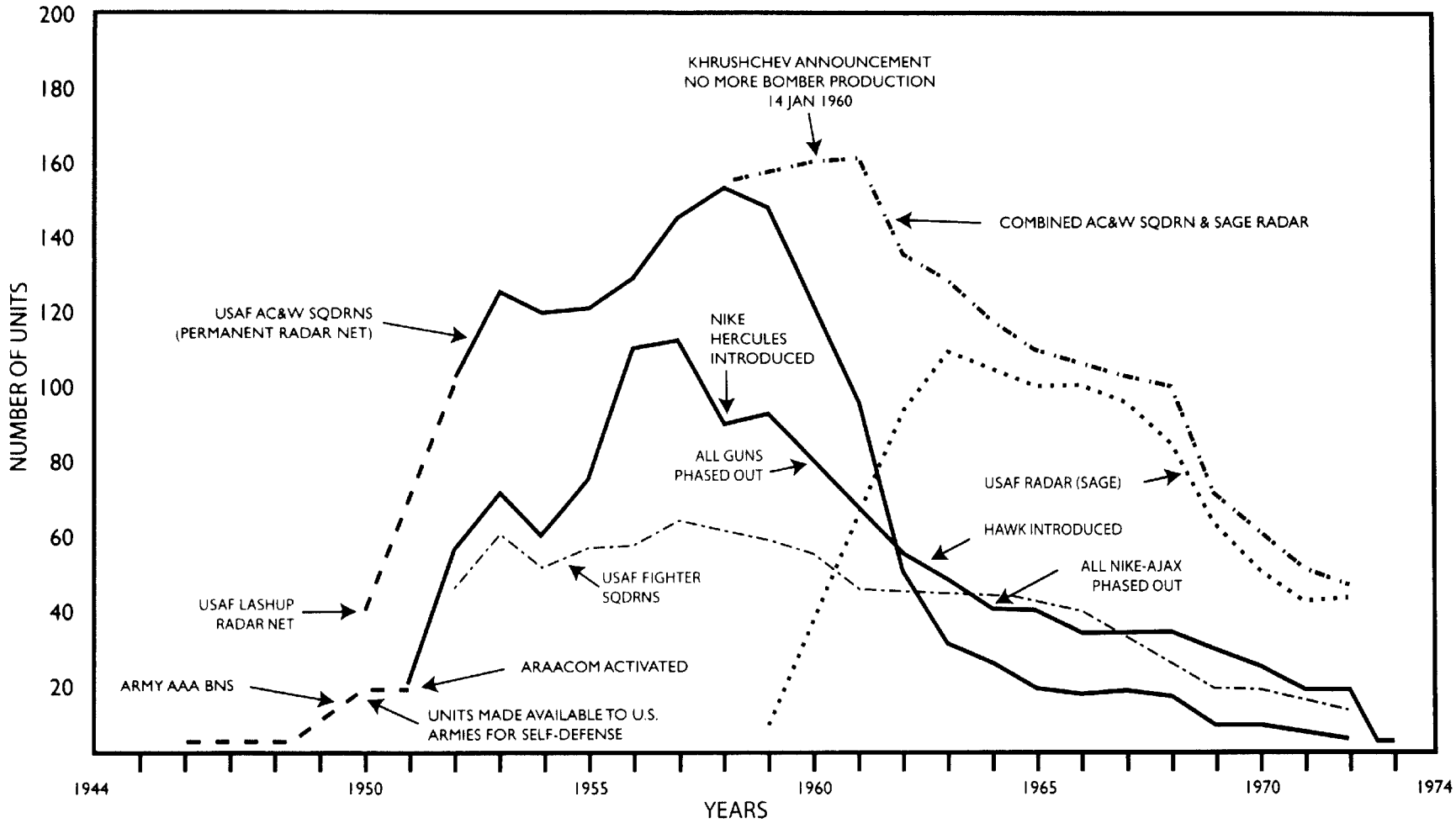


Figure 15—Post-1954 Soviet Air Defense Organization

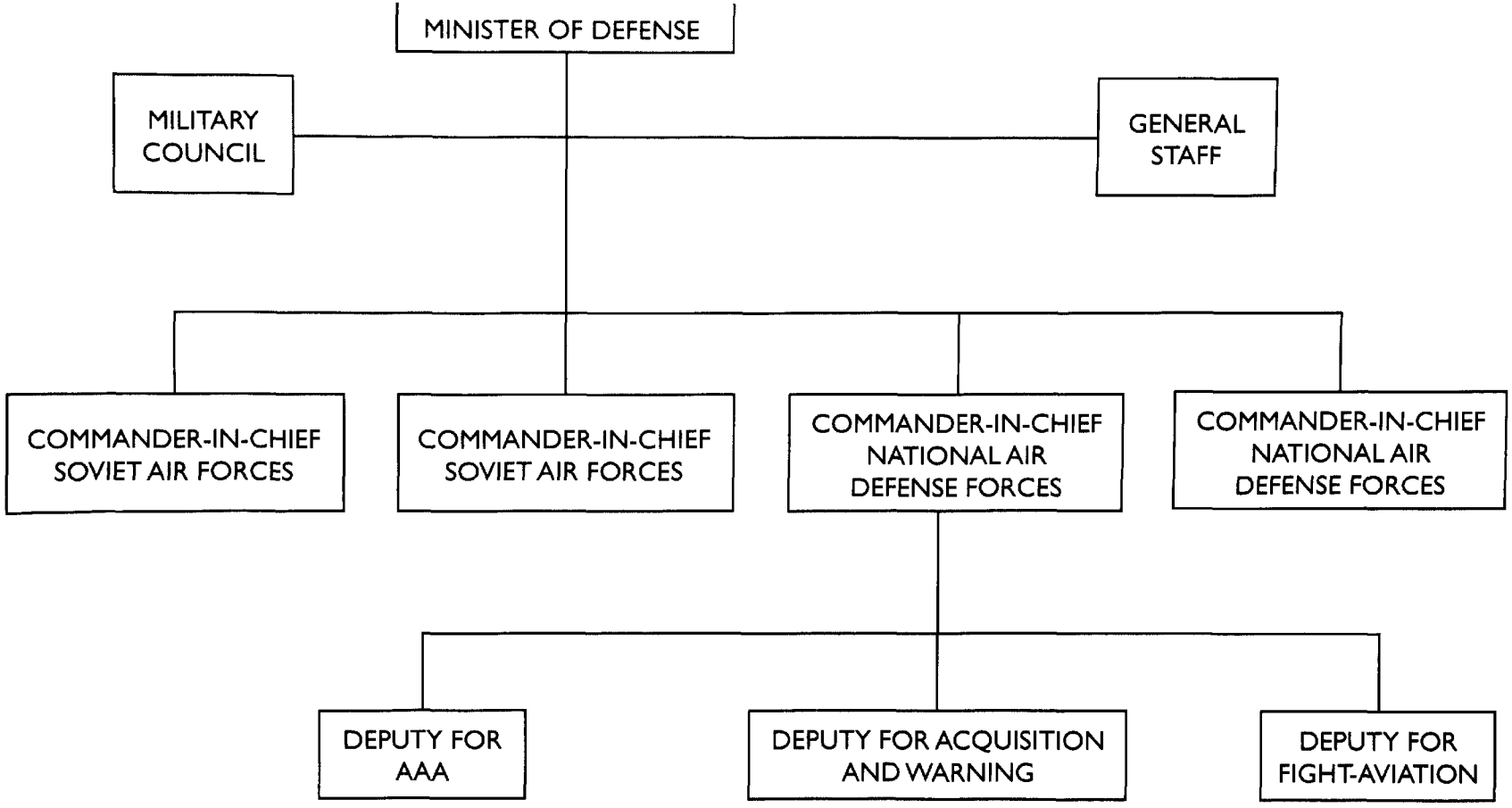


Figure 16—Soviet Aircraft Control and Warning Radar Development

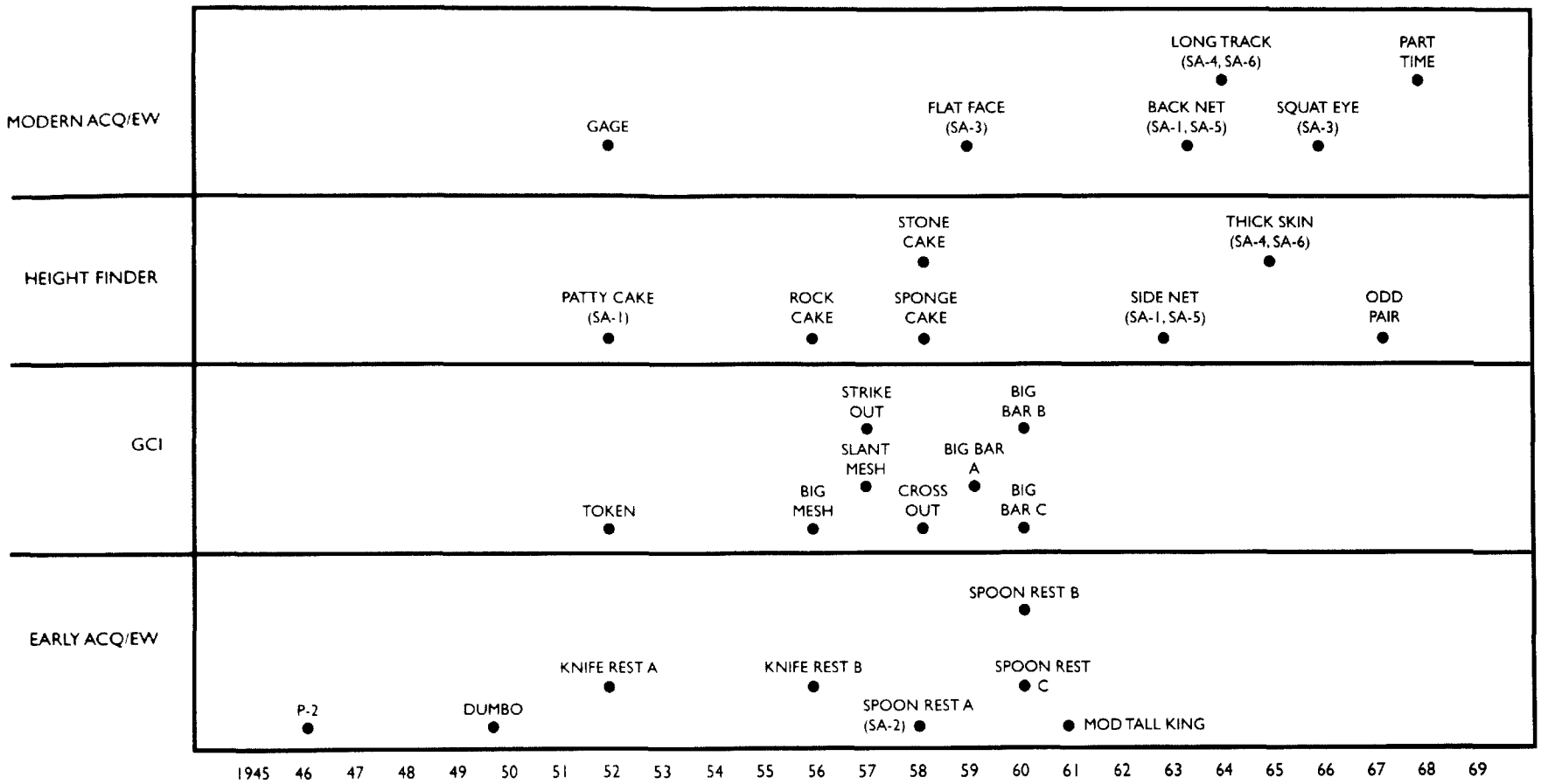


Figure 17—Estimated Soviet Fighter Production, 1946–1955

Designation	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	Total
Soviet NATO Propeller											
YAK-3	1400	300									1700
YAK-9 Frank	1300	650	650	300							2900
LA-7 Fin	1300	30									1330
LA-9/11 Fritz/Fang	15	700	1300	450	200	5					2670
Total Prop.	4015	1680	1950	750	200	5					8600
Jet											
YAK-15	15	250									265
MIG-9 Fargo	15	400	400								815
YAK-17 Feather		10	300	300							610
MIG-15 Fagot			60	850	2700	4200	3600	1100			12510
LA-15 Fantail			20	100							120
YAK-23 Flora				10	550	370					930
MIG-17 Fresco							400	3200	3500	2700	9800
MIG-19 Farmer									10	250	260
YAK-25 Flashlight									50	200	250
Total Jet (45)	30	660	780	1260	3250	4570	4000	4300	3560	3150	25560
Total Fighter	4045	2340	2730	2010	3450	4575	4000	4300	3560	3150	34160

