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The "Air Operation": A Warsaw Pact Strategy for Achieving Air Superiority (U)

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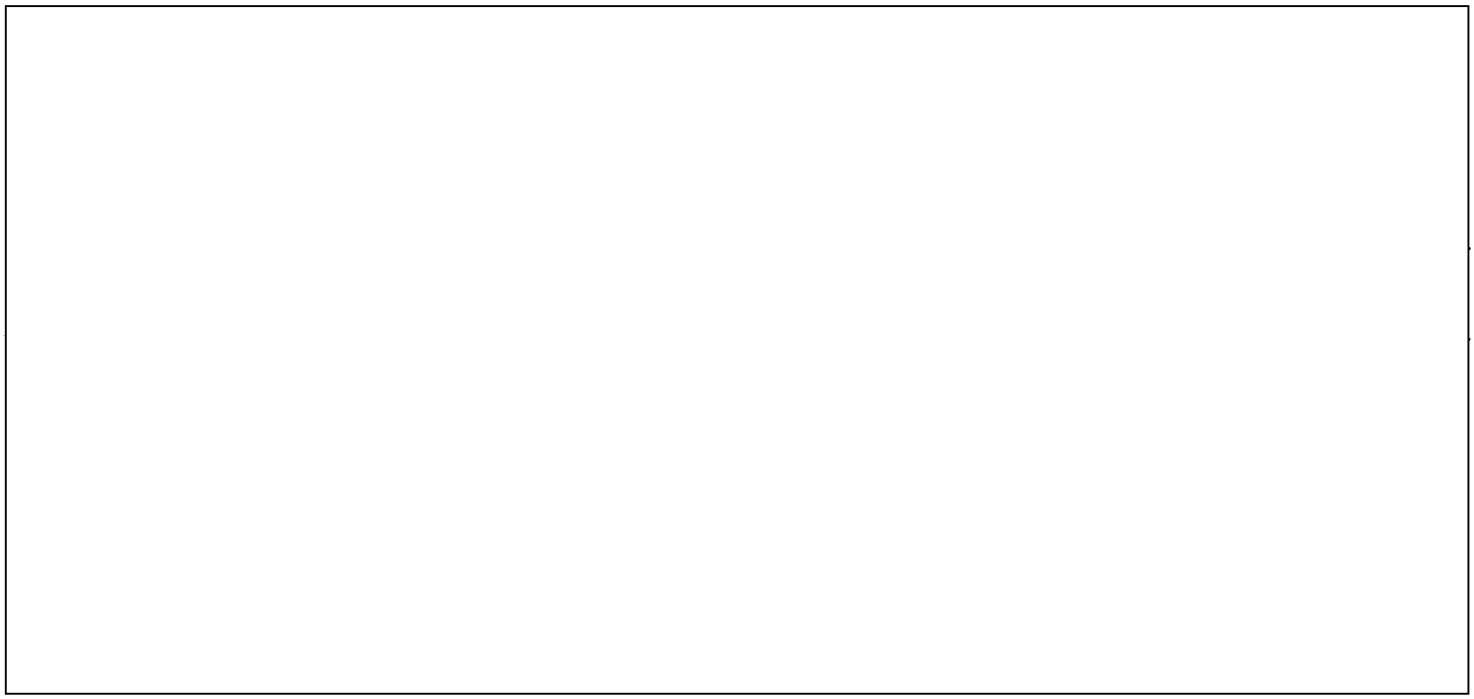


The "Air Operation": A Warsaw Pact Strategy for Achieving Air Superiority

Key Judgments

Warsaw Pact planners consider that early air superiority is critical to their chances for victory in a war with NATO. Believing that the first stage of such a war may be fought with conventional forces only, they have developed plans for a large-scale, theaterwide, conventional air offensive intended to achieve superiority in the first few days of such a war. The Soviets refer to this offensive as the "Air Operation."

Some aspects of the Air Operation are known:
- The Pact would commit most of its tactical aircraft and many of its Long Range Aviation (LRA) bombers to a series of air assaults.
- The first wave in each assault would be intended to destroy or suppress NATO's air defense in certain corridors. Subsequent waves would fly through these corridors to strike airfields and air-associated command and control facilities.
- LRA bombers would be the primary force for attacking airfields. Most of the tactical air forces would be used to suppress the air defenses, especially the HAWK missile batteries.
- Some aircraft would be withheld for nuclear operations, and relatively few would be assigned to the direct support of the ground forces.

The Air Operation would not achieve air superiority, in our judgment, although it would do considerable damage to NATO's air defenses. We base this conclusion on the following evaluation of Pact capabilities:
- The Pact is unlikely to achieve strategic surprise; to enhance the prospects of a general offensive in Central Europe it would feel compelled to make extensive preparations, which NATO would detect.
- The Pact's ability to orchestrate precisely timed multiple sorties—by various categories of aircraft under different commands—is open to question.
- With their current weapons, the Pact's tactical aircrews would have difficulty suppressing NATO's HAWKs.
- The Pact could do only limited damage to NATO airfields, because the force it apparently intends to commit to this task is inadequate, the weapons ineffective, and the tactics faulty.
- The aircrews generally are not well trained for combat in a hostile environment.
- The Pact tactical aircraft—as currently equipped—cannot perform their mission unless they have high ceilings and good visibility.

We estimate that the Pact air forces could cause greater damage to NATO airfields if they were to modify their tactics. For example, they would be more effective if they concentrated their efforts on cratering runways rather than attacking both runways and aircraft shelters. Even so, the Air Operation would be unable to achieve early air superiority.

Contents

Figures

Tables

Preface

This paper presents evidence from [redacted] and unclassified documents to show how planning for the Air Operation has evolved and assesses the Pact's current ability to carry out the operation. It does not discuss future capabilities, except to identify areas in which the Pact is already making improvements. The analysis focuses on a conventional air attack against those NATO targets in Central Europe—airfields and air defense facilities—that the Warsaw Pact would have to destroy if it were to achieve air superiority. We do not consider the Pact's ability to destroy other targets—such as nuclear storage sites and surface-to-surface missiles—nor attempt to calculate the aircraft each side may lose in air-to-air combat. [redacted]

In sum, this paper presents our analysis of the damage that NATO could expect from a massive Pact conventional airstrike against its air forces and air defenses in the near term. We believe this paper presents a worst-case situation for NATO. [redacted]

"*Vozdushnaya operatsiya* (air operation): coordinated combat actions of one or several air formations and field forces, conducted independently or in cooperation with other branches of the armed forces, with a single aim and plan, to achieve a strategic or operational objective. . . .

"An air operation will be characterized by the massed employment of forces and facilities, the crucial nature of the objectives, and great spacial scope. Great importance is attached to the element of surprise in an air operation, which is achieved by concealing preparations for it, selecting the most advantageous time for carrying out the first massed strike, and timely suppression and destruction of radioelectronic means of detection and control of the enemy's air defense system. . . .

"Interaction among the operational field forces and formations taking part in an air operation is achieved by allocating the missions and objectives among them and coordinating the time and procedure for delivering the strikes, as well as by taking steps in support of the combat operations."

Ye. G. Veraksa and M. N. Kozhevnikov
Soviet Military Encyclopedia, 1976

"*Gospodstvo v vozdukhe* (air supremacy): a decisive superiority over the enemy by the aviation of one of the belligerents in the airspace over a theater of military operations or on an important axis. The gaining of air supremacy makes it possible for the ground forces, the navy, air forces, and rear of a nation (coalition of nations) to perform their tasks without significant interference from the enemy's aviation or air defense. . . .

"The need to achieve and retain air supremacy remains an important task. In order to accomplish it the enemy's air grouping (groupings) as well as the main resources must be destroyed and the air defense system neutralized in one theater of military operations or in several simultaneously. *The air force has the main role in the achievement and retention of air supremacy,* although other branches of armed forces also participate in the struggle for air supremacy. Air supremacy may be strategic, operational, or tactical, depending on the scale." [Emphasis added.]

A. N. Yefimov
Soviet Military Encyclopedia, 1976

The "Air Operation": A Warsaw Pact Strategy for Achieving Air Superiority

Soviet strategy for war with NATO calls for a massive and rapid ground offensive into Central Europe [1] to defeat NATO forces, disrupt mobilization, and seize or destroy ports and airfields to prevent reinforcement. Pact planners regard the early attainment of air superiority as critical, and they intend to carry out a large-scale, theaterwide conventional air offensive in order to achieve air superiority in the first days of a war.

The Air Operation Concept

Planning for the initial air offensive is based on what the Soviets call the "Air Operation." Soviet military writers use this term to describe the combined use of air units from several sources—for example, from the air armies of two or more fronts and from Long Range Aviation (LRA)—under centralized control above the front level to achieve a strategic objective assigned by the High Command.

The Air Operation is intended to enable a superior command to assume temporary control of the various tactical air armies in pursuit of a common objective. The concept, which was developed during World War II, is still a part of Soviet doctrine because of the decentralized structure of the Pact's tactical air forces. These forces are normally parceled out to the various front commanders to provide air support as required by "front operations."

The details of Air Operation contingency plans that the Pact may currently have on the shelf are not known. However, from [redacted] human sources, and unclassified military writings we can determine their objectives and principal characteristics. The following combat operations make up the Air Operation:

- A defense suppression phase, involving the jamming and destruction of NATO airborne and ground-based air defenses.
- A primary strike phase, consisting of attacks against NATO airfields and command and control facilities.
- A poststrike reconnaissance phase.

The most detailed evidence on the conduct of the Air Operation is provided by scenarios that we believe were formulated by the Soviets as part of overall Pact strategic planning. (One such scenario is shown in figure 1.) The scenarios are similar in a number of ways:

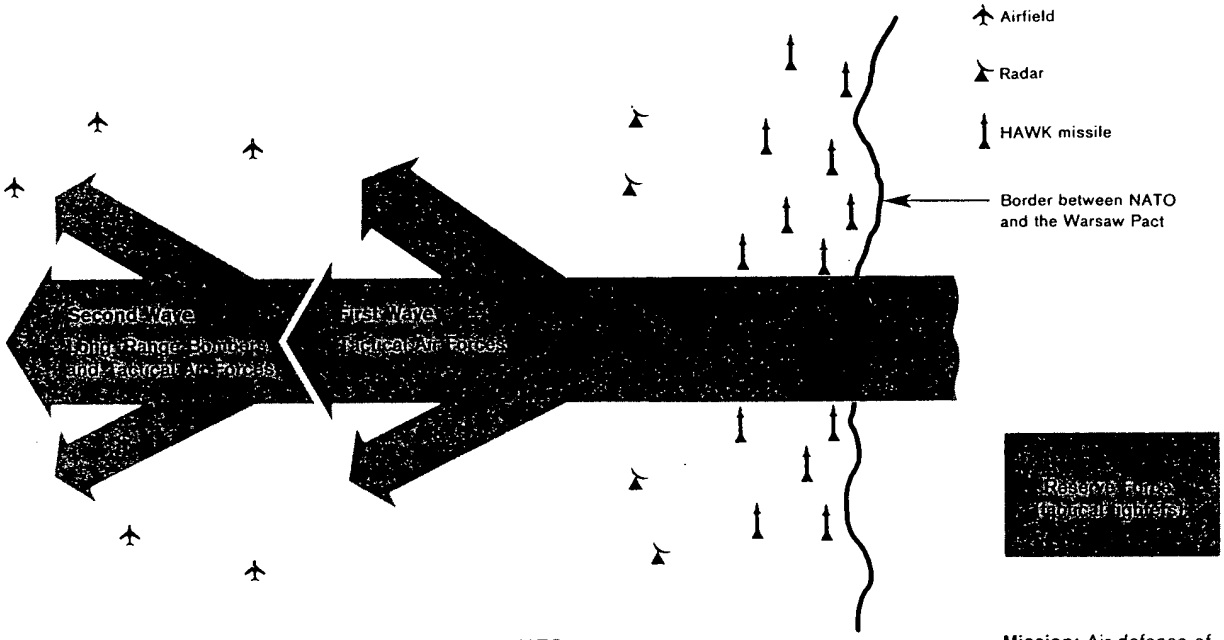
- Assaults consist of sequential sorties, with a first wave by tactical aviation for the suppression of NATO air defenses and several subsequent waves by tactical air forces and LRA.
- The targets to be struck are usually identical and include HAWK surface-to-air missiles, surface-to-surface missiles, air defense command and control facilities, and airfields.
- The LRA is limited primarily to attacking airfields.

The scenarios do not provide a clear indication of Soviet intentions regarding reinforcement of Pact air forces in Central Europe with aircraft from the western Soviet Union. Two types of scenario [redacted] in one the participating air forces would have required extensive reinforcement from the Soviet Union, and in the other the participating forces could have conducted the operation with little or no reinforcement.

[1] In this assessment, the term Central Europe is used to include the NATO Guidelines Area (East and West Germany, Poland, Czechoslovakia, and Benelux) plus Denmark.

Figure 1

Warsaw Pact Air Operation Scenario



This operation was to use fewer than 2,000 aircraft over a two-day period. Two assaults, eight hours apart, were to be flown the first day, with a third and concluding assault on the second day.

Factors Affecting the Availability of Forces

The Pact has more than 4,000 combat aircraft available for use in Central Europe: about 3,000 tactical aircraft, including those based in the western USSR; almost 800 East European air defense interceptors; and more than 500 Soviet medium bombers (see table 1).[2] If the Air Operation were put into effect, the number actually committed to it would be determined by the number of aircraft moved forward from the USSR and the number allocated to other missions.

[2] Our figures, based on estimates, are rounded in the text. We do not round them in the tables, in order to maintain consistency from one table to another.

Allocation of Aircraft to Other Missions

Although most of the Pact's aircraft would be involved in the Air Operation, some would be reserved for other types of missions, including strategic air defense of Eastern Europe, maintenance of a nuclear-armed response force, and direct air support to the front commanders for front operations.

The actual commitment of aircraft would vary according to conditions in Central Europe at the time and cannot be predicted in other than general terms. We do

Table 1

Warsaw Pact Combat Aircraft Available for Use in Central Europe (January 1979)

Type of Aircraft	Total	Based in Central Europe [1]	Based in Western USSR [2]
Tactical fighters	1,240	880	360
Ground attack	1,390	870	520
Tactical reconnaissance	450	350	100
Air defense interceptors	770	770	0
Medium bombers	520	0	520 [3]

[1] Pact air forces based in East Germany, Poland, and Czechoslovakia.
[2] Tactical air forces in the Baltic, Belorussian, and Carpathian Military Districts.
[3] TU-16 Badgers, TU-22 Blinders, and Backfires in the Northwest and Southwest Bomber Commands.

have information, however, that indicates how many would be allocated to other missions:

- Strategic air defense is the responsibility of the East European national air defense elements. Thus, the 770 non-Soviet Warsaw Pact (NSWP) interceptors probably would not be used in offensive operations.
- At least 150 medium bombers and 200 tactical aircraft would be withheld from conventional operations to form a nuclear force.
- At a minimum, 20 percent of the remaining tactical aviation force would be under control of the front commanders for direct support of ground operations.

These allocations would leave a maximum of 2,670 aircraft for the Air Operation. Our analysis suggests that the Pact probably would assign about 2,000.

Aircraft Movement Before Hostilities

The Pact has various options in the deployment of aircraft, which would affect the number of aircraft that could be involved in the Air Operation. The in-place option would be to use those forces that are able to attack NATO targets from their peacetime locations, and the full reinforcement option would be to bring forward all the Pact tactical aircraft based out of range of NATO targets and commit them to the operation. Somewhere between lies the option that we consider the Pact most likely to choose. The number of aircraft available in each option is shown in table 2.

In-Place Option. Pact air forces could use the in-place option to support a "standing start" attack against NATO.[3] The number of aircraft would be limited to those which the planners consider to have sufficient range to attack NATO targets from their home bases. The time required to prepare for this option—about 24 hours—would give NATO virtually no warning of attack. It would also give the Pact air forces too little time to complete the logistics and command and control preparations which they believe they would need for a sustained, effective air operation.

Full Reinforcement Option. The full reinforcement option would make available the maximum number of aircraft. The time required to prepare for it—approximately 72 hours—would permit the Pact to complete its initial air logistics and command and control preparations. Soviet planners recognize a significant drawback to this option, however: the forward area does not have enough hangarettes to protect the newly arrived aircraft, which would be vulnerable to a NATO preemptive strike. The planners may also be concerned about stripping second-echelon fronts of their air support before the ground armies could be brought into the theater.

The Soviets probably would consider using the full reinforcement option as a part of a fully prepared ground offensive. In such an offensive, the three fronts from East Germany, Czechoslovakia, and Poland would be committed to the attack, and the two fronts from the western USSR would be brought forward and made available from the outset as theater reserves. Although the air elements for such an attack could be ready in 72 hours, the planners are apparently

[3] See National Intelligence Estimate 4-1-78, *Warsaw Pact Capabilities for Going to War in Europe: Implications for NATO Warning of War*, for a discussion of the "standing start" and two-, three-, and five-front attack scenarios and the likelihood of their occurrence.

Table 2

Postulated Allocation of Pact Aircraft to Initial Air Operation in Central Europe

	In-Place Option	Full Reinforcement Option
Total aircraft in Eastern Europe and western USSR	2,940	4,370
Aircraft withheld for:		
Air defense	770	770
Nuclear warfare	350	350
Medium bombers	150	150
Tactical aircraft	200	200
Front operations	300	580
Aircraft available for Air Operation	1,520	2,670
Medium bombers	370	370
Tactical aircraft	1,150	2,300

reluctant to conduct a full air reinforcement until the reinforcing ground units have arrived in Central Europe from the western USSR—and this could take as long as two weeks. They probably are concerned about the aircraft vulnerability and the need to maintain the integrity of the fronts.

Most Likely Reinforcement Option. Warsaw Pact military exercises consistently portray the initial combat operations in Central Europe as a response to a NATO attack made before the Pact could achieve full reinforcement. Most exercise scenarios involve the mobilization and movement of Pact air forces available in Central Europe, plus a limited reinforcement from the Soviet Union. This option would require moving about 550 tactical fighters and bombers,[4] of which some 450 could be allocated to the Air Operation.

[4] The movement of tactical aircraft in our postulated limited reinforcement option would include seven Polish air regiments with 350 aircraft, one East German wing with 50 aircraft, one Czech air regiment with 50 aircraft, and one Soviet light bomber division with 100 aircraft.

This would give the Pact a total of 1,600 tactical aircraft for the initial attack. According to Pact planning, 1,600 tactical aircraft and 370 medium bombers would be enough to attack, in a single assault, all of those NATO airfields in Central Europe that support nuclear strike units, plus 40 percent of the HAWK sites and 30 percent of the primary air defense early warning and control radars.[5]

Mounting the Air Operation

Force Preparation

We estimate that preparing the forces in the limited reinforcement option would take a minimum of three days. Preparations would include setting up a wartime command and control system, readying individual air units and their aircraft, establishing a logistics structure to support the rebasing of air units and to sustain the Air Operation, and collecting and processing intelligence on the disposition of NATO forces.

Command and Control Preparations. Establishing the command and control system would take the most time. It would include manning and activating main and alternate command posts at the regiment, division, army, front, and theater levels; establishing interlinking means of communications; and deploying additional ground control radars and ground-based navigation aids.

Air Unit Preparations. Preparations within the air regiments themselves would require about 24 hours. Activities would include repairing disabled aircraft, arming and fueling aircraft for combat, and readying them for deployment to other airfields. Because Pact air forces are manned in peacetime well below their wartime authorized strengths, reservists would have to be called up. The reservists, including some from the Soviet Union, probably would perform such duties as transporting ammunition and petroleum, oil, and lubricants (POL) to airfields from off-base depots and supply points.

[5] For purposes of calculation in appendix A we have rounded these 1,600 tactical aircraft and 370 bombers to a force of 2,000 aircraft.

Logistics Preparations. Activation of airbases to receive tactical air units deploying nearer NATO borders would involve extensive movement of logistic materials, support personnel, and equipment. Pact exercises indicate that tactical air units already in Central Europe would use motor transport for this movement and would take about 24 hours. Longer hauls, such as those required to move the supporting elements of a light bomber division from the USSR into East Germany, probably would be made by air transport. Such a move would require approximately 100 AN-12 Cub flights and would take about 36 hours. (U)

Intelligence Preparations. The Pact would have to acquire and process intelligence on NATO forces before the Air Operation, especially if NATO had been alerted. It almost certainly would attempt to learn the location of any air defense and surface-to-surface missile units that had moved from their peacetime positions. It would also try to identify the airfields used for dispersal, especially of nuclear-capable units. To accomplish these tasks, the Pact has agent networks in NATO countries, ground-based SIGINT networks, and aircraft equipped for ELINT, COMINT, and radar and photographic reconnaissance. Most of the airborne reconnaissance would be flown in a standoff mode without penetrating NATO airspace, but some penetration with manned aircraft is likely. (

Combat Operations

Jamming. The Pact would depend heavily on airborne as well as ground-based electronic countermeasures (ECM) to reduce losses while penetrating NATO airspace. Defense suppression attacks would begin with a massive, coordinated jamming effort aimed at disrupting the radars and the communications links of NATO's air defenses.

Pact ground force ECM units and air force MI-8PP helicopters probably would concentrate on the UHF ground-to-air and air-to-air communications that NATO uses to control its interceptor operations. Their ECM is effective only along the line of sight, however, and their effectiveness against NATO radars would probably be limited.

The jamming of NATO's various radars—early warning, ground-controlled intercept, and acquisition—would be the responsibility of aircraft (such as the AN-12 Cub C/D) carrying ECM equipment. Because of its vulnerability, this aircraft probably would be used only for standoff jamming, but even so, when orbiting over East Germany and Czechoslovakia at 6,000 meters it could cover most of the ground-based radars in West Germany.

Attacks Against HAWK Batteries. In the initial phase of the Air Operation, attacks would be made against NATO's air defenses. The Pact probably would choose to suppress the defenses within certain corridors; this would eliminate the need to suppress all 84 of the HAWK batteries NATO has currently deployed in Central Europe and would allow more Pact aircraft to be directed against primary targets. If, for example, three corridors were to be established, only 30 to 35 HAWK sites would have to be suppressed or destroyed. On the basis of current Pact planning factors, this number of sites would require about 200 fighter-bomber sorties. NATO's Nike-Hercules sites probably would not be subjected to a major suppression effort, at least during this initial phase.

Tactical aircraft attacking HAWK units probably would go after their fire-control radars and associated electronics vans, using unguided bombs and rockets as well as precision-guided munitions. They could also use the AS-7 Kerry tactical air-to-surface missile, but its effectiveness would be limited. (Its accuracy is poor, and the carrying aircraft must linger in the area—becoming highly vulnerable—in order to guide the weapon to its target.) The AS-9 tactical antiradiation homing missile also appears to be of little use in attacking HAWK sites; Consequently, the AS-9 would be able to engage the HAWK's high-altitude acquisition radar, but not its more important low-altitude acquisition radar, high-power illuminator, and range-only radar. (

Attacks Against Radar Sites. Pact planners probably would also see a need to attack all 10 of NATO's forward-deployed NADGE primary early warning ground-control radar sites.[6] Given Pact planning factors, this could require as many as 100 fighter-bomber sorties. Whether any of the 15 facilities that make up NATO's tactical air control system (TACS) would also come under attack in the initial assault would depend on whether Pact reconnaissance had located them. Unlike the NADGE facilities, which are in fixed positions, the TACS facilities can be relocated. Although the TACS sites are intended primarily for control of offensive operations by NATO's air forces, they could control air defense interceptor operations if NADGE sites were destroyed.

Pact ground force tactical surface-to-surface rockets and missiles probably would supplement the defense suppression strikes by tactical aviation. The FROG-7 and the SS-21—and possibly the Scud-B—can carry conventional cluster warheads and could be used against air defense radar sites.

Attacks Against Airbases. The main strike force, consisting of medium bombers and tactical fighter-bombers, would closely follow the defense suppression raids of the tactical air units and would attack the principal objectives—airfields at which aircraft with a nuclear strike mission are based. The Pact would target these aircraft for two reasons: because of their potential use in nuclear operations and because they are, in general, NATO's most modern and effective conventional attack aircraft. With the Pact's current planning—one air regiment against each airfield—a force of 370 medium bombers could attack 12 airfields.

We estimate that approximately 70 percent of the attacking medium bomber force would be used to strike airfields and would concentrate on closing or interdicting the runways and taxiways and destroying NATO aircraft on the ground. The principal conventional munitions currently in the Pact's inventory and intended for these purposes are 250-kilogram and 500-kilogram general purpose bombs. The Badger and Blinder medium bombers could deliver about 3,000 kg of bombs from their home bases in the USSR to NATO targets in Central Europe. The Backfire, which is replacing the Badger, could deliver 6,000 to 7,000 kg over the same distance.

The remaining 30 percent of the attacking medium bombers would be committed to support roles, such as electronic warfare or attacks on NATO's early warning radar sites and the air defense missile and artillery units located near airfields. These aircraft would use both active jamming and chaff to disrupt NATO's radar defenses and would use antiradiation missiles against the NADGE and TACS radar sites.

While the main effort of the Air Operation would be directed against targets in West Germany and Benelux, Pact forces would also strike a limited number of airfields on NATO's northern and southern flanks. Evidence suggests, however, that Pact planners are not seriously considering strikes against airfields in France and the United Kingdom. We believe they omit France because they are uncertain what role the French would play in a NATO-Pact war. We are less certain about why exercise scenarios omit strikes against the United Kingdom. The F-111s based there would be particularly important targets. Pact planners, however, may have assigned higher priority to a number of targets on the continent—which are also more accessible and therefore pose fewer operational problems. It is also possible that the planners do not appreciate the importance of the UK bases to NATO's military capability.

Reconnaissance. Although the Pact would conduct some aerial reconnaissance before and during the Air Operation, a major effort would be made immediately after the bombing attacks to evaluate the operation's success. After an assessment of the damage inflicted on NATO and of their own losses, the Pact commanders would decide on the nature of succeeding assaults.

The Pact has three primary types of manned aircraft for reconnaissance: the MIG-25 Foxbat B/D, the YAK-28R Brewer D, and the MIG-21R Fishbed H. The Foxbat probably would be used to photograph

[6] The area analyzed in this assessment contains 17 NATO air defense ground environment (NADGE) sites, but only 10 are deployed forward.

targets deep in NATO territory, while Fishbed and Brewer aircraft would cover those nearer Pact borders. Manned aircraft would be supplemented by short-range reconnaissance drones over the border areas.