Figure 18—Soviet Fighter Prototype Maximum Speed

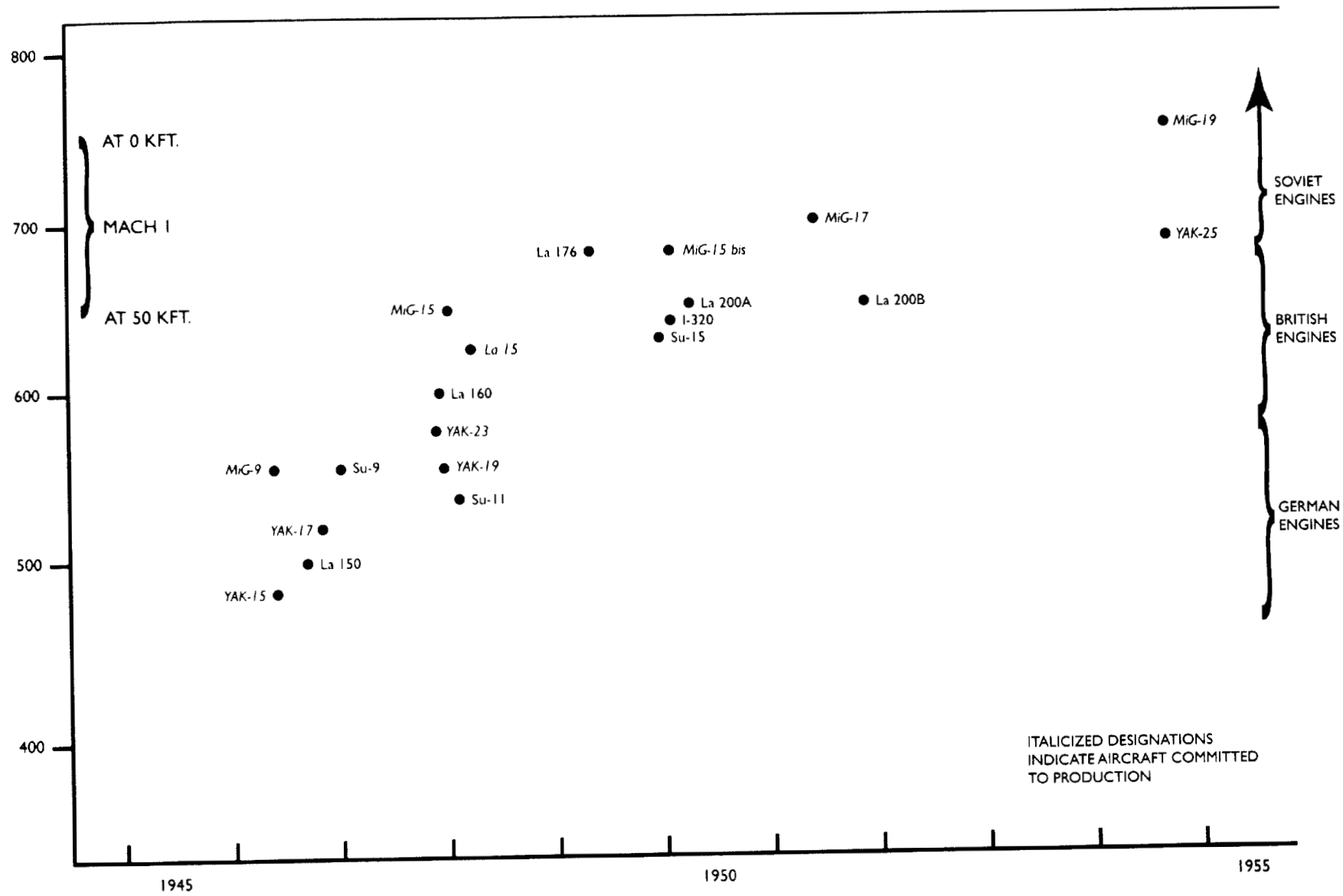


Figure 19—Development of Soviet Antiaircraft Artillery, 1945–1960

Caliber	Year of Introduction	Maximum Vertical Range (Ft)	Rate of Fire (Rds/min)
85 mm	1939	34,450	15–20
85 mm	1945	38,060	12–15
100 mm	1949	47,560	15
130 mm	1955	72,000	10–12

Figure 20—U.S.S.R. Civil Defense Key Characteristics

1945–1960

- CD UNDER MINISTRY OF INTERNAL AFFAIRS (MVD)
- CD DIRECTED BY COL TOLSTIKOV
- CD ORGANIZED AROUND LOCAL AAA (MPVO)
- CD ORIENTED TOWARD CITY AND POINT DEFENSE
- ROLES AND FUNCTIONS EXECUTED BY COMPLEX OF CIVIL POLICE, FIREMEN, MUNICIPAL TEAMS AND PLANT TEAMS

1960–1972

- CD UNDER MINISTRY OF DEFENSE
- CD DIRECTED BY MARSHAL CHUIKOV WITH FIRST DEPUTY COL GEN TOLSTIKOV
- MILITARY INFRASTRUCTURE DEVELOPING THROUGHOUT CIVIL GOVERNMENT
- MILITARY CD OCS ESTABLISHED
- CD BECOMES BASIC ELEMENT OF SOVIET ARMED FORCES
- CD DEPUTIES PLACED ON MILITARY DISTRICT STAFFS
- MIL/CIV CD UNITS IN JOINT EXERCISES
- CD TRAINING TOWNS BUILT
- CD TRAINING PERVADES ENTIRE CIV/MIL STRUCTURE

Figure 21—Chronology of Soviet C³ for Air Defense

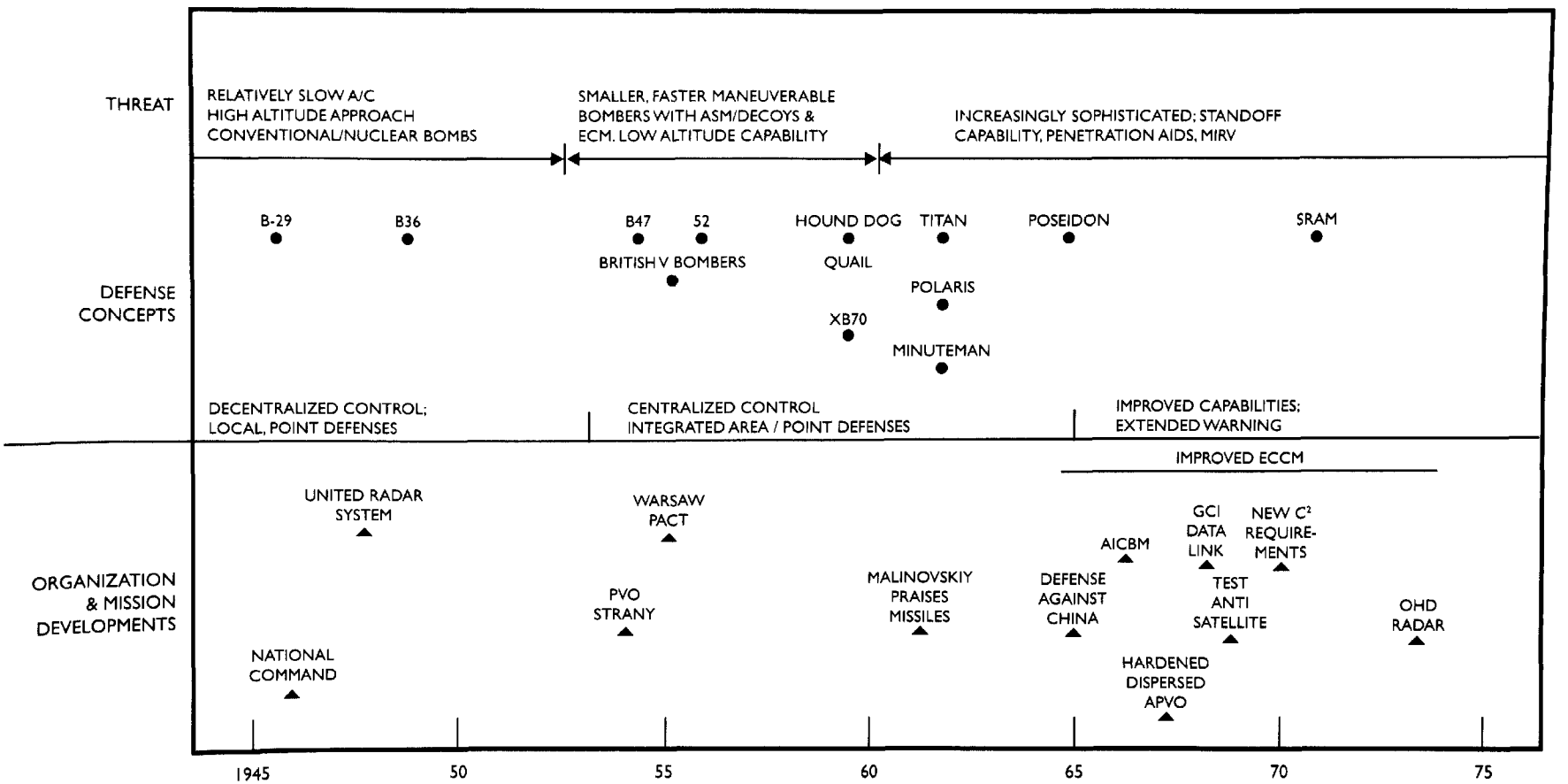
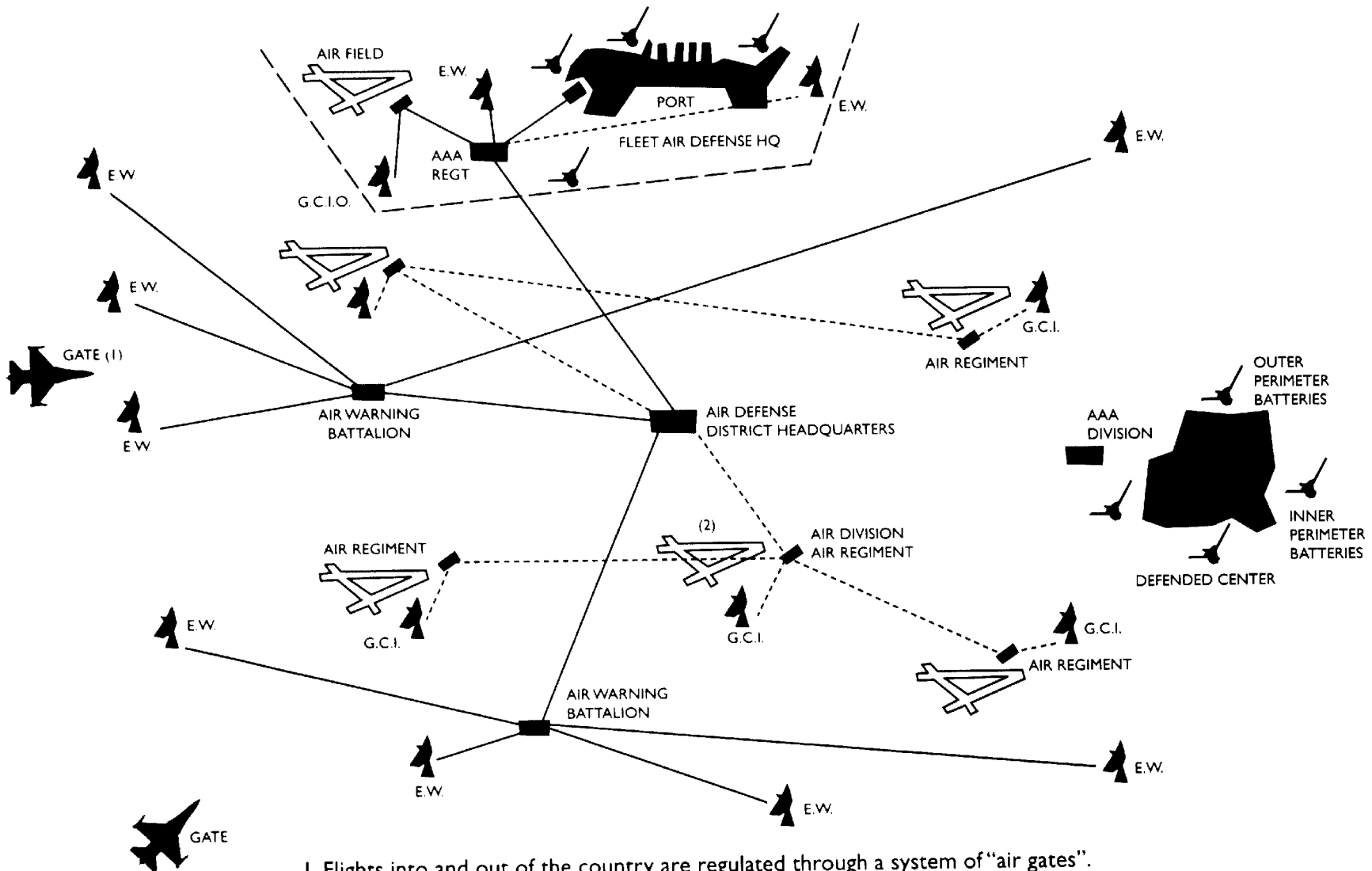