Factors Affecting Pact Prospects for Success

The initial Air Operation by itself probably could not inflict a decisive defeat on NATO's air forces. It could neutralize an important part of NATO's ground-based air defenses but probably would not destroy a significant number of NATO aircraft.

studies of NATO air defense capabilities indicate that Pact air losses during such an operation would be large—perhaps as much as half of the participating forces over the several days of attacks. The losses would probably be most heavy in medium bombers, which are more vulnerable than tactical fighters. In addition, unlike the tactical forces (which have a significant reserve in the Soviet Union), the LRA would be unable to replace lost aircraft.

Several variables would affect the ability of the Pact's air forces to reduce the effectiveness of NATO's air forces. Chief among these are:

- The degree of surprise achieved.
- The skill in coordinating multiple flights by many aircraft.
- The suppression of NATO's air defenses.
- The effectiveness of the attack on NATO airfields.
- The proficiency of Pact aircrews.
- The ability of Pact air forces to perform their missions in poor flying weather.

Surprise

The Pact is unlikely to achieve complete, or strategic, surprise.[1] To enhance the prospects for success of a general offensive in Central Europe and to reduce the risk of escalation to nuclear weapons, Pact leaders almost certainly would feel compelled to make extensive preparations. They would not only mobilize and move the Pact air, ground, and naval forces but also put the political, economic, and civil defense systems on a war footing.

Soviet military doctrine for offensive operations emphasizes both the need for surprise and the need for heavy superiority in the main battle area. In general, the Soviets hope to achieve both but, if forced to choose, they are likely to opt for force superiority. This is real, and its benefits are certain, while surprise is less tangible and is easily compromised.

Military writings on the advantage of achieving surprise in an air offensive indicate that Soviet planners are thinking of tactical surprise—attack at a place and time, and with a strength, that the enemy does not expect—rather than of strategic surprise. Soviet planners probably rule out being able to achieve strategic surprise because of their keen appreciation of NATO's ability to detect preparations and to react quickly.

A surprise would pin down more aircraft at NATO's bases, but it would not necessarily increase the Pact's ability to destroy them. NATO has enough concrete shelters to protect about three-fourths of the combat aircraft normally based in Central Europe. Consequently, until the Pact has large numbers of precision-guided munitions (such as the AS-10 missile or a laser-guided bomb) suitable for attacking shelters, those aircraft have considerable protection from conventional weapons. The main advantage of a surprise attack would be in cratering runways and taxiways while some NATO aircraft were still waiting to take off.

Soviet planners probably have considered minimizing NATO's warning time by making a preemptive strike, in which Pact air forces would take off from their home bases and fly the most direct route to their targets. Such a strike, which would make no attempt to suppress NATO's forward air defenses, would give Soviet planners an alternative to devoting the first wave to clearing corridors through those defenses. Although this tactic would undoubtedly catch a larger

[1] See NIE 4-1-78, on warning of war in Europe, for a fuller discussion of Pact intentions regarding surprise and its role in Central Europe.

portion of NATO's air forces on the ground, it would probably increase Pact aircraft losses, particularly among the relatively vulnerable long-range bombers. As long as Soviet planners believe that they must use their long-range bombers in the Air Operation, they are not likely to endorse a scenario which omits the suppression of NATO defenses.

Coordination of Forces

The ability of Warsaw Pact forces to conduct the Air Operation is open to question. It would require the precise coordination of multiple sorties by Soviet bombers flying out of the USSR with operations of the Soviet and East European tactical air forces and several different air defense forces. Although the Pact's physical facilities for command, control, and communications are probably adequate, the full system has not been tested.

Command and control deficiencies might not seriously affect the execution of the initial assault, because the participating forces would have only to carry out one or another of various missions already planned. Subsequent assaults, however, would demand much more skillful command and control, especially as the results of the first strikes, and NATO's reaction to them, demanded changes in targets and tactics

An additional problem for the Pact is that its air forces would become less effective as they penetrated deeper into NATO territory, because most of their tactical aircraft depend for navigation on a network of ground-based control stations. They would have to fly high enough to remain within radio line of sight of the control network (and thus become more vulnerable to NATO's air defenses) or fly low to increase their chances of surviving (and thus lose contact with their primary navigation aid). The only Pact tactical attack aircraft that can effectively navigate without such assistance are the Fencer A, Flogger D, and Fitter D. Currently these aircraft make up less than 15 percent of the tactical aircraft available for operations in Central Europe—although their numbers are increasing steadily.

NATO jamming could seriously affect Pact management and coordination. Pact air forces generally are dependent on an electronic control system, both for navigating to distant targets and for conducting aerial intercepts, and this dependence makes them especially vulnerable to electronic countermeasures. Pact electronic systems susceptible to jamming include short-range navigation systems, ground-to-air communications systems, the radars used to vector aircraft in air-to-air engagements, the Doppler navigation systems aboard the Fencer A, Flogger D, and Fitter D, and the bomb-navigation systems on Soviet bombers.

Suppression of NATO Air Defense

The Pact's ability to find and destroy NATO's primary radar sites probably is adequate to eliminate at least the NADGE radar sites, because all of them are fixed. Munitions which the Pact is likely to use against these sites include unguided munitions and a variety of antiradiation missiles (ARMs). Use of ARMs would reduce the need to locate individual targets precisely—a task that would pose some difficulty in the case of transportable and camouflaged facilities like the TACs.

Attacking NATO's HAWK surface-to-air missiles would be a significantly greater challenge because those tactical aircraft that the Pact would assign to this task are equipped mainly with direct-attack weapons—the aircrews would have to see the HAWKs before they could strike them. This would be considerably more difficult if NATO were alerted and moved the HAWKs from their peacetime positions. Their mobility would probably force the Pact to search for the HAWKs again before each assault.[8]

Recent improvements in Pact reconnaissance capabilities should increase the speed with which strike aircraft could react to intelligence giving the location of HAWK batteries. Soviet reconnaissance units in Central Europe now have aircraft (Brewer D and Fishbed H) equipped with television. Each of these aircraft also has a direct data link to ground control

[8] See appendix A for a more detailed analysis of Pact capabilities for the suppression of NATO's HAWK defenses in the Central Region.

stations which would be used to transmit information on newly identified targets as it was gathered. To gather useful information, however, the Brewers and Fishbeds would have to overfly NATO territory, where they would be exposed to NATO air defenses. Several Soviet aircraft do carry side-looking airborne radar, but it probably does not have sufficient resolution to locate HAWK sites.

The introduction of antiradiation missiles capable of attacking the HAWK's principal engagement radars would significantly improve Pact capabilities to suppress the HAWK.[9] Such ARMs would reduce the need to locate with precision those ground-based units whose fire-control radars are emitting signals. Instead of suppressing all air defenses in the selected corridors, aircraft equipped with ARMs could escort the strike aircraft and engage only those HAWK sites that threatened them directly. We expect ARMs of this sort to be available in the early 1980s.

Tactics of the Airfield Attack

Pact planners appear to underestimate the difficulty of attacking NATO's airfields, and their tactics seem ill conceived. These planning factors would probably limit severely the success of such an attack.[10]

Of the 43 main operating bases that NATO normally maintains in peacetime, we believe that about 15 could be attacked in a single assault during the Air Operation. This assessment is based on the number of LRA and tactical air regiments the Pact would probably commit to airfield attacks and on Pact planning factors indicating that one regiment of aircraft would be assigned to attack one NATO airfield. Pact strategists thus face a difficult choice. Our analysis shows that over a three-day period they could attack each of NATO's major bases once or could conduct repeated attacks against fewer airfields—selecting, for example, those where nuclear delivery aircraft are based. The desire of Pact strategists to reduce NATO's air nuclear strike potential suggests that they would select the latter alternative. At present, NATO maintains 10 airfields in Central Europe where nuclear strike aircraft are based in peacetime and two others where nuclear weapons are stored.

Our analysis of Pact tactics indicates that the planners do not understand how to maximize the potential effectiveness of the force committed to attacking airfields. Evidence from exercises shows that they tend to commit the attacking force against both shelters and runways, instead of focusing on one or the other. Furthermore, the Pact has used munitions that are not well suited for airfield attack and has used an ineffective delivery technique.

By correcting its employment doctrine, the Pact could far better exploit its present capabilities for closing runways and could bring more airfields under attack in a single sortie. Current deficiencies in the doctrine also prevent the Pact air forces from taking full advantage of the increased potential of the new aircraft and munitions they are now receiving.

Analysis shows that if the Pact were to strike both the aircraft shelters and the runways of 15 airfields, a single assault would destroy some 60 sheltered aircraft [11] and close three or four runways. The runways probably could be reopened within four hours and fully repaired within approximately 16. This judgment is based on analysis of the amounts and kinds of ordnance various types of Pact aircraft would deliver, the effectiveness of that ordnance, the accuracy of Pact delivery, and the ability of NATO to repair runways. Two more attacks of the same kind would probably destroy 120 more aircraft and, if directed against the same 15 airfields, would aggravate the initial damage to the runways but would probably not seriously impede NATO's use of the airfields.

[9] The Fitter C/D can carry the AS-9 ARM. [redacted] could not home on the HAWK continuous wave fire-control radar.

[10] Appendix B provides evidence supporting our analysis of Pact plans for attacking NATO airfields and provides the background analysis for our damage assessments.

[11] This analysis is based on the assumption that all shelters are occupied and that the destruction of the shelter also destroys the protected aircraft.

By designing an assault to crater runways only and employing more effective munitions, the Pact could strike a greater number of airfields—our analysis is based on 30—in a single sortie. We believe that such an assault could put as many as 12 runways out of operation—equivalent to about one-fourth of NATO's main bases—for 12 to 20 hours, rendering up to 25 percent of NATO's combat aircraft temporarily unusable. If the same runways were subjected to two followup attacks, they could be closed for several days.

Our analysis shows that an attack aimed solely at destroying shelters would show an equal increase in effectiveness. Three successive assaults against the shelters at 30 airfields could destroy approximately 350 aircraft, or about 20 percent of NATO's immediately available combat aircraft.[12]

The Pact's potential for airfield attacks should increase substantially as Backfires continue to replace aging Badgers and as precision-guided munitions are introduced. The most dramatic change would be in the ability to destroy aircraft in shelters. For example, if Pact planners adjusted their tactics to make the most efficient use of the newer aircraft and weapon systems, by the mid-1980s the Pact would have the potential capacity to destroy up to 45 percent of NATO's aircraft in Central Europe in a series of three assaults. Its ability to interdict runways also would increase. An airfield attack mounted with today's tactics and a force of the size the Pact currently intends to use could close 12 runways, whereas the same force using the newer systems and better tactics could close some 25. In addition, the damage from each assault would be greater and would require more time for repair.

Aircrew Proficiency

Pact tactical aircrews generally are not well trained for combat in the hostile environment they would probably encounter in the Air Operation. Their training is stereotyped, lacks realism, and neglects some of the potential of their aircraft and weapon systems. Pact pilots are not exposed to the tactics NATO pilots would be expected to employ, and when they practice ground attacks the simulated air defense environment is not realistically hostile. Of the training flights a Pact aircrew makes each year, only about one-fourth involve any combat-related events.

Two other aspects of training could affect the execution of the Air Operation. One is that Pact aircrews receive a limited amount of training for flying combat missions at low altitudes or over long distances. Another is that they have little experience in operating independently. Peacetime training is conducted under strict ground control in order to compensate for the rudimentary navigation instrumentation aboard most Pact tactical aircraft. In operations beyond the range of their control stations, the crews would be ill prepared to seek out and attack airborne NATO aircraft or targets on the ground.

Another factor prejudicial to the success of the Air Operation is that the Pact must keep a portion of its force on alert for nuclear operations. We estimate that this duty probably requires up to 200 of its most experienced tactical aviation aircrews. Consequently, of the 1,600 pilots that would be needed to fly the aircraft available for an initial assault, approximately one-third would be third class. By Pact standards, third-class pilots are not qualified to fly combat missions in darkness or in unfavorable weather.

Weather

Most of the Pact's tactical aircraft require favorable weather conditions. We judge that only the Fencer and Backfire can navigate at low altitude and attack targets in poor visibility, because only they are estimated to have full inertial navigation systems and terrain avoidance and bomb-navigation radars. Other Pact aircraft require ceilings of several thousand meters and visibilities of over 1.5 kilometers.

Thus, weather conditions could be critical to the success of the Air Operation, which would demand several consecutive days of good weather. Throughout much of the year the skies in Central Europe are so overcast that air operations would be severely degraded. The tabulation below shows the percentage

[12] These figures are summarized in table 11, page 34.

of time there will likely be cloud cover at or below various altitudes in Central Europe for representative months in the four seasons:

	300-meter ceiling	600-meter ceiling	3,000-meter ceiling
January	57	63	92
April	24	41	86
July	29	37	72
October	42	54	83

A ceiling of 300 meters or below will probably prevent any aircraft that is not equipped for all-weather operation from participating in long-range operations. When the ceiling is over 3,000 meters, operations are unimpeded. Between these extremes, the weather will have varying effects on aircraft and weapons performance. In sum, the uncontrollable variable of weather is one that could severely degrade the effectiveness of the Air Operation—especially while few Pact aircraft are equipped for all-weather flying.