Figure 22—Typical Soviet Air Defense District, 1955



1. Flights into and out of the country are regulated through a system of "air gates".
2. Each airfield defended normally by an independent AAA battalion.

Bibliography

Congressional Hearings and Reports, Government Contracts, U.S. Department of Defense Magazines and Periodicals

Congressional Hearings and Reports, Government Contracts, U.S. Department of Defense Magazines and Periodicals

AAF, "Roundup of Red Radars," *Intelligence Digest*, Volume 7, No. 8, January 1954.

AAF Statistical Digest, 1946.

"AA Situation in Soviet Zone of Germany," USAFE, *Intelligence Summary*, July 1953.

"Activation of New AAA Units," *The Coast Artillery Journal*, Volume 91, July–August 1948.

"Aerospace Force in the Sixties," *Air University Quarterly Review*, Volume XII, Winter and Spring, 1960–1961.

"Air Defense," *Bol'shaya Sovetskaya Entsiklopediya* (The Great Soviet Encyclopedia), 2nd edition, Volume 35, Moscow, 1955.

Air Materiel Command, *An Electronic Air Defense Environment for 1954*, McRee HQ, 15 December 1950.

Air Materiel Command, *Case History of the F-89 All-Weather Fighter Airplane (August 1945–January 1951)*, March 1952.

Air Materiel Command, *Development of Guided Missiles Through 1945*, Historical Study No. 237.

Air Materiel Command, *Development of Guided Missiles 1945–1950*, Historical Study No. 238.

"Air Warning System of the Soviet Union," *RCAF Intelligence Summary*, April 1955.

Annual Reports of the Secretary of Defense, 1948–1955.

Annual Reports of the Service Secretaries to the Secretary of Defense, U.S. Government Printing Office, Washington, D.C., 1948–1955.

Antiballistic Missile: Yes or No? For: Donald G. Brenna and Leon W. Johnson, Against: Jerome B. Wiesner and George S. McGovern, Introduction by: Hubert H. Humphrey, Epilogue by: William O. Douglas, Hill & Nang, New York, 1969.

Associated Universities, Inc., *Project East River*, New York, 1952.

Associated Universities, Inc., *1955 Review of the Report of Project East River*, New York, 1955.

Aviation Week, 1948–1955 issues.

"Bear Gives Reds a Longer Reach," *Air Intelligence Digest*, June 1955.

Bell Telephone Laboratories, Inc., *Antiaircraft Guided Missile System*, 15 July 1945.

Bell Telephone Laboratories, Inc., *Historical Summary of Nike-I Research and Development Program, July 1945–July 1951*.

Bell Telephone Laboratories, Inc., *Lokiya System Study*, 1 August 1954.

Bell Telephone Laboratories, Inc. and Douglas Aircraft Company, Inc., *Project Nike-I-History of Development*, New York, April 1954.

"Best Pictures to Date of Soviet V-Beam Radar," *Air Intelligence Digest*, March 1953.

"Bison, Badger Reveal Armament Development," *Air Intelligence Digest*, November 1954.

"Bison, Badger Reveal Electronics Progress," *Air Intelligence Digest*, November 1954.

Braddock, Dunn and McDonald, Inc., *Continuing Analysis of Strategic Defense Force (CASDET)*, 7 volumes in 3 parts, BDM/CS-15-69-0035, El Paso, Texas, 22 August 1969.

CIA, "Changing Soviet Civil Defense Concepts," Current Support Brief, 11 September 1962.

CIA, "Civil Defense in the U.S.S.R.," Economic Intelligence Report, November 1956.

CIA, *A Summary of Soviet Guided Missile Intelligence U.S./U.K.*, GM 4-52, 20 July 1953.

"Civil Defense of the U.S.S.R.," *Intelligence Review*, No. 209, October 1953.

"A Comparison of Soviet and U.S. Aircraft Production," *Air Intelligence Digest*, March 1949.

DIA, *Defensive Missile Systems (Trends) U.S.S.R.*, ST-CS-15-288-73, DIA Task No. T72-15-02, June 1973.

"Development Possibilities of Soviet Missiles," *Air Intelligence Digest*, October 1955.

DIA, DID, "A Decade of Soviet AC&W, Height Finder (HF) Radar Developments," Volume 1, No. 7–8, May–December 1963.

"DOSAAF Trains Soviet Civil Defense," *Air Intelligence Digest*, December 1953.

Ebenstadt Commission on Unification of the Armed Forces.

"Engine Development Projects in the U.S.S.R.," USAFE, *Air Intelligence Summary*, 1953.

"Estimate: By 30 June, Soviets Will Have Produced 40 Bisons," *Air Intelligence Digest*, June 1955.

"Estimate of Soviet Technical and Scientific Capabilities," *Intelligence Review*, No. 202, March 1953.

"Estimate of Soviet Technical and Scientific Capabilities," *Intelligence Review*, No. 203, April 1953.

Executive Office of the President, National Security Resources Board, *United States Civil Defense*, U.S. Government Printing Office, Washington, D.C., 1950.

Pyatdesyat Let Sovetskikh Vooruzhennykh Sil (50 Years of the Soviet Armed Forces), Voyenizdat, Moscow, 1967.

"First of the Many," *Air International*, November 1974.

Five Series of "Spotlight" Reports on Soviet Aircraft Designers, *Air Intelligence Digest*, 1950.

"Fly-By Highlights," *Air Intelligence Digest*, June 1955.

"From Cambodia to Cuba, the Ubiquitous MiG-17," *Air Enthusiast*, December 1972.

"Four Versions of Fresco," *Air Intelligence Digest*, December 1955.

"Further Data on New Soviet Medium AA Gun," Tactical and Technical Notes, *Intelligence Review*, No. 208, September 1953.

Georgia Institute of Technology Engineering Experiment Station, *Missile Catalog: A Compendium of Guided Missile and Seeker Information*, Research Project No. A-169, 1 April 1956.

"German-Designed Soviet Missiles," *Air Intelligence Digest*, December 1954.

Government Research Corporation, *Defense of the U.S. Against Attack by Aircraft and Missiles*, 1957.

Great Britain, Army, GHQ, AA Troops, *The Flying Bomb. The Defense of Antwerp and Brussels*, Printing and Stationery Service, 21 Army Group (British), May 1945.

"Ground Weapons Development in the U.S.S.R. in 1953," *Intelligence Review*, December 1953.

"How Far Can Bison (Type 37) Fly?," *Air Intelligence Digest*, October 1954.

"How Russia Stormed the Sonic Barrier," *Aviation Week*, 12 September 1955.

"How the Reds Build MiG-15s," *Air Intelligence Digest*, September 1952.

"How the Soviets Use Tactical Air Power," *Air Intelligence Digest*, April 1954.

"How U.S. and U.S.S.R. Aircraft Compare," *Air Intelligence Digest*, August 1953.

Hudson Institute, *Arms Control and Civil Defense*, edited by D. G. Brennan, Prepared for the U.S. Arms Control and Disarmament Agency, Harmon-On-The-Hudson, 1963.

Human Science Research, Inc., Civil Defense bibliography, January 1966, a compilation of reference relevant to the study of societal recovery from nuclear attack, McLean, Virginia, 1966.

"Impact of Nuclear Warfare," *Air Intelligence Digest*, January 1956.

"The Implications of the Soviet Air Defense Missile Program," ATC WIS, No. 6:54, 11 February 1954.

Institute for Research in Social Science, University of North Carolina, *The Soviet Aircraft Industry*, Chapel Hill, North Carolina, 1955.

International Business Machines Corporation, *The SAGE/Bomarc Air Defense Weapons System: An Illustrated Explanation of What it is and How it Works*, New York, 1959.

Johns Hopkins University, Operations Research Office, *Analysis of Military Assistance Programs*, 21 January 1958.

Johns Hopkins University, Operations Research Office, "Areas to be Defended Against Attack by Air," Stanford Research Institute, Washington, D.C., 1 December 1949.

Johns Hopkins University, Operations Research Office, "Areas to be Defended Against Attack by Air, Final Report," Stanford Research Institute, Washington, D.C., February 1950.

Johns Hopkins University, Operations Research Office, "Defense of the United States Against Attack by Aircraft and Missiles," Appendices G and H, "Weapons Studies-Part II," ORO-R17, 1955.

"Korea: Enemy Tactics," *Air Intelligence Digest*, December 1950.

"Last of the Lavochkins," *Flying Review International*, April 1968.

"Last of the Lavochkins—Part 2," *Flying Review International*, May 1968.

"Long-Range Missile Research in the U.S.S.R.," USAFE, *Intelligence Summary*, December 1953.

Los Angeles University of South California Department of Psychology, *Decision Strategies in AAW: I. Analyses of Air Threat Judgments and Weapons Assignments*, Principal Investigator: Joseph W. Rigney, Los Angeles, California, April 1966.

"Lyulka: A Soviet Pioneer," *Air Enthusiast*, November 1971.

McKinsey and Company, Inc., *Report on Non-Military Defense Organization Part I: A Framework for Improving Non-Military Defense Preparedness*, Washington, D.C., 31 December 1957.

McKinsey and Company, Inc., *Report on Non-Military Defense Organization Part II: Organization for Non-Military Defense Preparedness*, Washington, D.C., 21 March 1948.

McKinsey and Company, Inc., *Study of Civil Defense Reorganization*, Washington, D.C., 14 July 1961.

Memo(s) of MG H. R. Oldfield and others for G3, WD, Subject: AAA, cited in Greenfield, 27 September 1943.

"Malenkov: No. 1 Man in the U.S.S.R.," *Air Intelligence Digest*, April 1953.

"MiG-21: Air Superiority Soviet Style," *Air Enthusiast*, August 1971.

"MIKULIN Designed the Engine," *Air Intelligence Digest*, November 1954.

"Military Notes: U.S.S.R.," *Intelligence Review*, No. 209, October 1953.

"Missiles and Rockets," *Missiles and Rockets Eighth Annual World Missile/Space Encyclopedia*, Volume 15, July 1964.

"Missiles Around Moscow," *Air Intelligence Digest*, October 1955.

"More Punch in Soviet AA?," *Air Intelligence Digest*, March 1955.

"Moscow's AAA Defenses," *Air Intelligence Digest*, November 1951.

"The Moscow Military Supply Complex," *Intelligence Review*, No. 213, February–March 1954.

National Planning Association, Special Policy Committee on Non-Military Defense Planning, *A Program for the Non-Military Defense of the United States*, Washington, D.C., 9 May 1955.

"Newest Red Radar Resembles U.S. GCI," *Air Intelligence Digest*, July 1953.

"New Soviet AA Weapons," *Air Intelligence Digest*, October 1955.

Nike-I–Ajax Historical Monograph, AGG MA, 30 June 1959.

North America Air Defense Command, Office of Information, *The Aerospace Defense Story*, lecture, Colorado Springs, Colorado, 1962.

North America Air Defense Command, Office of Information, Direct of Command History, *Historical Summary: NORAD and CONAD*, Ent AFB, Colorado, December 1958.

North America Air Defense Command, Directorate of Command History, *Fifteen Years of Air Defense*, Ent AFB, Colorado, 1 December 1960.

North America Air Defense Command, *Operations of the Mid-Canada Line*, NORADM 55-7, 4 January 1962.

North America Air Defense Command, *Phase III: Sage/Missile Master Integration/ECM-ECCM Test (Deep River)*, Ent AFB, Colorado, 1963.

North America Air Defense Command, *Seventeen Years of Air Defense*, Historical Reference Paper No. 9, Ent AFB, Colorado, 1 June 1963.

Office of the White House, Executive Order 9562, 30 June 1945.

Office of the White House, Executive Order 10193 (15 F.R. 9031), 50 USCA APP 2153.

Office of the White House, Proclamation No. 2914, 15 F.R. 9029, 16 December 1950.

Ordinance Guided Missile and Rocket Programs Technical Report, Volume 2, 30 June 1955.

OSD Historian's Office, *History of Strategic Arms Competition Chronology U.S.*, Volume 1, October 1974, Volume 2, November 1974, Volume 3, December 1974.

OSD Historian's Office, U.S. Department of Defense, *History of Strategic Arms Competition (1945–1972) Chronology, U.S.S.R.*, Volume III, December 1974.

"Polikarpov: The Prolific Pioneer," *Flying Review International*, July 1968.

"Probable Guided Missile Sites Around Moscow," *Air Intelligence Brief*, No. 55-3, 30 August 1955.

Propaganda: Agitatsia, Leningrad, No. 18, quoted by Frederick C. Barghorn, *The Soviet Image of the United States*, Harcourt, Brace & Company, New York, 1950.

RAND, *Air Defense Study: Cost Methodology*, RM-1170, 2 September 1954.

RAND, "Recent Soviet Literature on Tactical Air Doctrine and Practice," S-1-71, 03164C, RP R25rm, 6336, July 1970.

RAND, *A Study of Non-Military Defense*, Report No. R-322, Santa Monica, California, 1958.

"Red AD Communications," *Air Intelligence Digest*, Volume 10:18–22, February 1957.

"Reds Latest AA Gun," *Air Intelligence Digest*, September 1954.

"Reds 7000-Pound-Threat Engine," *Air Intelligence Digest*, October 1954.

"Red War Ministry Journal Boosts Fighter Aviation," a condensation from "Military Thought" article, "Fighter Aviation in Modern War" by COL A. Volkov, *Air Intelligence Digest*, February 1953.

"Report on AAA Expansion," *The Coast Artillery Journal*, Volume 91, September–October 1948.

Research and Development Board, *Consolidated Technical Estimate*, 12 October 1950.

Rockefeller Brothers Fund, *International Security—The Military Aspect*, Special Studies Panel II Report, 1958.

Royal Institute of International Affairs, *Survey of International Affairs 1939–46*, Part III, "America, Britain, and Russia, 1941–46."

"Security Organs of the U.S.S.R. in Peacetime," *Intelligence Review*, No. 207, August 1953.

"Six Communist Fire Control Radars," *Air Intelligence Digest*, January 1954.

"Soviet AA Gunners' Training," *Air Intelligence Digest*, August 1955.

"Soviet Aerodynamics Research," *Air Intelligence Digest*, November 1955.

"Soviet Aircraft Armament," *Air Intelligence Digest*, November 1948.

"Soviet Air Defenses: How Good Are They?," *Air Intelligence Digest*, July 1954.

"Soviet Air Defenses: Role of AA Artillery," *Air Intelligence Digest*, July 1954.

"The Soviet Air Defense System: How Effective is it?," *Air Intelligence Digest*, March 1956.

"The Soviet Air Defense System: How it is Equipped," *Air Intelligence Digest*, March 1956.

"The Soviet Air Defense System: How it Operates," *Air Intelligence Digest*, March 1956.

"Soviets Air Order of Battle Enters New Stage," *Air Intelligence Digest*, October 1954.

"Soviet Air R&D," *Air Intelligence Digest*, September 1955.

"Soviet Air Shows," *Air Intelligence Digest*, October 1949.

"Soviet Air Tactics," *Air Intelligence Digest*, December 1949.

"Soviet Air Warning and Control of Interruption," Great Britain *Military Intelligence Report*, No. 83, 10 December 1952.

"Soviet Aviation Air Show: 1953," *Air Intelligence Digest*, November 1953.

"Soviet's 'Big Five' Aircraft Designers," *Air Intelligence Digest*, February 1954.

"Soviet Civil Defense: Policies and Priorities," Intelligence Memorandum, April 1967.

"Soviets Compress Aircraft Production Lead Times," an article on the series by MAJ George J. Keegan on "The Foundations of Red Air Power," *Air Intelligence Digest*, November 1955.

"The Soviet Concept of Active Air Defense," USAFE, *Intelligence Summary*, January 1954.

"The Soviets Copied the Derwent V Jet Engine," *Air Intelligence Digest*, March 1954.

"Soviet Electronic Countermeasures," *Air Intelligence Digest*, March 1955.

"Soviet Exploitation of Foreign Equipment," *Air Intelligence Digest*, November 1951.

"Soviet Guided Missiles Program," Joint British-U.S. Study of U.S.S.R.'s Guided Missile Program: A Survey Covering the Period from May 1945 to the Present, *Air Intelligence Digest*, July 1949.

"Soviet High-Thrust Engine?," *Air Intelligence Digest*, January 1954.

"Soviets Lead the World in Numbers of Aeronautical Engineers Trained," based on research by Mr. Nicholas DeWitt of Russian Research Center, Harvard University, *Air Intelligence Digest*, September 1955.

"Soviets Modernize Air Defenses," *Air Intelligence Digest*, August 1955.

"Soviets Modernize Naval Air Arm," *Air Intelligence Digest*, April 1955.

"Soviet Research and Development Centers," *Air Intelligence Digest*, May 1949.

"Soviet Scientific Developments," *Intelligence Review*, December 1953.

"Soviet Tactical Aviation-IV," *Air Intelligence Digest*, October 1955.

"Soviet Telecommunications," *Intelligence Review*, No. 83, 18 September 1947.

"Soviet Union Ranks in Aircraft Production Capacity," *Air Intelligence Digest*, October 1955.

Stanford Research Institute, *An Analysis of the U.S.-Soviet Strategic Interaction Process*, March 1967.

Stanford Research Institute, *Soviet Strategies, Objectives and Force Postures in Response to U.S. BMD, 1968–80*, March 1969.

Stockholm International Peace Research Institute, 1972.

"Three Soviet Air Force Academies," *Air Intelligence Digest*, June 1950.

"The Transient Glory of SAF Brass," *Air Intelligence Digest*, 1952.

"The Trend in Soviet AA Weapons," PACCOM-WID, *Air Intelligence Summary*, Volume 2–54, 8 January 1954.

"The 24th Tactical Air Army," *Air Intelligence Digest*, August 1953.

"Unification of the Soviet Military High Command," *Intelligence Review*, No. 213, February–March 1954.

"Unification Soviet Style: Military Power Held by Defense Ministry," *Air Intelligence Digest*, April 1953.

USAF Statistical Digest, 1947–1954.

"The Use of Radar in Soviet Antiaircraft Defense," Volume 7, No. 1, *Air Ministry Secret Intelligence Summary*, 1950.

U.S. Air Force, *Background Intelligence Data for Posture Statement on Strategic Initiatives*, AF/INAF, 3 January 1975.

U.S. Air Force, *Program and Manpower: Peacetime Planning Factors*, AFL 15-10, 2 February 1953.

U.S. Air Force, *Research and Development in the United States Air Force*, Report of a Special Committee of the Scientific Advisory Board to Chief of Staff, USAF, 21 September 1949.

U.S. Air Force, Air Defense Command, Historical Division, *Air Defense in Theory and Practice 1918–1945*, Denis Volan, Colorado Springs, Colorado, 1964.

U.S. Air Force, Air Defense Command, Directorate of Historical Services, *The Air Defense of Atomic Energy Installations, March 1946–December 1952*, Colorado Springs, Colorado, 5 August 1953.

U.S. Air Force, Air Defense Command, *The Air Defense of the U.S.: A Study of the ADC and its Predecessors Through June 1951*, Ent AFB, Colorado Springs, Colorado, 1952.

U.S. Air Force, Air Defense Command, *Air Defense Tactics-Techniques: A Stud of Air Defense Means and SOPs for Units Employed in Defense*, Ent AFB, Colorado, 1 July 1948.

U.S. Air Force, Air Defense Command, Historical Division, Office of Information, *A Chronology of Air Defense 1914–1961*, Historical Study No. 19, Ent AFB, Colorado.

U.S. Air Force, Air Defense Command, Historical Division, *The Development of Continental Air Defense to 1 September 1954*, USAF Historical Study No. 126, Maxwell AFB, Alabama.

U.S. Air Force, Air Defense Command, *Mutual Agreement for the Air Defense of the United States*, Ent AFB, Colorado, 15 July 1952.

U.S. Air Force, Air Defense Command, *Organization and Responsibility for Air Defense, March 1946–September 1955*, CONAD, ADC Historical Study No. 9.