Sortie Rates

The Warsaw Pact's ability to sustain intensive, large-scale offensive air operations over a period of days would be crucial to the success of the Air Operation. We have no direct evidence on this ability—there is, for example, little reliable information on stocks of air munitions or POL in Central Europe. Major information gaps of this sort, as well as methodological uncertainties, have so far permitted us to make only tentative assessments. In peacetime the Pact air forces are significantly undermanned—apparently mostly in ground support and rear services. The implications of this undermanning are not well understood, but it could reduce significantly the Pact's ability to sustain operations in the initial days of a war.

Losses in Air-to-Air Combat

Pact planners view the air-to-air combat phase of the Air Operation as an opportunity to inflict heavy losses on NATO's interceptor force. Pact planners expect as much as 30 percent of NATO's losses to occur in aerial engagements. They may be planning to allocate up to 800 aircraft—40 percent of their total force—to air-to-air missions.

Although we are unable to formulate an assessment of the number of aircraft each side might lose in air-to-air combat, we believe that the optimism of the Pact is unfounded. We recognize that it might be able to outnumber NATO in the air by more than 2.5 to 1, but several factors make it unlikely that the Pact can gain significantly from this imbalance:

- NATO's interceptors, mostly F-4s and F-15s, are superior to the MIG-21s and MIG-23s they would be engaging.
- NATO's aircrews are better trained.
- NATO has the advantage in command and control.

Conclusions

Given the present Warsaw Pact capabilities and tactical concepts, we estimate that the Air Operation—in which only conventional weapons are used—would not inflict decisive damage on NATO's air and air defense forces.[13] It probably would have the following impact:

- It would put out of operation a large part of NATO's ground-based air defense control facilities—that is, the NADGE and TACS radar systems. Their loss would hamper the offensive and defensive use of NATO's air forces, but the E-3A airborne warning and control system would continue to provide command and control.
- It would probably cause little other damage to NATO's air forces or airfields. The Pact probably could not destroy a significant number of NATO aircraft—we think it would lose more aircraft than NATO would.
- It probably would not eliminate the capability of NATO's air forces to respond with nuclear weapons. Any loss of nuclear-capable aircraft in the initial operation could reduce NATO's ability to provide direct nuclear support to local ground commanders, but we believe such losses would have little effect on

[13] This assessment does not consider the contribution of the Pact's ground-based air defenses to the achievement of air superiority.

NATO's ability to execute the SACEUR Priority Strike Plan. Aircraft losses would have to approach 50 percent of the nuclear-capable force before the Priority Strike Plan would be endangered. The chances that an Air Operation could inflict losses of this magnitude are minimal even under optimum operational conditions.

In sum, the Warsaw Pact plans to conduct a series of assaults based on the Air Operation concept, with the general objective of achieving air superiority. We are not certain of the minimum damage the Pact would hope to inflict and the maximum losses it would be willing to accept. We judge that Pact planners estimate too highly both their capabilities and the probable results of their Air Operation. This overoptimism results from their misconception of the effectiveness of bombing raids on NATO airfields

Appendix A

Warsaw Pact Capabilities for HAWK Suppression

One of the factors that would affect the success of the Air Operation is the ability of the Pact air forces to suppress NATO's air defenses. This appendix presents an analysis of the Pact's capability to counter NATO's HAWK surface-to-air missile defenses and describes the kinds of information we used in our model.[14] The model enabled us to quantify the effectiveness of HAWK-suppression attacks, under various conditions, in reducing the number of Pact aircraft lost. In an actual assault, this effectiveness would depend heavily on the Pact's ability to provide the attack force with precise information on the location of HAWK units. The Pact's ability to do this was not evaluated in this analysis

Attack Scenario

The attack scenario in our analysis assumes that a major portion of the Pact Air Operation is aimed at a central corridor through the midsection of West Germany, where most of NATO's air strength—as well as US air and air defense forces—is located. To attack that area, we believe the Pact planners may assign as much as 40 percent of their total force. In our analysis we allocated 720 aircraft to that attack. This is 36 percent of the roughly 2,000 aircraft that we estimate would be available, assuming limited reinforcement from the Soviet Union. (Table 3 shows the NATO targets and our postulated allocation of Pact forces against them; for a discussion of the reinforcement options, see pages 3 and 4.)

Our hypothetical force flew two types of attack. In one (which we considered for purposes of comparison) we assumed the Pact would make no attempt to suppress the NATO HAWKs but would order all 720 aircraft to attack targets in the rear areas of West Germany. In the other we assumed a first wave would attack the forward HAWK sites. Figure 2 illustrates the forward HAWK suppression attack and figure 3 the primary strikes (that is, the followup strikes against other targets).

Table 3

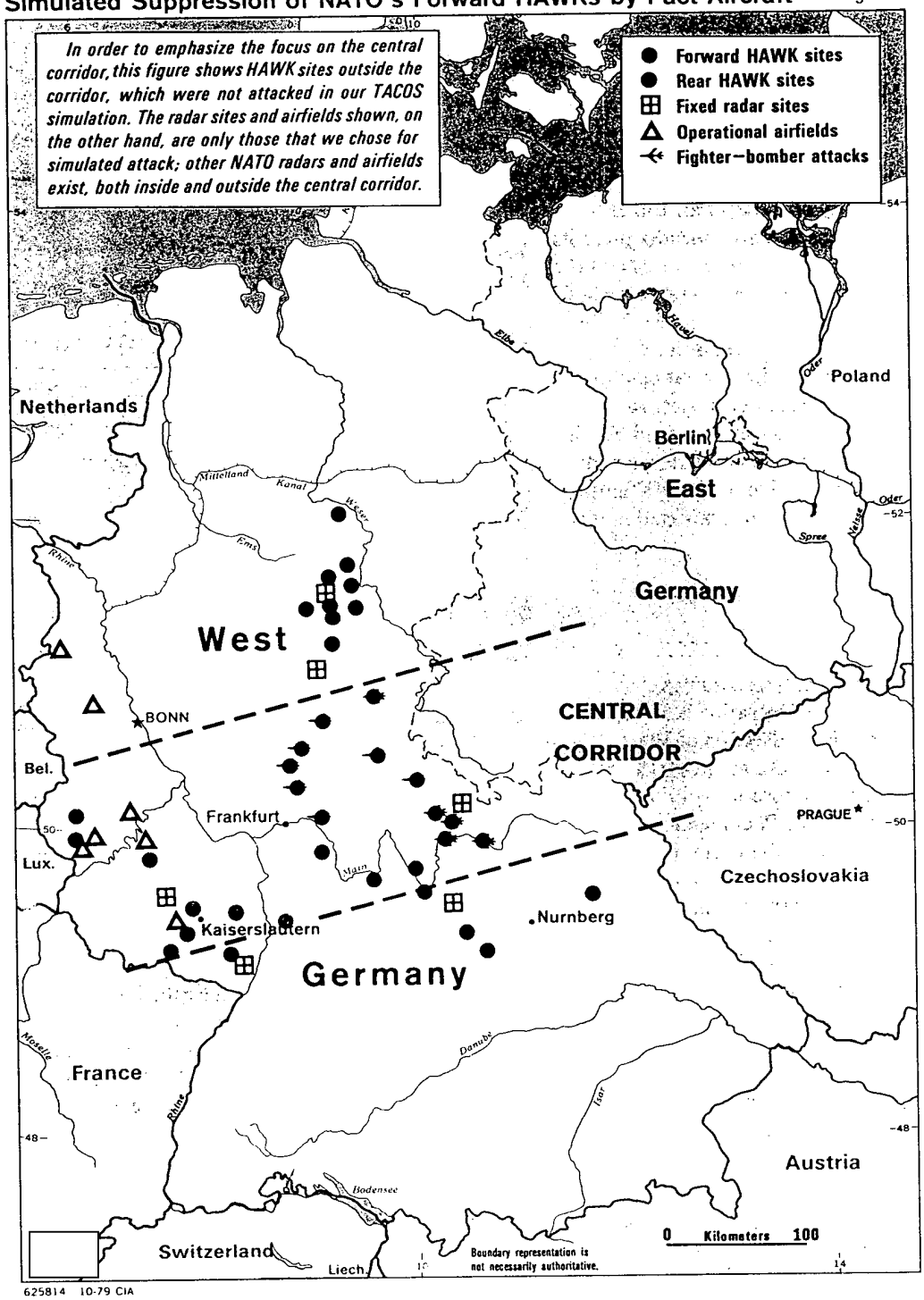
Postulated Allocation of Pact Strike Forces in the TACOS Simulations

NATO Targets	Number of Targets	Pact Aircraft Committed	
		Mission	Total
Initial Strike			
Forward HAWK sites	12	60 strike 12 ECM support	72
Followup Strike			
Rear HAWK sites	4	20 strike 4 ECM support	24
Fixed radar sites	7	70 strike 21 ECM support	91
Operational airfields	7	119 strike 56 ECM support	175
Aircover			358
Total	**30**		**720**

In all cases, we postulated that the attacking force would use a variety of penetration tactics, consistent with the missions and flight characteristics of the particular aircraft involved. The tactical strike and ECM support aircraft were directed to penetrate NATO's air defenses at an altitude of 200 meters, with an ingress speed of 450 knots and egress speed of 540 knots. The medium bombers were directed to fly at 200 meters also but at a slightly slower speed, 380 knots. The bombers' fighter escorts were assigned higher altitudes, with some coming in as high as 1,100 meters.

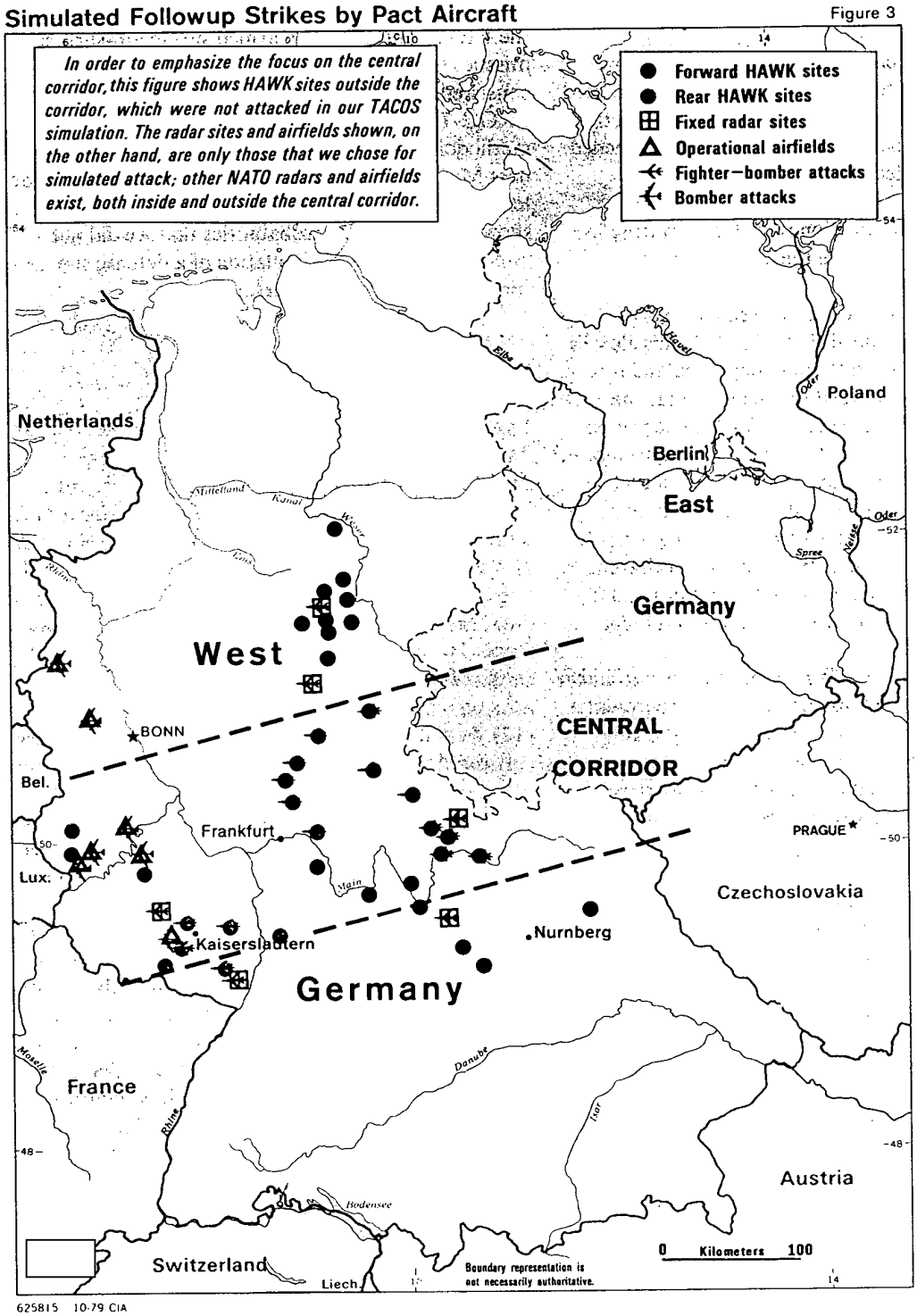
Simulated Suppression of NATO's Forward HAWKs by Pact Aircraft

Figure 2



Simulated Followup Strikes by Pact Aircraft

Figure 3



Methodology

To simulate the interaction of the Pact attack force with the defending force of NATO HAWKs, we used the TACOS model.[15] This model recorded the activity of each battle and performed the calculations needed to generate a detailed report. (

We simulated the interaction repeatedly, putting in alternative data to evaluate the effect of three variables:

- To test the effect of ECM, we used two sets of estimates of the likelihood that a HAWK missile will shoot down a Pact aircraft, an undegraded and a degraded set. The degraded set assumed that the Pact's ECM would halve the HAWK's undegraded engagement probability of kill (P_k). The single-shot P_k for both sets of estimates are summarized in table 4.
- To test the effect of different air-delivered munitions, we varied the P_k for a single attacking aircraft against a single HAWK site. We used three different P_k figures—0.1 to simulate unguided munitions and 0.4 and 0.6 to simulate two classes of precision-guided munitions.
- To test the effect of HAWK responses, we put in two different alert rates—a 40-percent rate to represent a force attacked with little or no warning and a 100-percent rate to represent full alert. (In both cases we assumed that 10 percent of the sites on alert were unable to engage Pact aircraft because of equipment failures.) (

The model was run a total of 16 times, with varied parameters. In 12 variations we assumed that the Pact preceded its primary attack by a suppression attack against the HAWKs, and we varied the input to measure the effects of that suppression under different conditions. In four other variations we assumed that the attacks were conducted without suppression. (Each of the 16 variations of the attack simulation was run five times to increase our confidence in the results and to reduce the effects of statistical variance.)