U.S. Air Force, Air Defense Command, *Report of Conference: Improved Air Defense Systems Program*, 17–21 August 1953.

U.S. Air Force, Air Defense Command, Directorate of Historical Services, *Short History. A Decade of Continental Air Defense 1946–1956.*

U.S. Air Force, Air Defense Command, Historical Division, *United States Air Force Operations in the Korean Conflict 25 June–1 November 1950*, Historical Study No. 71, Maxwell AFB, Alabama, July 1952.

U.S. Air Force, Air Defense Command, Historical Division, *United States Air Force Operations in the Korean Conflict, 1 November 1950–30 June 1952*, Historical Study No. 72, Maxwell AFB, Alabama, 1953.

U.S. Air Force, Air Defense Command, Historical Division, *United States Air Force Operations in the Korean Conflict, 1 July 1952–27 July 1953*, Historical Study No. 73, Maxwell AFB, Alabama, 1953.

U.S. Air Force Air University Evaluation Staff, *Organization of the Air Defense Command*, Project No. AUIL-51-ES (AWC 5131), Maxwell AFB, Alabama, 10 December 1951.

U.S. Air Force Air University, *Fundamentals of Aerospace Weapons Systems*, U.S. Government Printing Office, Washington, D.C., May 1961.

U.S. Air Force Air University Chronology of World War II, *Development of Night Air Operations 1941–1952*, Historical Study No. 92, Maxwell AFB, Alabama.

U.S. Air Force Air University Libraries, *Air Defense, Air Tactics and Air Combat Tactics*, Maxwell AFB, Alabama, 10 September 1953.

U.S. Air Force Air University Libraries, *Air Defense Exercises of U.S. on the North American Continent*, Maxwell AFB, Alabama, 22 April 1957.

U.S. Air Force Air University Libraries, *Air Defense. The Role of the Air Force*, Maxwell AFB, Alabama, 8 March 1956.

U.S. Air Force Air University Libraries, *Air Base Defense*, Maxwell AFB, Alabama.

U.S. Air Force, Assistant Chief of Staff, Studies and Analysis, *Alternative Strategic Strategies*, prepared by MG Glenn A. Kent, Washington, D.C., 14 July 1969.

U.S. Adjutant General's Office, *Command and Staff Structure for an Arm Force in Air Defense of the U.S.*, Washington, D.C., 11 July 1950.

U.S. Army, *Field Manual 44-1: U.S. Army Air Defense Employment*, 1964.

U.S. Army Air Defense Command, "Chronology of Army Ballistic Missile Defense System Development and Deployment," Ent AFB, Colorado, Department of the Army, U.S. Army Air Defense Command, 15 May 1970.

U.S. Army, Air Defense Command, *Historical Data Book, Part I*, September 1969.

U.S. Army, Air Defense Command, *Report of Major Activities*.

U.S. Army Air Defense Panel, *Report of Army Air Defense Panel, 15 January 1949, to C of S, USA, Through Chief, Arm Field Forces*, Fort Monroe, Virginia, 1949.

U.S. Army Air Defense School, *Air Defense: An Historical Analysis*, Department of the Army, HQ, USAADS, Fort Bliss, Texas, June 1965.

U.S. Army Air Defense School, *Commanders Air Defense Information Book*, Fort Bliss, Texas.

U.S. Army Antiaircraft Command, *Antiaircraft Artillery in the Air Defense of the United States*, Ent AFB, Colorado, 12 December 1951.

U.S. Army, Army Ground Forces, Army Air Defense Panel, *Report of Army Air Defense Panel*, Volume III, 28 January 1949.

U.S. Army, The Artillery School, Antiaircraft Artillery and Guided Missiles Branch, Research and Analysis Department, *AAA Operational Difficulties World War II*, Technical Report No. 11, 15 June 1949.

U.S. Army Chief of Ordnance, "Letter to Bell Telephone Laboratories," 31 January 1945.

U.S. Army, Forces, Far East, Military Intelligence, *Homeland Defense Operations Record*, Japanese Monograph No. 157 (includes 157, 158, 159).

U.S. Army, Forces Far East, and Eighth U.S. Army (Rear), *Homeland Operations Record*, Japanese Monograph No. 17 (includes 17–20).

U.S. Army Ground Forces, Commanding General, "Letter to Chief of Staff, U.S. Army," 26 August 1946.

U.S. Army Safeguard System Command, "Chronology of the Development of Ballistic Missile Defense (1955 to the Present)," Department of the Army, U.S. Army Safeguard System Command, Huntsville, Alabama, 14 July 1970.

U.S. Army War College, *Air Defense Instruction at CSAWC and the Air WC*, a comparison prepared by COL P. H. Eubank, Carlisle Barracks, Pennsylvania, 24 February 1958.

U.S. Commission on Intergovernmental Relations, *A Staff Report on Civil Defense and Urban Vulnerability*, U.S. Government Printing Office, Washington, D.C., 1955.

U.S. Congress Joint Committee on Atomic Energy, *Civil Defense Against Atomic Attack*, Hearing, 81st Congress, 2nd Session, U.S. Government Printing Office, Washington, D.C., 1950.

U.S. Congress, *Investigation of the B-36 Bomber Program*, 81st Congress, 1st Session, 1949.

U.S. Congress, *National Aviation Policy*, Reprint of the Congressional Aviation Policy Board, 0th Congress, 2nd Session, Washington, D.C., 1948.

U.S. Congress, *The National Defense Program . . . Unification and Strategy*, 81st Congress, 1st Session, 1949.

U.S. Continental Air Defense Command, *The Air Defense of North America*, Ent AFB, Colorado, 7 February 1955.

U.S. Defense Civil Preparedness Agency, *Introduction to Civil Preparedness*, U.S. Government Printing Office, Washington, D.C., 1972.

U.S. Department of the Army, Air Defense Ad Hoc Committee, *CONUS Integrated Air and Missile Defense 1965–1970: A Study*, Washington, D.C., October 1959.

U.S. Department of the Army Assistant Chief of Staff, Intelligence, *Soviet Threat Relating to U.S. Army Air Defense Systems (Except Nike-I-X)-1964–1976*, Washington, D.C., 2 July 1964.

U.S. Department of the Army, DA Pamphlet 70-10, "Chronological History of Army Activities in the Missile/Satellite Field, 1943–1958," Department of the Army, Washington, D.C., 17 September 1958.

U.S. Department of the Army, *Civil Defense: 1960–1967, A Bibliographic Survey*, U.S. Government Printing Office, Washington, D.C., 1967.

U.S. Department of the Army General Staff, G-3, *Project Lineup*, Washington, D.C., 1955.

U.S. Department of the Army, *Nike-I Data Book*, January 1957.

U.S. Department of Defense, *Adjustment of Army/Air Force "Differences" in Air Defense*, Memo for the Chairman, JCS, Washington, D.C., 2 November 1956.

U.S. Department of Defense, *CONUS AD Program*, Memo for JCS, 19 June 1959.

U.S. Department of Defense, Office of Civil Defense, *Harbor Project*, Washington, D.C., 1963.

U.S. Department of Defense, Office of the General Council, A Report to the Secretary of Defense on the Organizational Questions Involved if Major Civil Defense Functions are Assigned to the Department of Defense, Washington, D.C., 10 June 1961.

U.S. Department of Defense, *Research Development Program*, November 1950.

U.S. Executive Office of the President, Office of Civil and Defense Mobilization, *Legislative History: Volume IV. Amendments to the Federal Civil Defense Act of 195*, Washington, D.C., 1991.

U.S. Federal Civil Defense Administration, *Annual Report*, 1951–1958.

U.S. Forces, European Theater of Operations, General Board, Antiaircraft Artillery Section, *Tactical Employment of Antiaircraft Units, Including Defense Against Pilotless Aircraft (V-1)*, Study No. 38, 1945.

U.S. General Accounting Office, "Activities and Status of Civil Defense in the U.S.," Report to the Congress on the Department of the Army by the Comptroller General of the U.S., Washington, D.C., 1971.

U.S. House of Representatives, Committee on Armed Services, *Amending the Federal Civil Defense Act of 1950, As Amended*, House Report No. 694 (to accompany H.R. 7576), 85th Congress, 1st Session, Washington, D.C., 5 July 1957.

U.S. House of Representatives, Committee on Armed Services, *Civil Defense Fallout Shelter Program*, Hearings before Subcommittee #3, 88th Congress, 1st Session pursuant to H.R. 3516, U.S. Government Printing Office, Washington, D.C., 1963.

U.S. House of Representatives, Committee on Armed Forces, *Civil Defense in Western Europe and the Soviet Union. Fifth Report*, 86th Congress, 1st Session, U.S. Government Printing Office, Washington, D.C., 1959.

U.S. House of Representatives, Committee of Conference, *Federal Civil Defense Act of 1950*, House Report No. 3235, 81st Congress, 2nd Session, Washington, D.C., 1951.

U.S. House of Representatives, Committee on Science and Astronautics, "A Chronology of Missile and Astronautic Events," 87th Congress, 1st Session, U.S. Government Printing Office, Washington, D.C., 1961.

U.S. House of Representatives, Hearing Before the Subcommittee of the Committee on Appropriations, 80th Congress, 1948–1949.

U.S. House of Representatives, Hearing on Research and Development, Government Operations Committee, 85th Congress, 2nd Session, 1958.

U.S. House of Representatives, Subcommittee on Military Operations of the Committee on Government Operations, *Analysis of Civil Defense Reorganization*, Reorganization Plan No. 1 of 1958, House Report No. 1874, 85th Congress, 2nd Session, Washington, D.C., 12 June 1958.

U.S. House of Representatives, Subcommittee on Military Operations of the Committee on Government Operations, *Atomic Shelter Programs*, House Report No. 2554, 85th Congress, 2nd Session, Washington, D.C., 12 August 1958.

U.S. House of Representatives, Subcommittee on Military Operations of the Committee on Government Operations, *Civil Defense for National Survival*, House Report No. 2946, 84th Congress, 2nd Session, Washington, D.C., 27 July 1956.

U.S. House of Representatives, Subcommittee on Military Operations of the Committee on Government Operations, *Hearings Civil Defense for National Survival*, 84th Congress, 2nd Session, Washington, D.C., 1956.

U.S. House of Representatives, Subcommittee on Military Operations of the Committee on Government Operations, *Status of Civil Defense Legislation*, House Report No. 829, 85th Congress, 1st Session, Washington, D.C., 22 July 1957.

U.S. House of Representatives, *Organization and Administration of the Military R&D Programs*, Hearings before a Subcommittee of Government Operations, 83rd Congress, 8–24 June 1954.

U.S. House of Representatives, *Organization and Management of Missile Programs*, Eleventh Report by the Committee on Government Operations, 86th Congress, 2 September 1959.

U.S. House of Representatives, *U.S. Defense Policies Since World War II*, Document No. 100, 85th Congress, 1st Session, 1957.

U.S. Joint Air Defense Board, *Doctrines and Procedures for Joint Air Defense: A Study*, Ent AFB, Colorado, 12 May 1954.

U.S. Joint Chiefs of Staff, Guided Missile Committee, *Guided Missile Syllabus*, Washington, D.C., 1946.

U.S. Joint Chiefs of Staff, Guided Missile Committee, Subcommittee No. 4, *Programs and Policies of the Services with Regard to Surface-to-Air Guided Missiles*, 14 August 1945.

U.S. Joint Chiefs of Staff, *Terms of Reference for CINCONAD*, Washington, D.C., 4 September 1956.

U.S. National Military Establishment, Office of the Secretary of Defense, *A Study of Civil Defense*, War Department, Civil Defense Board, "Bull Report," Washington, D.C., 1948.

U.S. National Military Establishment Office of Civil Defense Planning, *Civil Defense for National Security*, "Hopley Report," Washington, D.C., 1948.

U.S. National Security Resources Board, *United States Civil Defense*, NSRB Document 128, Washington, D.C., 1950.

U.S. Navy Secretary of the Navy Court of Inquiry, *Navy Court of Inquiry (in re: Pearl Harbor)*.

U.S. Office of Civil and Defense Mobilization, *Basic Report of Civil Defense and Defense Mobilization: Roles, Organization, and Programs*, For President John F. Kennedy, by Frank B. Ellis, Washington, D.C., February 1961.

U.S. Office of Civil and Defense Mobilization, *Federal Emergency Plan C: Working Draft*, Washington, D.C., 15 June 1961.

U.S. Office of Civil Defense Planning, *Civil Defense for National Security*, "Hopley Report," U.S. Government Printing Office, Washington, D.C., 1948.

U.S. Office of Defense Mobilization, *Report of the Gaither Committee*, The White House, 1957.

U.S. Office of Emergency Planning, *The National Plan for Emergency Preparedness*, Washington, D.C., 1963.

U.S. Office of Emergency Planning, *Report on the Evaluation of Exercise Spade Fork*, Washington, D.C., 21 December 1962.

U.S. President's Air Policy Commission, *Survival in the Air Age*, Summary of the Report of the President's Air Policy Commission, Finletter, Baker, Hoyt, et al., U.S. Government Printing Office, Washington, D.C., 1948.

U.S. President (Truman), *Unification of the Armed Forces of the United States*, Message from the President of the United States, H.D. 392, 79th Congress, 1st Session, U.S. Government Printing Office, Washington, D.C., 19 December 1945.

U.S. Senate Committee on Armed Services, *Civil Defense Program*, Hearing before the Civil Defense Task Force of the Preparedness Committee, 82nd Congress, 1st Session, U.S. Government Printing Office, Washington, D.C., 5 September 1951.

U.S. Senate Committee on Armed Services, *Hearings on the Federal Civil Defense Act of 1950*, 81st Congress, 2nd Session, Washington, D.C., 1950.

U.S. Senate Committee on Armed Services, "Study of Airpower: Hearings before the Subcommittee on the Air Force of the Committee on Armed Services," testimony of GEN Earle E. Partridge, CINCONAD, 84th Congress, Senate, 2nd Session, 16 April–1 June 1956.

U.S. Congressional Senate Subcommittee or Civil Defense of the Committee on Armed Services, Hearings on Operations and Policies of the Civil Defense Program, 84th Congress, 1st Session, Washington, D.C., 1955.

U.S. Senate, Subcommittee on Civil Defense of the Committee on Armed Services, *Interim Report on Civil Defense*, 84th Congress, 1st Session, Washington, D.C., 1955.

U.S. Strategic Bombing Survey, *The Effects of Atomic Bombs on Hiroshima and Nagasaki*, Washington, D.C., 1946.

U.S. Strategic Bombing Survey Chairman's Office, *Overall Report (European War)*, U.S. Government Printing Office, Washington, D.C., 30 September 1945.

U.S. Strategic Bombing Survey Military Analysis Division, *The Strategic Air Operations of Very Heavy Bombardment in the War Against Japan (XX Air Force)*, U.S. Government Printing Office, Washington, D.C., 1 September 1946.

U.S. War Department, Board of Officers, "Reorganization of the War Department and Related Matters," LG Alexander M. Patch, President, 18 October 1945.

U.S. War Department, Assistant Chief of Staff, G-2, German Military Document Series, RS-259, "Aviation and PVO," Peoples' Commissariat of Defense, 1938.

U.S. War Department, Assistant Chief of Staff, G-2, German Military Document Series, RS-158, "Communications in the Local Air Defense System," 1941.

U.S. War Department, Assistant Chief of Staff, G-2, German Military Document Series, RS-7, "Manual of the Soldier of VNOS," 1959.

U.S. War Department, Chief of Staff, G-2, German Military Document Series, RS-735, "Organization and Tactics of Local Air Defense," Directorate of Air Defense of the Red Army, 1940.

U.S. War Department, Assistant Chief of Staff, G-2, German Military Document Series, RS-37, "Temporary Instructions for the Air Defense of Troops," 1936.

U.S. War Department, "Circular No. 138," 14 May 1946.

U.S. War Department General Staff Office of the Provost Marshal General, *Defense Against Enemy Actions Directed at Civilians*, Study 3-B-1, Washington, D.C., 1946.

U.S. War Department, Memorandum(s) for CGs AGF, AAF, "Integration of AAA with AAF," 8 February 1943.

U.S. War Department, Office of the Provost Marshal General, "Defense Against Enemy Action Directed at Civilians," 30 April 1946.

U.S. War Department, OPD Memo for G-3, "Integration of AAA with AAF," 23 February 1943.

U.S. War Department Secretary of War, *Report of Pearl Harbor Board*, 1945.

"U.S.S.R. Air Defense System," *Air Intelligence Digest*, February 1950.

"U.S.S.R. Jet Development," *Air Intelligence Digest*, February 1949.

"What We Learned," *Air Intelligence Digest*, September–October 1953.

"Why Did Soviets Show Their New Bombers?," *Air Intelligence Digest*, November 1954.

WSEG, *The Continental Air Defense System*.

"Yakovlev's Lightweight—The YAK-23," *Air Enthusiast*, May 1973.

Author and Title

Adams, Benson D. *Ballistic Missile Defense*, American Elsevier Publishing Company, New York, 1971.

Ahnstrom, D. N. *The Complete Book of Jets and Rockets*, World Publishing Company, New York, 1957.

Akimov, N., et al. *Civil Defense*, National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia, 1971. (Unclassified)

Alexander, Arthur. *Conversations on Soviet Aviation*, RAND Internal Note 21989, 22 February 1972.

Alexander, Arthur and Nelson, J. R. *Measuring Technical Change: Aircraft Turbine Engines*, RAND R-1017-ARPA/PR, June 1972.

Alexander, Arthur. *R&D in Soviet Aviation*, RAND R-589-PR, November 1970.

Alexander, Arthur. *Trip Report: 1973 Paris Air Show*, RAND Internal Note 22550-ARPA, July 1973.

Anderson, Dillon. "Selected Materials, Organizing for National Security," U.S. Senate, Committee on Government Operations, Subcommittee on National Policy Machinery, U.S. Government Printing Office, Washington, D.C., 1960.

Appleman, Roy E. "Okinawa, The Last Battle," U.S. Army in World War II: The War in the Pacific, Washington, D.C., Department of the Army, 1948.

Arnold, H. H. *Global Mission*, Harper & Row, New York, 1949.

Ashkerov, COL V. "Development of Air Defense Force Tactics During the Great Patriotic War," *PVO Herald*, (ACS/I Translation), April 1974.

Ashkerov, V. P., Zabelok, B. G., Kalugin, Ye. I., and Sherchenko, L. P. *Voyska Protivovozdushno Oboron Strany* (National Air Defense Forces), Moscow, 1960.

Barghoorn, Frederick C. *The Soviet Image of the United States*, Harcourt, Brace & Company, New York, 1950.

Barlow, E. J. *Active Air Defense of the U.S. 1954–1960*, RAND R-250, Santa Monica, California, 1 December 1953.

Barlow, E. J. *Contiguous Radar Coverage in the U.S. Air Defense Systems 1953–1960*, RAND RM-1077, Santa Monica, California, 1 May 1953.

Barnard, LTC Roy S. *The History of ARADCOM*, Volume 1, *The Gun Era 1950–1955*, HQ ARADCOM Historical Project, ARAD5M-1.

Batitskiy, P. "Development of the Tactics and Operational Art of the Country's Air Defense (PVO) Troops," *Voyennaya Mysl'* (Military Thought), No. 10, October 1967, (translated by Foreign Broadcast Information Service, 25 October 1968), FPD 0146/68. (Confidential/ NOFORN)

Batitskiy, P. "The Soviet Armed Forces in the Defense of the Gains of the October Revolution—The National Air Defense Troops," *Voyenno-Istoricheskiy Zhurnal* (Military History Journal), No. 8, Moscow, August 1967.

Batitskiy, P. *Voyska Protivovozdushno Oboron Strany* (National Air Defense Forces), Voyenizdat, Moscow, 1968.

Batitskiy, P. "Worldwide Historical Victory," *Vestnik Protivovozdushnoy Oborony* (Air Defense Herald), No. 5, Moscow, 1970.

Baumbach, Werner. *The Life and Death of the Luftwaffe*, Coward-McCann, Inc., New York, 1960.

Bordeaux, T. A., et al. *Comparison of U.S. and U.S.S.R. Land-Based Air Defense Systems*, RDA-TR-5500-003, R&D Associates, May 1974.

Bottome, Edgar M. *The Missile Gap: A Study of the Formulation of Military and Political Policy*, Fairleigh Dickinson University Press, Rutherford, Pennsylvania, 1971.

Bridgman, Leonard, ed. *Jane's All the World's Aircraft, 1951–52*, McGraw-Hill Book, Company, Inc., New York, 1951.

Brodie, Bernard. *Strategy in the Missile Age*, RAND, Princeton University Press, Princeton, New Jersey, 1959.

Brown, Eunice H., et al. *Development and Testing of Rockets and Missiles at White Sands Proving Grounds*, Historical Information Branch, Information Office, U.S. Army, White Sands Missile Range, New Mexico, 1 October 1959.

Broybrook, Roy H. "Sukhoi's Fighters . . . The Fishpot and Fitter," *Flying Review International*, December 1963.

Bush, Vannevar. *Modern Arms and Free Men*, Simon & Schuster, 1949.

Byland, W. R. *History of Nike-I Project*, New York Ordnance District, 24 April 1954.

Chayes, Abraham and Weisner, Jerome B., eds. *ABM: An Evaluation of the Decision to Deploy an Antiballistic Missile System*, Harper & Row, New York, 1969.

Check, Gilbert John. *Defense of the Continental United States*, Carlisle Barracks, Pennsylvania, 11 March 1954.

Chesalov, A. "General Designer," *Aviatsiya i Kosmonavtika* (Aviation and Cosmonautics), No. 9, 1963.

Chidlaw, Benjamin Wiley. *Air Defense*, Carlisle Barracks, Pennsylvania, 25 March 1953.

Chidlaw, GEN B. W. *Air Defense*, Speech to NWC and ICAF, Fort McNair, Washington, D.C., 8 February 1954.

Chipman, William K. *Nonmilitary Defense for the United States—Strategic, Operational, Legal, and Constitutional Aspects*, National Security Studies Group, University of Wisconsin, Madison, Wisconsin, 1961.

Churchill, Winston. *Triumph and Tragedy*, Houghton Mifflin, Boston, Massachusetts, 1953.

Cibula, LTC Alvin M. *Antiaircraft Command and Center Study*, No. 26, Historical Section – Army Ground Forces, 1946.

Cobb, MAJ T. W. "Air Defense in the Soviet Union," *Air Defense Trends*, U.S. Army Air Defense School, Fort Bliss, Texas, June 1973.

Cole, J. P. and German, F. C. *A Geography of the U.S.S.R., The Background to Planned Economy*, 2nd edition, Butterworths, London, 1970.

Collier, Basil. *The Battle of Britain*, The MacMillan Company, New York, 1962.