We also evaluated, although in less detail, the ability of the Pact's conventionally armed surface-to-surface missiles to suppress the HAWKs. This evaluation consisted of calculating the lethality of the Scud-B, FROG-7, and SS-21 against the HAWK,

. (Table 5 summarizes the missile characteristics used in this evaluation.) Our calculations showed such low kill probabilities that we did not undertake a TACOS simulation of a defense suppression attack by those missiles.

Results of the Analysis

Suppression of HAWKs by Aircraft

Table 6 summarizes the results of the TACOS simulations, expressing (in terms of Pact aircraft losses) the effectiveness of HAWK suppression attacks under various conditions. It shows the numbers of Pact aircraft lost, of HAWK sites destroyed, and of missiles fired by the forward HAWKs. Table 7, using the same data, shows Pact losses as a percent of the attacking force. The number of aircraft in the attack (72 assigned to HAWK suppression and 648 with other missions) and the number of HAWK sites attacked (12) were held constant in all cases. These simulations permitted us to draw several conclusions.

In all cases, the Pact suppression attacks reduced the capability of the HAWKs and thus reduced the Pact's aircraft losses. Suppression was most effective when the HAWKs were on full alert—that is, the alert HAWKs scored twice as many kills when undisturbed as they did when they were bothered by suppression. On the other hand, suppression was relatively ineffective (in terms of reducing Pact aircraft losses) when the HAWKs were not on alert—that is their unreadiness reduced their effectiveness so greatly that the Pact's use of suppression became far less significant. These conclusions assume the use of the Pact's current air-delivered munitions; we judge that the use of precision-guided munitions would make suppression effective under any conditions.

Table 4

Effectiveness of Pact Electronic Warfare Systems [1]

NATO HAWK vs Pact Aircraft	HAWK Single-Shot P_k			
	Undegraded by Pact ECM		Degraded by Pact ECM	
	Single target	Multiple targets	Single target	Multiple targets
Engagements at 0 - 6,000 meters (altitude)				
2.8 - 15 km (range)	.72	.56	.27	.23
15 - 30 km	.74	.58	.27	.23
30 - 42 km	.61	.46	.24	.20
Engagements at 6,000 - 7,500 meters (altitude)				
2.8 - 15 km (range)	.68	.53	.26	.22
15 - 30 km	.64	.49	.25	.21
30 - 42 km	.31	.24	.14	.11

[1] The effectiveness of Pact ECM is expressed in terms of the HAWK single-shot probability of kill (P_k) against Pact aircraft with and without ECM equipment. The undegraded set of P_k estimates was derived from US Army evaluations of the HAWK performance in a non-ECM environment. The degraded set assumed that the Pact's ECM would halve the HAWKs' P_k. The figures under "multiple targets" indicate the HAWK P_k against a single aircraft if two or more aircraft are within the same radar resolution cell.

Table 5

Technical Data on Selected Soviet Missiles [1]

System	Maximum Range (km)	Accuracy-CEP (m)	Warhead Data			System Reliability
			Weight (kg)	Number of Submunitions	Pattern Diameter (m)	
Scud-B	300	970	1,000	60	410	.80
FROG-7	65	410	430	24	265	.75
SS-21	120	250	700	42	350	.80

[1] This table shows the characteristics of the conventionally armed surface-to-surface missiles that we considered the Pact might use against the HAWK. The circular error probable (CEP) shown here is measured at two-thirds of the missile's maximum range. The warhead estimates for the Scud-B and FROG-7 are based on estimates of the SS-21 warhead. Each of the submunitions was similarly assumed to weigh 14 kg and have a mean area of effectiveness-fragmentation (MAE-F) of 1,280 square meters against a radar van such as the HAWK battery control center.

Table 6

Results of TACOS Simulation of the HAWK Suppression Engagement

	100% HAWK Alert Rate		40% HAWK Alert Rate	
	Pact has no ECM	Pact has ECM	Pact has no ECM	Pact has ECM
Pact Air Operation With HAWK Suppression				
Aircraft P_k Against HAWK = 0.1				
Aircraft lost in suppression strike	16	7	12	5
Aircraft lost in followup strike	95	54	54	33
HAWK sites killed	4.4	4.6	5.0	5.2
Missiles expended by forward HAWKs	277	277	160	174
Aircraft P_k Against HAWK = 0.4				
Aircraft lost in suppression strike	13	3	5	5
Aircraft lost in followup strike	66	48	22	23
HAWK sites killed	10.2	10.2	10.2	11.4
Missiles expended by forward HAWKs	211	224	127	127
Aircraft P_k Against HAWK = 0.6				
Aircraft lost in suppression strike	15	6	5	2
Aircraft lost in followup strike	72	35	42	25
HAWK sites killed	10	11.4	11.8	11.8
Missiles expended by forward HAWKs	226	200	118	141
Pact Air Operation Without HAWK Suppression				
Aircraft lost	146	87	79	48

The loss rate of aircraft attacking the HAWKs was generally about twice that of aircraft in the subsequent waves—when the suppression was conducted against a fully alert HAWK force and without Pact ECM. When the HAWKs' efficiency was degraded either by jamming or by a reduced alert rate, the suppressor aircraft suffered about the same losses as the rest of the force. In two cases the simulation showed that the force attacking the HAWKs suffered a greater loss rate than the entire force suffered in attacks made without any attempt at suppression.

The HAWK-suppression assault did not ensure that more aircraft would actually complete the primary mission. For example, if 72 aircraft were assigned to the first-wave assault—and therefore became unavailable for the followup—their suppression of HAWKs would save some of the followup aircraft, but fewer than 72. Only after several HAWK-suppression assaults would an increasing number of Pact aircraft survive the followup mission and be available for subsequent missions.

When we put in improvements in the effectiveness of the attackers' munitions, the rate of kill against HAWK and the survivability of the primary strike force increased. This effect was most pronounced with the increase in munition P_k from 0.1 to 0.4 and was less significant with further increases. The same improvements in munition effectiveness, however, did little to increase the survivability of the HAWK-suppression force; these aircraft suffered most of their losses before they reached the HAWKs—and therefore before they could bring their improved munitions into play.

Table 7

Pact Aircraft Loss Rate (As a Percentage of Each Attacking Force)

	100% HAWK Alert Rate		40% HAWK Alert Rate	
	Pact has no ECM	Pact has ECM	Pact has no ECM	Pact has ECM
Pact Air Operation With HAWK Suppression				
Aircraft P_k Against HAWK = 0.1				
HAWK suppression force	22.2	9.7	16.6	6.9
Followup strike force	14.7	8.3	8.3	5.1
Total force	15.4	8.5	9.2	5.3
Aircraft P_k Against HAWK = 0.4				
HAWK suppression force	18.1	4.2	6.9	6.9
Followup strike force	10.2	7.4	8.0	3.5
Total force	11.0	7.1	7.9	3.9
Aircraft P_k Against HAWK = 0.6				
HAWK suppression force	20.8	8.3	6.9	2.7
Followup strike force	11.1	5.4	6.5	3.8
Total force	12.1	5.7	6.5	3.8
Pact Air Operation Without HAWK Suppression				
Total force	20.2	12.1	11.0	6.7

The expenditure rates noted in the various TACOS runs indicate that HAWK units in the field with three missiles per launcher would have enough missiles for a three-day massive air operation. Individual units might exhaust their initial supply after a day or two, however, and might need more; these could be supplied from the rear or from nearby units which were not within engagement range of the suppression corridors.

The TACOS simulation showed aircraft losses suffered by the primary strike force to be greatest in two situations: attacking targets in areas where the HAWKs had not been suppressed and penetrating the HAWK belt at other than low altitude. Losses in the first category are not unexpected—Soviet planners recognize that some of their tactical forces may have to fly strikes into unsuppressed areas and apparently are willing to accept the losses.

The high loss rates noted among aircraft penetrating at medium and high altitudes were somewhat artificial—a product of the engagement logic of TACOS—but they demonstrate an important point. Some Pact tactical aircraft will be unable to penetrate the belt at low altitude. Air superiority fighters, which are searching out and engaging NATO interceptors, are particularly likely to come in high—and to be readily engaged by HAWKs. In the target-rich environment that the Air Operation presents to the HAWK defenses, low-altitude medium bombers may be able to slip through—at the expense of the tactical fighters at higher altitudes. In all our simulations, the loss rate of medium bombers was much lower than that of fighters flying at higher altitudes. Soviet planners have discussed the merits of saturation and may be willing to sacrifice tactical aircraft (which can be replaced) in order to conserve their limited LRA bomber forces. Such a tactic would force the HAWK defenses to establish priorities for targets.

Suppression of HAWKs by Surface-to-Surface Missiles

Our analysis of attacks against HAWK sites by conventionally armed surface-to-surface missiles showed that they were ineffective. The Soviets' best missile for this role, the SS-21, was found to have a single-shot P_k of only about 0.14, and those of the older FROG-7 and Scud-B were 0.034 and 0.015, respectively. To achieve a cumulative P_k of 0.75 against a single HAWK battery control center, the Pact would have to launch nine SS-21s, 38 FROG-7s, or 90 Scud-Bs.

The most important limitation of surface-to-surface missiles is their inaccuracy, which accounted for nonkills 57 percent of the time in the case of the SS-21, 70 percent for the FROG-7, and 78 percent for the Scud-B. The warheads for these missiles appear to be adequate, however; targets were killed 65 percent of the times when the missile succeeded in putting the warhead over the target.

Conclusions

With good intelligence, and with the Pact's current munitions inventory, an Air Operation attack could destroy 50 to 60 percent of NATO's HAWKs over a three-day period. However, such an attack could cost the Pact air forces as many as 180 aircraft (or about one-fourth of those allocated to HAWK suppression over the three days). If the attacking aircraft had precision-guided munitions, they could probably destroy 80 to 90 percent of the HAWKs, while their own loss rate would be about the same.

The Pact may choose to use surface-to-surface missiles in the HAWK suppression role, but aircraft appear to be far better suited for this job. Missiles are more dependent on precise target location information than are manned aircraft, and even with such information their inaccuracy is so great that multiple launches are required to assure a kill.