Craven, Wesley F. and Cate, James L., eds. *The Army Air Force in WWII, The Pacific: Matterhorn to Nagasaki*, June 19 to August 1945, University of Chicago Press, Chicago, Illinois, 1953.

DeSeversky, Alexander P. *Air Power: Key to Survival*, Simon & Schuster, New York, 1950.

Dick, William White. *U.S. Army Air Defense Command*, USAWC Lectures 1962/63, Carlisle Barracks, Pennsylvania, 21 March 1963.

Digby, James F. *A Broader View of Some Air Defense Decisions: Notes for a Discussion*, RAND RM-3407 PR, Santa Monica, California, December 1962.

Dzhordzhadze, MG A. I. and Shesterin, COL F. "The Role of Historical Experience in Perfecting Antiaircraft Defense," *PVO Herald*, (ACS/I Translation), February 1972.

Dzhordzhadze, MG A. I. and Shesterin, COL F. "The Lessons of History and Improving Air Defense," *PVO Herald*, (ACS/I Translation), January 1972.

Egorov, P. T. *Civil Defense*, edited by Joanne S. Gailar, et al., U.S. Department of Commerce Technical Information Service, Springfield, Virginia, 1972.

Emme, Eugene M. *The Impact of Air Power*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1959.

Englebardt, Stanley L. *Strategic Defenses*, Crowell, New York, 1966.

Erickson, John. *The Soviet High Command, 1918–1941*, MacMillan and Company, Ltd., London, St. Martin's Press, New York, 1962.

Field, James A., Jr. *History of United States Naval Operations, Korea*, U.S. Government Printing Office, Washington, D.C., 1962.

Finletter, Thomas K. *Foreign Policy: The Next Phase*, Harper Brothers, New York, 1958.

Futrell, Robert Frank. *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force 1907–1964*, Volume 1, Aerospace Studies Institute, Air University, June 1971.

Futrell, Robert Frank. *The United States Air Force in Korea 1950–1953*, Duell, Sloan and Pearce, New York, 1961.

Gallagher, Matthew P. and Spielman, Karl F., Jr. *Soviet Decision-Making for Defense: A Critique of U.S. Perspectives on the Arms Race*, Praeger, New York, 1972.

Gallai, Mark L. *Ispytano v Nebe—Cherez Nevidnu u Barr'yeru* (Tested in the Sky—Through Unseen Barriers), Molodaya Grardiya, Moscow, 1965.

Garrett, Ralph L. *Civil Defense and the Public: An Overview of Public Attitude Studies*, (revised), Office of Civil Defense, Office of Secretary of the Army, Washington, D.C., 1971.

Garthoff, Raymond L. *Soviet Military Doctrine*, RAND, The Free Press, Glencoe, Illinois, 1953.

Garthoff, Raymond L. *Soviet Strategy in the Nuclear Age*, (revised edition), Praeger, New York, 1958.

Gatland, Kenneth W. *Development of the Guided Missile*, ILIFFE and Sons, Ltd., London, 1954.

Geiger, MAJ George J. "Roundup on Russian Jet Fighters," *Air Progress*, Fall 1960.

Gilpin, Robert. *American Scientists and Nuclear Weapon Policy*, Princeton, New Jersey, 1965.

Ginsburgh, Robert N. *U.S. Military Strategy in the Sixties*, W. W. Norton & Company, Inc., New York, 1965.

Goen, Richard L. *Analysis of National Entity Survival*, Stanford Research Institute, Menlo Park, California, 1967.

Goldberg, A. *A History of the U.S. Air Force 1907–1957*, D. Van Nostrand Company, Princeton, New Jersey, 1957.

Goure, Leon. *The Role of Civil Defense in Soviet Strategy*, Prepared for U.S. Air Force Project RAND, RAND 3703, Santa Monica, California, 1963.

Goure, Leon. *The Soviet Civil Defense Program*, RAND RM-2564, 1 August 1960.

Goure, Leon. *The Soviet Civil Defense Program: A Trip Report*, RAND RM-2684, 5 January 1961.

Goure, Leon. *Soviet Emergency Planning*, RAND P-4042, Santa Monica, California, 1969.

Golonne, N. N. *Views on Air Defense*, Gale and Polden, Ltd., New Jersey, Aldershot, England.

Grant, C. L. *The Development of Continental Air Defense to 1 September 1954*, SAF Historical Study No. 126, Maxwell AFB, Alabama, 1954.

Green, Constance McLaughlin, Thomson, Harry C., and Roots, Peter C. *The Ordnance Department: Planning Munitions for War. U.S. Arm in World War II: The Technical Services*, Office of the Chief of Military History, U.S. Department of the Army, Washington, D.C., 1955.

Green, William. "Billion Dollar Bomber, Parts I–III," *Air Enthusiast*, Serial July, August, September, October, 1971.

Green, William. "Mikoyan Quarter Century," *Flying Review International*, November 1965.

Green, William. "Sukhoi . . . Designer from the Shadows," *Flying Review International*, February 1966.

Greenfield, Kent R., Palmer, Robert R., and Wiley, Bell I. "The Army Ground Forces: The Organization of Ground Combat Troops," Historical Division, Department of the Army, Washington, D.C., 1947.

Gurevich, Mikhail I. "I Designed the MiG-15," *Aero Digest*, July 1951.

Hackett, Robert. *Strategic Defensive Forces*, USAWC Lectures, Carlisle Barracks, Pennsylvania, 16 March 1967.

Hammond, Paul Y. *The Cold War Years*, American Foreign Policy Since 1945, Harcourt, Brace & World, New York, 1969.

Hammond, Paul Y. *Organizing for Defense: The American Military Establishment in the Twentieth Century*, Princeton University Press, Princeton, New Jersey, 1961.

Harman, Alvin J. *Analysis of Aircraft Development*, RAND P-4820, March 1973.

Head, Richard G. and Rokke, Ervin J, eds. *American Defense Policy*, Third Edition, The Johns Hopkins University Press, Baltimore, Maryland, 1973.

Nowarra, Heinz J. and Duval, G. R. *Russian Civil and Military Aircraft: 1884–1969*, Harleyford, London, 1970.

Helfers, M. D. *The Employment of V-Weapons by the Germans During World War II*, Office of the Chief of Military History, U.S. Department of the Army, Washington, D.C., 31 May 1954.

Hesse, Herbert R. and Morgenthaler, George W. "Remarks on the Optimal Commitment of Defensive Interceptors and Surface to Air Missiles," Institute for Air Weapons Research, Chicago University, Chicago, Illinois, Report M576, 24 January 1958.

Holst, John J. and Schneider, William, Jr., eds. *Why ABM? Policy Issues in the Missile Defense Controversy*, Hudson Institute, Perqamon Press, New York, 1969.

Hopley, Russell James. *Civil Defense for National Security*, U.S. Industrial College of the Armed Forces, Washington, D.C., L49-70, 14 January 1949.

Huntington, Samuel P. *The Common Defense: Strategic Programs in National Politics*, Columbia University Press, New York, 1961.

Huzar, Elias. *The Purse and the Sword*, Cornell University Press, 1950.

Izmaylov, A. A. *Aviation and Astronautics in the U.S.S.R.* (Aviatsiya i Kosmonavtika SSSR), (N.A.S.A. Technical Translation F-13,142), Military Press, Moscow, 1965.

Jackson, Robert. *The Red Falcons: The Soviet Air Force in Action, 1919–1969*, Clifton Books, Brighton, England, 1970.

Jacobson, James W. *Civil Defense, 1962*, USAWC Lectures 1961/62, Carlisle Barracks, Pennsylvania, 16 March 1962.

Johnson, Ellis A. "Defense of the North American Continent," Speech at 5th Annual Symposium of the Defense Research Board of Canada at Ottawa, 30 November 1953.

Johnson, Robert Wells. *The North American Air Defense Dilemma – Is There a Solution?*, USAWC Student Thesis 60/01, Carlisle Barracks, Pennsylvania, 10 February 1961.

Jones, Robert H. *The Roads to Russia*, University of Oklahoma Press, Norman, Oklahoma, 1969.

Keller, K. T. "Letter to the SECDEF," 10 January 1951.

Kelley, Robert L. *Army Antiaircraft in Air Defense 1946–1954*, Historical Study No. 4, Directorate of Historical Services, HQ ADC, Colorado Springs, Colorado, 30 June 1954.

Kennan, George F. *American Diplomacy, 1900–1950*, University of Chicago Press, Chicago, Illinois, 1951.

Khrushchev, Nikita S. *Khrushchev Remembers: The Last Testament* (attributed – Strobe Talbott, translator and editor), Little, Brown, New York, 1974.

Kilmarx, Robert A. *A History of Soviet Air Power*, Praeger, New York, 1962.

Kintner, William Roscoe. *Peace and the Strategy Conflict*, Frederick A. Praeger, New York, 1967.

Kintner, William Roscoe. *The Prudent Case for Safeguard*, National Strategy Information Center, New York, 1969.

Kintner, William Roscoe. *Safeguard: Why the ABM Makes Sense*, Hawthorn Books, New York, 1969.

Kissinger, Henry A. *Nuclear Weapons and Foreign Policy*, Harper Brothers, New York, 1957.

Kolkowicz, Roman. *The Soviet Military and the Communist Party*, Princeton University Press, Princeton, New Jersey, 1967.

Kolodziej, Edward A. *The Uncommon Defense and Congress, 1945–63*, Columbus, Ohio, 1966.

Kramish, Arnold. *Atomic Energy in the Soviet Union*, Stanford University Press, 1950.

Krosnov, COL A. "The Evolution of Fighter Tactics," *PVO Herald*, February 1972.

Kuebel, Fletcher and Bailey, Charles W. *No High Ground*, Bantam, New York, 1960.

Kulikov, General of the Army V. "Antiaircraft Defense in the Defense of the Soviet Nation," *PVO Herald*, (ACS/I Translation), April 1973.

Lapp, Ralph. *The New Priesthood: The Scientific Elite and the Uses of Power*, Harper & Row, New York, 1965.

Larkins, James Randall. *The International Aspects of the Air Defense of the United States Against Attack by Hostile Aircraft*, Georgetown University, Washington, D.C., June 1959.

Lechy, William. "Diary of William Lechy," *The Lechy Papers*, Library of Congress, Washington, D.C.

Lee, Asher. *Air Power*, Praeger, New York, 1955.

Lee, Asher. *The Soviet Air and Rocket Forces*, Praeger, New York, 1959.

LeMay, Curtis E. "Address on U.S. Air Defense and Military Policy to the Air Power Council CONVAIR Management Club of Fort Worth," Office of Public Affairs, Department of Defense, Washington, D.C., 26 August 1960.

MacKintosh, J. M. *Strategy and Tactics of Soviet Foreign Policy*, Oxford University Press, London, 1962.

McGowan, Samuel B. *Bomber Defense Against Surface-to-Air Missiles*, Study Project 21-55A, Senior Observer Section, Mather AFB, Mather Field, California, 30 June 1955.

McMullen, R. F. *Air Defense and National Policy 1946–1950*, ADC Historical Study No. 22, 1965.

McMullen, R. F. *Air Defense and National Policy 1951–1957*, ADC Historical Study No. 24, 1965.

McMullen, R. F. "History of Air Defense Weapons 1946–1962," ADC Historical Study No. 14, Historical Division, Office of information, HQ ADC.

McMullen, R. F. *Interceptor Missiles in Air Defense 1944–1964*, ADC Historical Study No. 30, February 1965.