Appendix B

Warsaw Pact Capabilities for Conventional Air Attacks Against NATO Airfields

This appendix describes Pact plans for attacking NATO airfields with conventional munitions and describes our analytical method of assessing Pact capabilities to destroy aircraft protected in shelters and to interdict runways. It presents an estimate of Pact capabilities under three circumstances:

- Using the force we believe the Pact currently has lined up for use against NATO airfields and what we believe to be current Pact tactics.
- Using the present Pact force, but employing tactics modified in ways we believe would enhance the effectiveness of an airfield attack.
- Using the force we estimate that the Pact will have in 1985, plus the modified employment concepts. (

Pact Planning for Airfield Attacks

The following picture of Soviet planning for airfield attack emerges from an analysis of Pact military writings and exercises:

- To attack a single airfield, the Soviets would employ an entire air regiment, whatever the type of regiment. Regiment-size attacks would vary in intensity from approximately 30 aircraft for tactical and LRA bomber regiments to 36 aircraft for tactical fighter-bomber regiments.
- Within the attacking regiment, only some 70 to 75 percent of the aircraft would be used for the actual attack on airfield facilities. Of these, one-half (about 35 percent of the total regiment) would be used to strike the airfield's runway and the other half to attack aircraft on the ground. The remaining 25 to 30 percent of the regiment's aircraft would be given support roles, including electronic warfare (EW) support, suppression of air defenses at the airfield, and weather and prestrike reconnaissance. (Although Pact writings have portrayed other airfield-related facilities—weapons storage, maintenance, electronics, and fuel supply and distribution systems—as targets, we have no evidence that these are included as targets in Pact exercise scenarios.)
- The Pact's principal munitions for airfield attack continue to be 250-kg and 500-kg bombs. Typically, runways would be attacked with 500-kg general purpose bombs, while soft targets (unprotected aircraft, for example) would be attacked with 250-kg and 500-kg cluster and fragmentation bombs. Advanced munitions designed specifically for airfield attack, such as runway or aircraft shelter penetrators, have not been noted and are probably not in the operational inventory.
- The combat bomb load of LRA's primary medium bombers—Badger and Blinder—may be no greater than about 3,000 kg. This is significantly lower than the maximum bomb load capability, which is 9,000 kg for both aircraft. The difference probably reflects Soviet operational planning, which sacrifices bomb tonnage in order to increase maneuverability and low-altitude penetration capability. (

Attack Objectives

The airfield attack in the Pact Air Operation would be intended to deny NATO the use of its aircraft. It could do so by destroying or damaging the aircraft on the ground, by interdicting runways, or by disrupting logistic support and command and control. Of these possibilities, Pact planners appear to focus on the first two. (

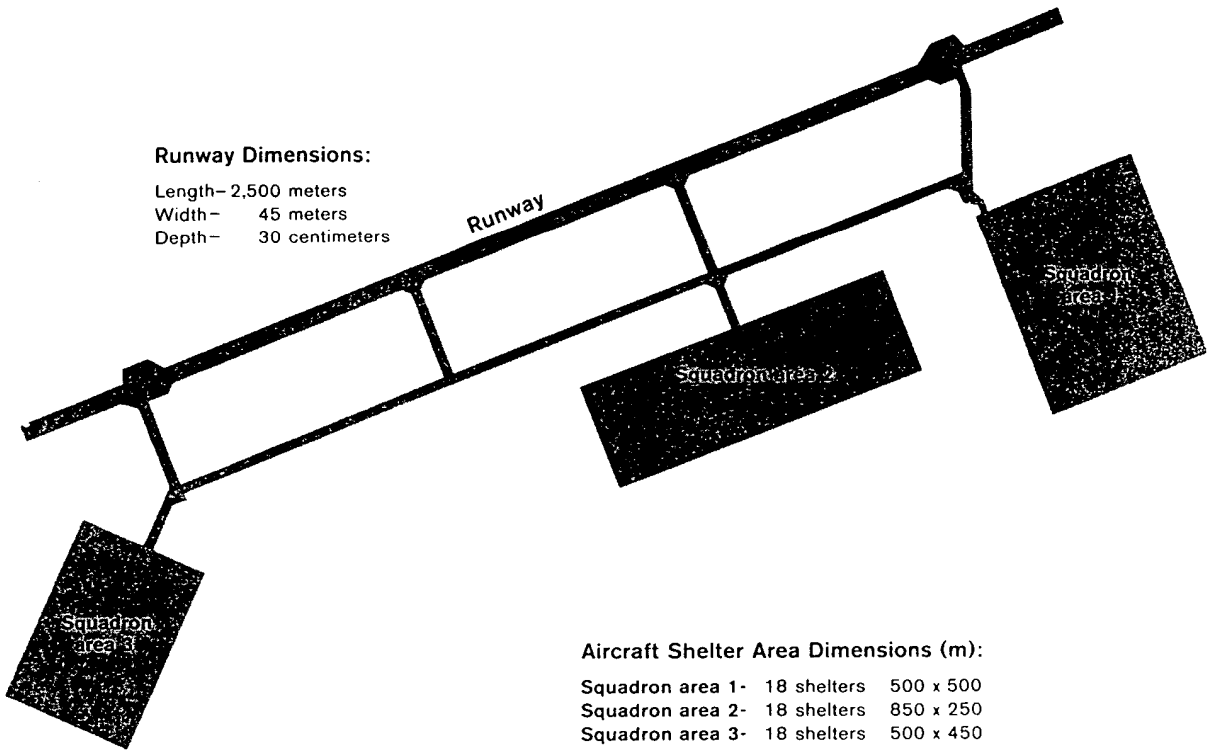
Destroying Sheltered Aircraft

Destruction of sheltered aircraft is very difficult. NATO currently has about 1,200 aircraft shelters in Central Europe, enough to protect about 70 percent of the aircraft it maintains in the area. If we assume that some of those aircraft would be airborne during the Pact's Air Operation, it follows that nearly all of the NATO combat aircraft on the ground are likely to be in shelters.

A typical NATO aircraft shelter (hangarette) consists of a shell in the shape of a half-cylinder about 18 meters wide, 7.5 meters high (at midpoint), and 33 meters long; it is made of steel-reinforced 31,000-kilopascal concrete 45 centimeters thick and has an aluminum blast door 4.4 centimeters thick. The hangarettes usually are grouped in squadron areas. Each NATO main operating base has two or three squadron areas, each with 18 to 24 shelters (figure 4). A squadron area typically contains one shelter for every 9,000 to 11,000 square meters.

Figure 4

Typical NATO Airbase



This is a typical NATO main operating base for three squadrons, with a total of 54 combat aircraft. It has one runway and 54 hangarettes, or shelters.

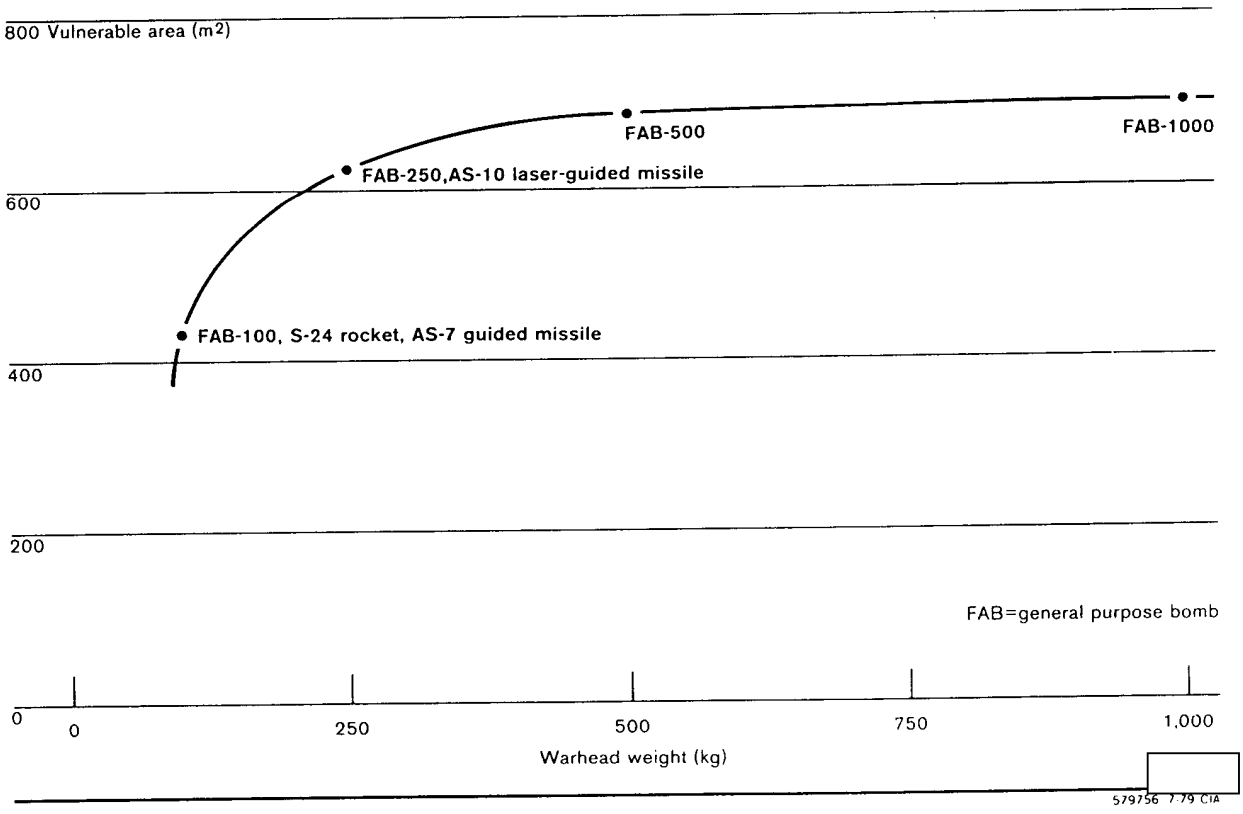
A sheltered aircraft can be destroyed or damaged by blast or by fragments, from weapons that have struck and perhaps penetrated the shelter shell or from weapons that have exploded in front of the shelter door. Theoretically, a bomb as small as 100 kg can damage a sheltered aircraft by striking the shell, but a blast sufficient to shatter a shelter door may require a weapon of 250 kg or more. Although shelters are more vulnerable to larger weapons, their vulnerability increases by only 15 to 20 percent as the bomb weight increases by 100 percent (figure 5). Therefore an attack with many small weapons would probably be more effective than an attack with a few large weapons.

Interdicting Runways

The number of bombs required to interdict the flight surface of a NATO airfield would depend on such factors as the number of runways, their dimensions and construction, the type of aircraft using them, and

Figure 5

Aircraft Shelter Vulnerability



The area within which a Pact air attack would damage a TAB-V hangarette (and an aircraft inside it) is shown to increase slowly, relative to the increasing weight of the Pact warhead. Weapons shown are typical Soviet bombs, rockets, and missiles.

the size of the bombs used. A typical NATO airfield has one reinforced-concrete runway approximately 30 cm thick, 2,500 meters long, and 45 meters wide. It is made up of concrete slabs poured in place and is built on a gravel and sand base 30 to 60 centimeters deep.

Runways are interdicted when their surfaces are so cratered that aircraft cannot land or take off. Craters may be clustered around one or more aiming points or distributed randomly over the entire runway surface. The intent is to ensure that no intact part of the runway is long or wide enough for takeoff or landing. The length and breadth of clear surface required depends on the type of aircraft using the runway. NATO's principal aircraft require a minimum clear width of 15 meters and a minimum clear length of 900 to 1,800 meters.

Appropriate weapons for runway interdiction include general purpose bombs, rockets, and penetration bombs with time-delayed fuses. While larger weapons produce bigger craters, this increase is most rapid up to about 500 kg; weapons heavier than that are not much more efficient in this role. Figure 6 shows that runways, like shelters, are most effectively interdicted by large numbers of small weapons.

Methodology

General

To assess the Pact capability for conventional air attacks on NATO airfields, we calculated the damage an air regiment could inflict on runways and sheltered aircraft. This appendix describes our analysis of the probability that such an attack would close a runway and of the probable number of aircraft shelters—and presumably aircraft—it could destroy. We evaluated the damage level to be expected from 46 variations of a regiment-size attack, to determine the Pact's capability to attack NATO airfields with current equipment and methods and also to reflect the effects of recent and projected improvements. These improvements include the better conventional bombing accuracy of the new generation of Pact fighter-bombers, the widespread availability of precision-guided weapons in the tactical air forces, and the replacement of Badgers by Backfires in LRA.

The size and composition of the Pact force and its weapons payload and accuracy of the delivery were key elements in our calculations. Given the payload capacity of the delivery aircraft, it is easy to estimate the amount of ordnance that could be delivered, but calculating accuracy involves such important variables as the type of ordnance used, the aircraft altitudes and speeds at time of delivery, aircrew proficiency, and the fire-control systems of the aircraft. Table 8 shows the ordnance type, delivery conditions, and delivery errors that we used in our calculations of runway closures and shelter destruction. Delivery errors were based on technical studies of each of the major aircraft considered.