McMullen, Richard F. *An Overview of ADC Weapons*, Aerospace Defense Command History, Colorado Springs, Colorado, 1973.

McVeigh, D. R. *The Development of the Bomarc Guided Missile 1950–1953*, WADC, January 1956.

Mallan, Lloyd. *Peace is a Three-Edged Sword*, Prentice-Hall, Englewood Cliffs, New Jersey, 1964.

Malwad, N. *Civil Defense: As Annotated Bibliography 1960- 1968*, Bhabha Atomic Research Centre, Trombay, India, 1970.

Marschak, Thomas, Glennan, Thomas K., Jr., and Summers, Robert. *A Strategy for R&D: Studies in the Microeconomics of Development*, New York, 1967.

Martin, Harold H. "Could We Beat Back an Air Attack on the U.S.?," *Saturday Evening Post*, 4 November 1950.

Martin, Thomas Lyle and Latham, Don C. *Strategy for Survival*, University of Arizona Press, Tucson, Arizona, 1963.

Maxam, William P. *Federal Civil Defense 1946–1963: A Study in Organization and Administration*, University Microfilms, Inc., Ann Arbor, Michigan, 1965.

Miller, Ed Mack. *Men of the Contrail Country*, Prentice Hall, Englewood Cliffs, New Jersey, 1963.

Millis, Walter, ed. *The Forrestal Diaries*, The Viking Press, New York, 1951.

Millis, Walter, Mansfield, Harvey C., and Stein, Harold. *Arms and the State: Civil Military Elements in National Policy*, Twentieth Century Fund, New York, 1950.

Mitchell, Donald W. *The Economics of National Security—Civil Defense: Planning for Survival and Recover*, ICAF, Washington, D.C., 1962.

Morenus, Richard. *DEW LINE: Distant Early Warning, The Miracle of America's First Line of Defense*, Rand McNally, New York, 1957.

Murdock, Clark A. *Defense Policy Formation: A Comparative Analysis of the McNamara Era*, State University of New York Press, Albany, New York, 1974.

Murphy, Charles H. *The Decision to Curtail Strategic Air Defense Programs in FY 1975: Rationale and Implications*, Congressional Research Service, U.S. Library of Congress, Washington, D.C., 15 April 1974.

Nemecek, Vaclav. "A Sukhoi Decade," *Flying Review International*, February 1966.

Nemecek, Vaclav. "A Sukhoi Decade, Part II: The Dry One's War," *Flying Review International*, May 1966.

Nemecek, Vaclav. "A Sukhoi Decade, Part III: Turbojets and Tribulations," *Flying Review International*, April 1966.

Newhouse, John. *Cold Dawn: The Story of SALT*, Holt, Rinehart and Winston, New York, 1973.

Palmer, Paul Carr. *Threat Ordering Criteria and Evaluation for An Antiballistic Missile Defense*, Thesis (MS), Naval PG School, Monterey, California, 1967.

Palmer, Robert R. *The Organization of Ground Combat Troops, United States Air Force in World War II*, Washington, D.C., 1947.

Partridge, Earle E. *CINCNORAD's Operational Concept for Control of Air Defense Weapons*, Speech given to the Armed Forces Policy Council, Colorado Springs, Colorado, 3 May 1956.

Partridge, Earle E. *Open Testimony Before the Armed Services Sub-Committee*, 25 May 1956, HQ Continental Air Defense Command, Ent Air Force Base, Colorado Springs, Colorado, 26 May 1956.

Perry, Robert. *Comparisons of Soviet and U.S. Technology*, RAND R-827-PR, June 1973.

Perry, Robert. *European and U.S. Aircraft Development Strategies*, RAND P-4748, December 1971.

Perry, Robert. *A Prototype Strategy for Aircraft Development*, RAND RM-5597-1-PR, July 1972.

Pile, Frederick A. *Ack-Ack*, George G. Harrap and Company, Ltd., London, 1949.

Ray, Thomas W. *A History of the DEW Line, 1946–1964*, ADC Historical Study No. 31, June 1965.

Reamer, Edward D. and Rogers, Jack D. "A Method for Air Defense System Evaluation," Operations Research Office, Johns Hopkins University, Chevy Chase, Maryland, 30 June 1954.

Robertson, Bruce, ed. *United States Arm and Air Force Fighters 1916–1961*, Harleyford Publications, Ltd., Letchworth, Herts, England, 1961.

Roderick, Harry E. *Organizational and Functional Relationship of Air and Civil Defense*, AWC Thesis No. 1334, U.S. Air University, Maxwell AFB, March 1957.

Saville, MG G. P. *Air Force Weapons, Capabilities, and Developments*, Lectures to National War College, 15 February 1950.

Sanders, Ralph. *The Politics of Defense Analysis*, Dunellen, New York, 1973.

Sayer, A. P., comp. *The Second World War, 1939–1945, Army, Army Radar*, The War Office, Great Britain, 1950. (British-Restricted, U.S.-Confidential-Modified Handling Authorized)

Schilling, Warner R., Hammond, Paul Y., and Snyder, Glenn H. *Strategy, Politics and Defense Budgets*, Columbia University Press, New York, 1962.

Scott, William F. "Survival in the Nuclear Age: An Examination of a Soviet Concept," (Unpublished Ph.D. Dissertation), The George Washington University, Washington, D.C., 1974.

Semmens, Paul. "Preliminary Chronology, Blue Air Defense Systems, Strategic Air Defense History," Braddock, Dunn and McDonald, Inc., Colorado Springs, Colorado, 2 volumes-BDM/CS-85-74-1-0073, 25 November 1974.

Smith, William J. *Air Defense of the North American Continent*, AWC Thesis No. 1347, U.S. Air University, Maxwell AFB, June 1957.

Sokolov, V. L. *Soviet Use of German Science and Technology*, Research Program on the U.S.S.R., New York, 1955.

Sokolovsky, Marshal S. U. V. D. *Military Strategy*, Third Edition, (Harriet F. Scott, Translator), SRI Technical Note SSC-TN-8974-29, January 1971.

Solzhenitsyn, Alexander I. *The Gulag Archipelago: 1918–1956*, (Thomas P. Whitney, Translator), Harper & Row, New York, 1973.

Staudt, H. R. The Department of Defense Decision-Making Process, Unpublished MIT Thesis, 1 May 1968.

Stanley, T. W. *American Defense and National Security*, Public Affairs Press, Washington, D.C., 1956.

Stockwell, Richard E. *Soviet Air Power*, Pageant, New York, 1956.

Stimson, Henry L. "The Decision to Use the Atomic Bomb," *Harper's Magazine*, February 1947.

Strickland, Donald A. *Scientists in Politics: The Atomic Scientists Movement 1945–1946*, Purdue University Studies, Lafayette, Indiana, 1968.

Sturm, Thomas A. *Organization and Responsibility for Air Defense, March 1946–September 1955*, Air Defense Command Study No. 9, U.S. Air Force, Air Defense Command.

Sturm, Thomas A., Volan, Denys, Billias, George, and Stevens, Howard. "The Air Defense of the United States: A Study of the Work of the Air Defense Command and its Predecessors through June 1951," Prepared by the Directorate of Historical Services, Office of the Air Adjutant General, HQ, ADC.

Taft, Robert A. *A Foreign Policy for Americans*, Doubleday & Company, New York, 1951.

Tammen, Ronald L. *MIRV and the Arms Race: An Interpretation of Defense Strategy*, Praeger, New York, 1973.

Terrett, Dulany. *The Signal Corps: The Emergency*, U.S. Army in World War II, The Technical Services, Office of the Chief of Military History, Department of the Army, Washington, D.C., 1956.

Thompson, George R. and Harris, Dixie R. *The Signal Corps: The Outcome*, U.S. Army in World War II, The Technical Services, Office of the Chief of Military History, Department of the Army, Washington, D.C., 1966.

Tikhomirov, V. I. and Paramonov, F. I. *Organization and Planning of Production at Aircraft Engine-Building Plants* Organizatsiya: Planirovaniye Proizvodstra na Aviadvigatele-Stroitel'nykh Zavodakh), (FTD Translation MT-24-499-73), Moscow, 1972.

Tokaev, G. A. *Betrayal of an Ideal*, (Alec Brown, Translator), Harvill Press, London, 1954.

Tokaev, G. A. *Comrade X*, (Alec Brown, Translator), Harvill Press, London, 1956.

Tokaev, G. A. *Soviet Imperialism*, Duckworth, London, 1954.

Tokaev, G. A. *Stalin Means War*, Weidenfeld & Nicholson, London, 1951.

Truman, Harry S. *Memoirs*, Garden City, New York, 1955.

Truman, Harry S. *Memoirs of Harry S. Truman II, Years of Trial and Hope*, Doubleday and Company, Garden City, New York, 1956.

Vandenberg, Arthur H. *The Private Papers of Senator Vandenberg*, Houghton Mifflin, Boston, Massachusetts, 1952.

Volan, Denys. *Air Defense in Theory and Practice 1918–1945*, Historical Division, Office of Information, HQ, ADC, 1964.

Weaver, Leon Hiram. *The Civil Defense Debate*, Social Science Research Bureau, Michigan State University, East Lansing, Michigan, 1967.

Welborn, M. C. *V-1 and V-2 Attacks Against the United Kingdom During WWII*, Technical Memorandum ORO-T-42, Operations Research Office, Johns Hopkins University, Washington, D.C., 1950.

Wesley, Frank Craven and Cate, James Lea, eds. "The Army Air Forces in World War II," *Men and Planes*, Volume VI, The University of Chicago Press, Chicago, Illinois, 1955.

Weyland, GEN O. P. "The First Jet Air War," *Air Intelligence Digest*, September–October 1953.

Wigley, Russell F. *History of the United States Army*, The MacMillan Company, New York, 1967.

Wigner, Eugene Paul, ed. *Who Speaks for Civil Defense?*, Scribner, New York, 1968.

Wilson, Charles E. *Continental Air Defense*, Memo to Secretary of the Air Force, U.S. Department of Defense, Washington, D.C., 21 June 1956.

Wohlstetter, Albert, et al. *U.S. Air Defense*, ORO Study R-17, Appendices D, E, F, N, 24 February 1958.

Wolfe, Thomas W. *Soviet Power and Europe 1945–1970*, The Johns Hopkins Press, 1970.

Wolfe, Thomas W. *Soviet Response to U.S. Military Policies and Problems*, RAND, RM-4798-PR, December 1965.

Yakimanskiy, N. and Gorbunov, V. "Certain Questions in the Development of the Theory of Operational Arts and Tactics of the National Air Defense Troops during the Postwar Period," *Voyenno Istoricheskiy Zhurnal* (Military History Journal), No. 3, Moscow, March 1973.

Yakovlev, Alexander S. *Fifty Years of Soviet Aircraft Construction*, (50 Let Sovetskogo Samoletostroeniya), (E. Vilim, Translator), N.A.S.A. Technical Translation, (Jerusalem, Israel Program for Scientific Translations), TTF-627, 1970.

Yakovlev, Alexander S. *Target of Life*, (Tsel' Zhizni), NTIS #AD674316, (1968 FTD Translation), Moscow, 1966.

Yarmolinsky, Adam. *The Military Establishment: Its Impacts on American Society*, Harper & Row, New York, 1971.

Zheltikov, COL. I. and Igolkin, COL V. *Certain Tendencies in the Development of Aircraft and Antirocket Defense, Voyennaya Mysl'* (Military Thought) April, 1965 (Translated by Foreign Documents Division, FPD 0146/68).

Index