Interdiction of Runways. To determine the probability of runway closure we used "Method 6—Single Weapons and Sticks of Weapons Against Runways,"

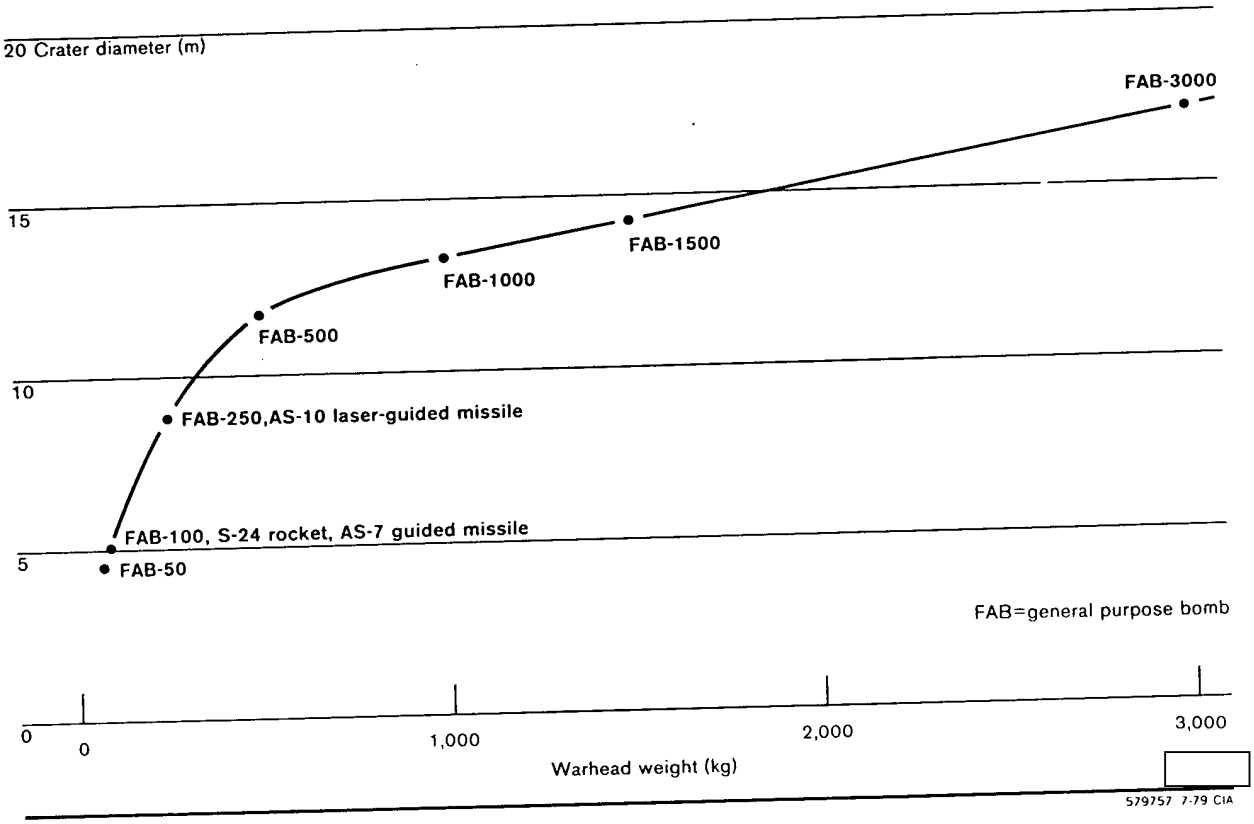
Method 6 is an adaptation of a methodology for assessing Pact air-delivered munitions

Destruction of Aircraft Shelters. In calculating the number of aircraft shelters an air regiment could destroy, we considered attacks aimed against individual shelters and general area attacks.

For an aimed attack we assumed the Pact would use highly accurate weapons such as the AS-10 laser-guided missile. We calculated the number of shelters that such an attack could destroy by determining the

Figure 6

Runway Vulnerability



These data show the ability of typical Soviet bombs and missiles to crater a concrete runway 30 centimeters thick. Their effectiveness increases slowly, relative to the increasing weight of the weapon.

probability of a hit during a delivery pass and multiplying this probability by the number of passes that could be made. Mathematically this is represented as

$S_d = P_{hsw} (N_w/_a) (N_a) (R_w)$,

where:

S_d represents the number of shelters destroyed,

P_{hsw} the probability of a hit with a single weapon,

$N_w/_a$ the number of weapons per aircraft,

N_a the number of aircraft in the attack, and

R_w the reliability of the weapon.

Calculations of P_{hsw} considered the accuracy of the weapon and the vulnerable area of the shelter (this area is a function of the size of the weapon's warhead). We did not consider collateral damage—damage caused to another shelter by a weapon that missed the one at which it was aimed.

Table 8

Air Operation Delivery Conditions and Errors

Aircraft Type	Ordnance Type	Mode of Delivery	Delivery Conditions			Delivery Errors [1] (m)
			Dive (deg)	Speed (m/s)	Altitude (m)	
Fitter A/C	Unguided bombs	Visual	30	230	1,500	220
Fitter D, Flogger D, or Fencer A	Unguided bombs	Visual	30	230	1,500	135
		Nonvisual	0	230	1,500	1,000
		Radar [2]	0	230	1,500	150
Badger or Blinder	Unguided bombs	Visual	0	200	600	150
		Radar	0	200	600	300
Backfire	Unguided bombs	Visual	0	200	600	100
		Radar	0	200	600	150
All fighters	Unguided rockets	Visual	30	230	1,500	80
Fitter C/D, Flogger D, or Fencer A	AS-7 missiles	Visual	30	230	1,500	50
	AS-10 missiles	Visual	30	230	1,500	10

[1] CEP is based on one pass in any flight position (other than lead) in a heavy air defense environment.
[2] Only the Fencer A can use radar for bomb delivery.

For an area attack, on the other hand, we assumed the Pact would use less accurate bombing systems, such as those with which the Badger medium bomber and the older generation fighter-bombers are equipped. An aircraft with one of these systems probably would drop a pattern of bombs throughout the shelter area rather than focusing upon a specific shelter. We calculated the number of shelters destroyed in such an attack by determining the number of bombs which the attacking aircraft—given their accuracy—could deliver in a shelter area and multiplying this bomb number by the ratio of total shelter vulnerable area to the total area occupied by a squadron equipped with shelters. Mathematically, this is represented as

$$S_d = N_w/_a\,(N_a)\,(P_w/_t)\,(A_v/A_t),$$

where:

S_d represents the number of shelters destroyed,

$N_w/_a$ the number of weapons per aircraft,

N_a the number of aircraft in the attack,

$P_w/_t$ the percentage of weapons dropped in the target area,

A_v the sum of the vulnerable areas of all the shelters within the squadron shelter area, and

A_t the total squadron shelter area.

The percentage of weapons landing in the target area is a function of the accuracy of the delivery and the width and length of the squadron shelter area and was calculated using JMEM monograms.

Assumptions

In applying these formulas to our study of expected damage levels, we made three major assumptions: that the strike force would suffer no attrition; that the numerous operational factors, which must be considered in any employment of combat aircraft, would be favorable to the attacker; and that the attack would cause no collateral damage.

In an actual air assault of the scope envisioned, the attacking regiment could lose from 30 percent to as much as 50 percent of its aircraft—and such attrition would reduce significantly the number of bombs it could actually deliver. In omitting such attrition from our calculations, we arrive at a damage level more favorable to the Pact than would actually be the case.

The operational environment is also assumed to favor the attacker. For example, we assume that all Pact aircrews navigate successfully and acquire their targets at the airfield and that they all are sufficiently trained and disciplined to deliver strikes with the best accuracy inherent in their bombing systems.

We ignored the question of the collateral damage any air attack would cause. The methodology was used only to measure damage to runways and shelters, which appear to be the primary focus of a Pact airfield attack. In any actual assault, bombs that missed their intended target could disrupt operations by wounding or killing personnel and damaging supply facilities, fuel distribution systems, or other airfield elements. The methodology also does not consider the psychological impact of such an attack.

Results of the Analysis

We calculated the damage a NATO airfield would suffer from a regimental-size attack by two different Pact forces—fighter-bombers and medium bombers. We assumed the forces to be directed against runways and shelters. Figures 7 through 10 show the level of damage each attacking force could achieve against each type of target, using different modes of weapon delivery.

Fighter-Bomber Effectiveness. On the basis of the damage they could do, the Pact's late-model fighter-bombers are the greatest threat to a NATO airfield, although they would normally carry smaller payloads than the current Soviet bombers. This is because they have better delivery accuracy and precision-guided weapons

The newest fighter-bombers are equipped with an integrated weapon delivery system with significantly greater accuracy than that of the older systems.[17] According to estimates, in a dive-bombing mode it has a system error of s, which could equate to a 20-mil system accuracy with a combat accuracy of mils.[18] A comparison with the 50-mil system accuracy of older Pact fighter-bombers suggests that the newer ones may be able to do the same amount of damage with significantly fewer aircraft. For example, an attack with fully loaded Flogger Ds would do about four times as much damage in a hangarette attack and twice as much damage against a runway as the same attack with fully loaded Fitter As.

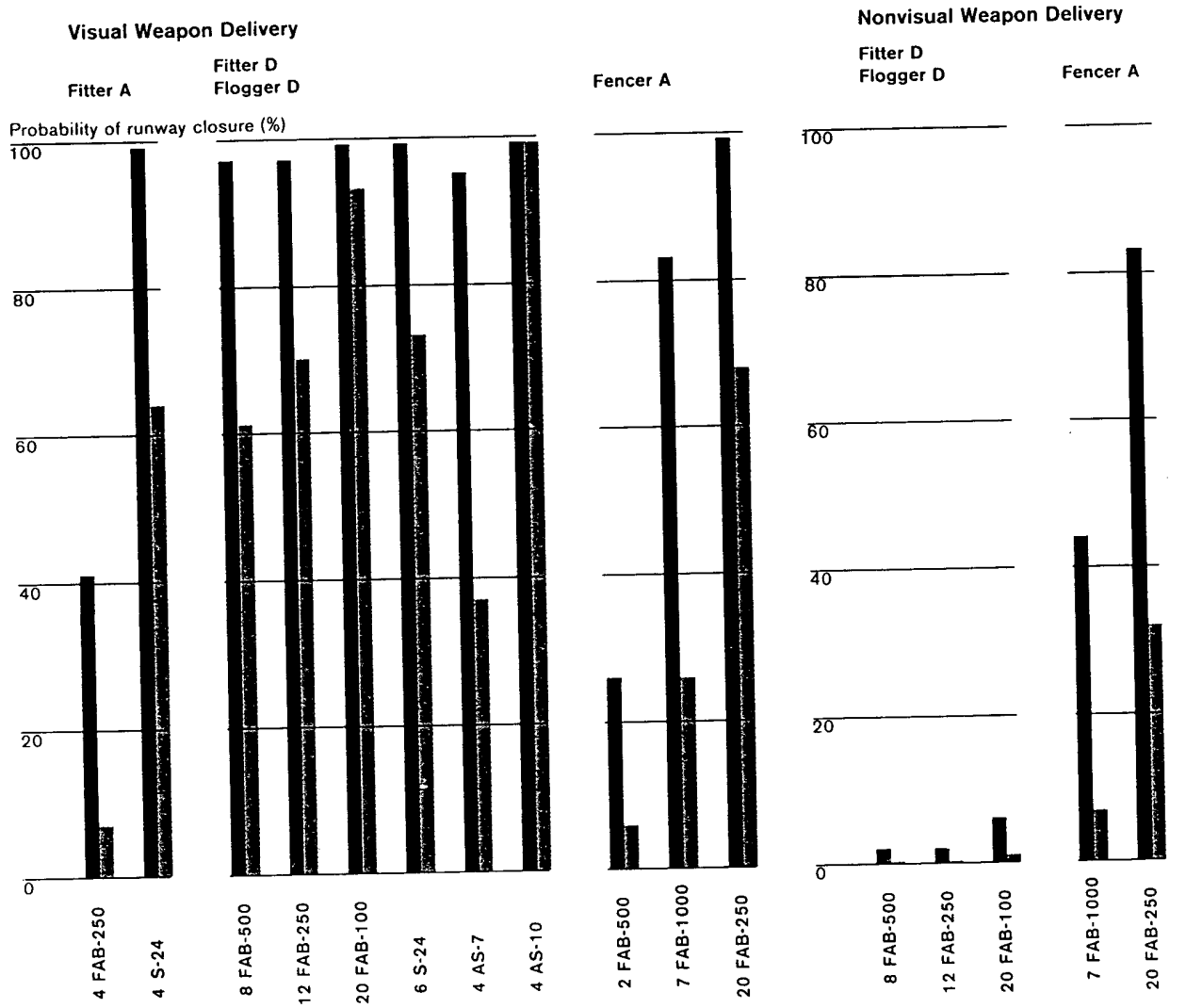
The precision-guided weapons that they have recently received will greatly increase the potential of the Pact's modern fighter-bombers. For example, with the AS-10 laser-guided missile, 20 aircraft could do as much damage as 100 older fighter-bombers. The AS-7, which has been operational since the early 1970s, has done little to improve the Warsaw Pact's capability to attack airfields. This is because its CEP is poor—about as compared to some for the AS-10. In addition, the AS-7 has delivery constraints that would be a handicap in a hostile air defense environment. The delivery aircraft can guide only one AS-7 missile at a time and must remain in the vicinity of the target during the entire period of guidance. To deliver a full load of AS-7s, the aircraft would have to make four separate passes at the target.

[17] This system consists of three major subsystems: a navigation component based on the SVOD short-range navigation system; an automatic control component; and a weapon delivery component which we believe includes a weapon computer, a laser rangefinder, and a heads-up display.

[18] This is roughly equivalent to the accuracy of early variants of the A-7 Corsair II.

Figure 7

Fighter–Bomber Attack on a Runway



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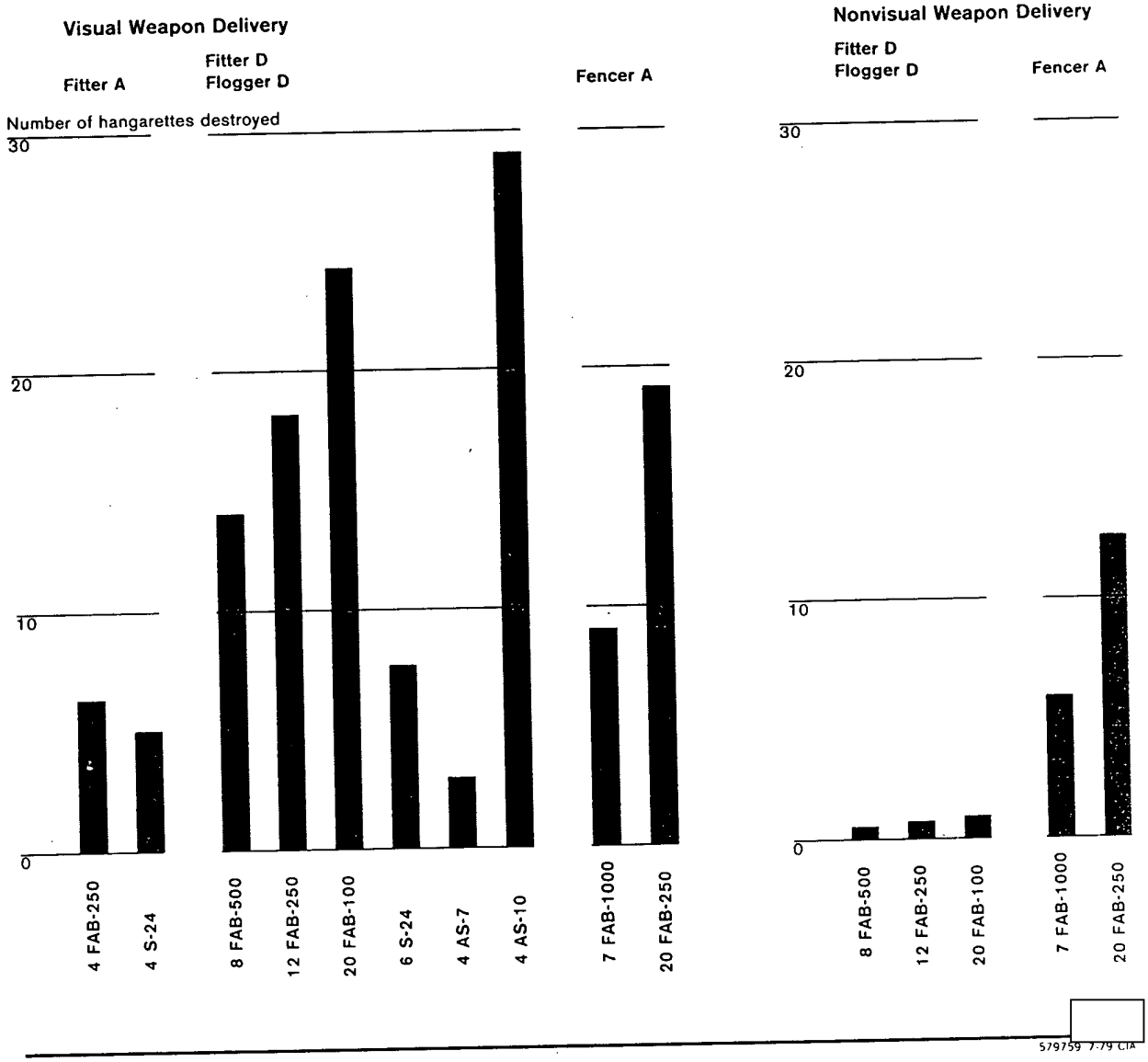
This chart shows the probability that a regiment of Pact fighter-bombers, in full or half strength, could close a NATO runway in one sortie. It shows the effectiveness of different modes of delivery and different weapons. The aircraft and weapons studied are those that we consider would be available and appropriate for the purpose.

Figure 8

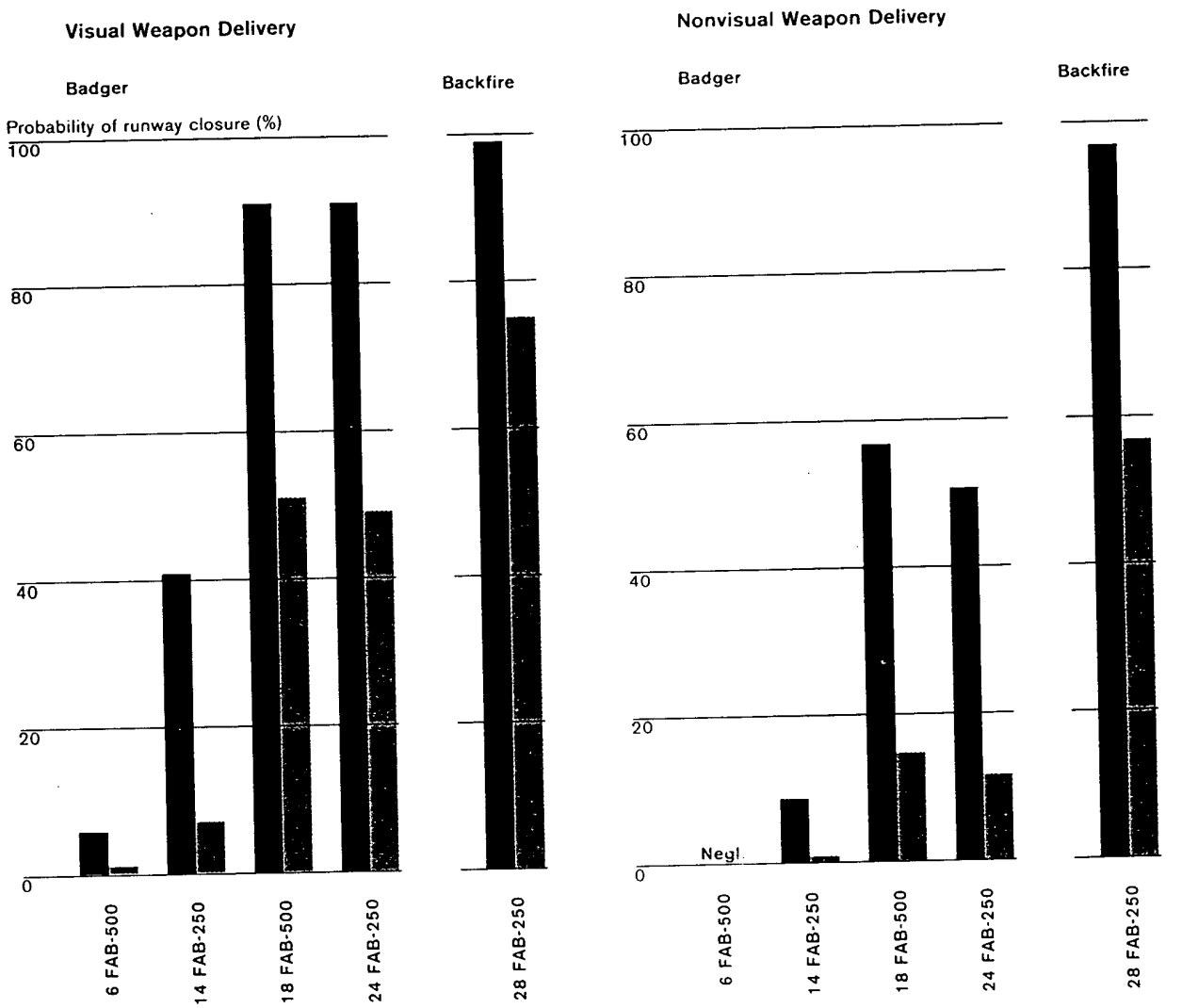
Fighter–Bomber Attack on Shelters



This chart shows the number of NATO aircraft shelters a Pact fighter-bomber regiment could destroy in one sortie. It shows the effectiveness of different modes of delivery and different weapons.

Figure 9

Bomber Attack on a Runway



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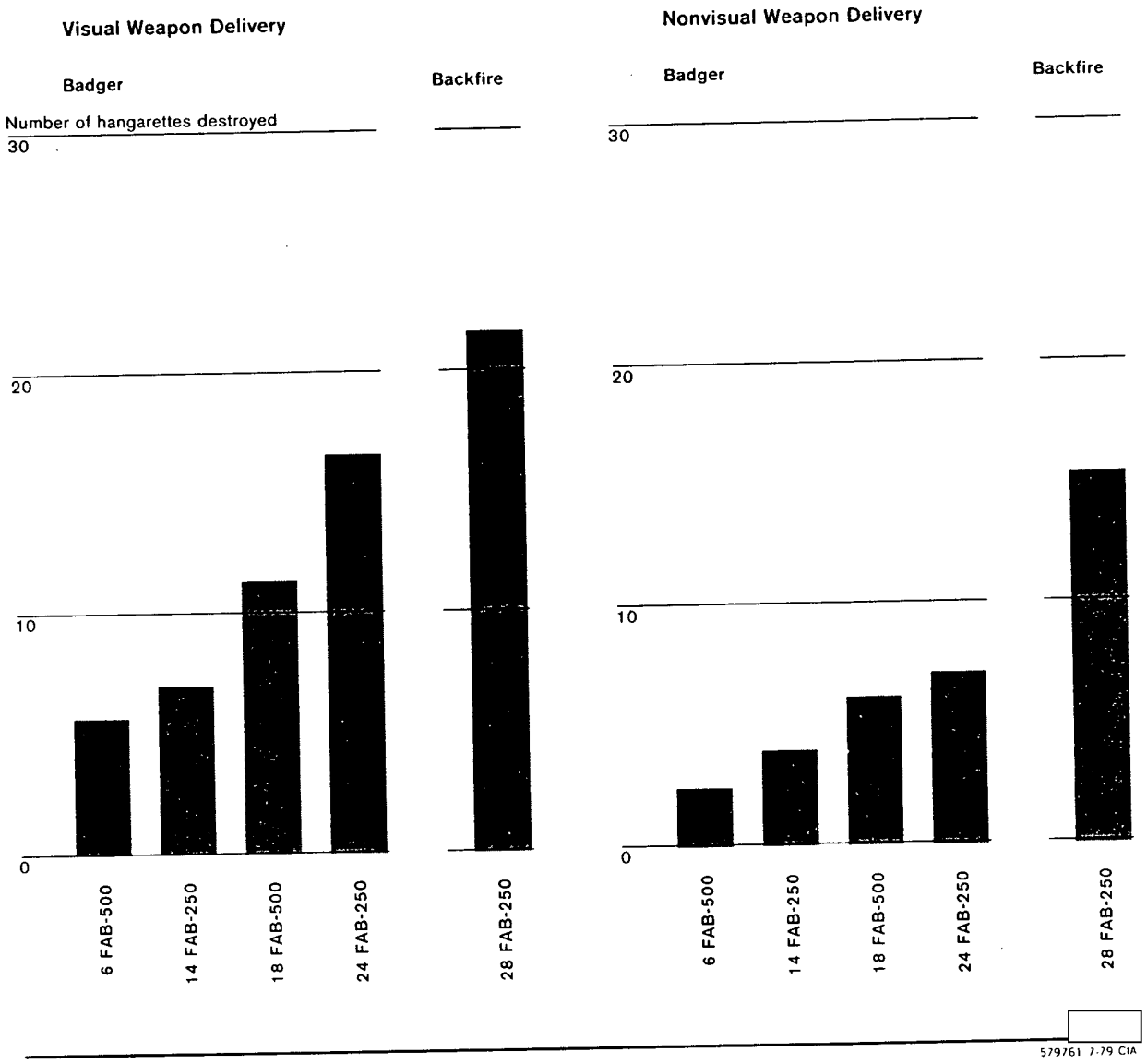
This chart shows the probability that a regiment of Pact medium bombers, in full or half strength, could close a NATO runway in one sortie. It shows the effectiveness of different modes of delivery and different weapons. A runway attack of half a regiment of Badgers, each loaded with six FAB-500 general purpose bombs, was considered to be a typical Badger attack with a standard combat load. The other aircraft and weapons studied are those that we consider would be available and appropriate for the purpose.

Figure 10

Bomber Attack on Shelters



This chart shows the number of NATO aircraft shelters a Pact medium bomber regiment could destroy in one sortie. It shows the effectiveness of different modes of delivery and different weapons.

Table 9

Pact Capability To Attack Runways

Aircraft	Munition Employed	Sorties Needed To Achieve Closure Probability of 0.8			
		Sorties by Individual Aircraft		Regiment-Size Sorties	
		Visual	Nonvisual	Visual	Nonvisual
Flogger D/Fitter D	AS-10	9	NC	0.30	NC
Backfire	Maximum bomb load	9	12	0.45	0.60
Fencer A	Maximum bomb load	12	21	0.60	1.05
Flogger D/ Fitter D	Maximum rocket load	18	NC	0.60	NC
Flogger D/Fitter D	Maximum bomb load	18	210	0.60	7.00
Badger/Blinder	Maximum bomb load	15	30	0.75	1.50
Flogger D/Fitter D	AS-7	27	NC	0.90	NC
Fitter A	Maximum bomb load	33	NC	1.10	NC
Badger/Blinder	Combat bomb load	30	200	1.50	10.0

NC indicates no capability.

This table shows the number of individual aircraft sorties and regiment-strength sorties needed to achieve an 80-percent probability of runway closure, with nine different aircraft/munitions combinations and either visual or nonvisual delivery. The entries are listed in rank order in terms of maximum destruction achievable by a regiment-size attack in visual conditions. A regiment of Fitter As or Ds or Flogger Ds is assumed to number 30 strike aircraft, all other regiments 20.

Medium Bomber Effectiveness. With the Pact's current medium bomber force, the LRA component is limited essentially to interdicting runways. A regiment of Badgers (carrying a maximum bombload optimized for attacking runways) has approximately a 90-percent chance of closing a runway in one attack; with a maximum payload optimized for attacking shelters, it could not destroy more than about 15. This capability will improve appreciably, however, as the Badgers are replaced by Backfires. At the ranges involved in attacks against NATO airfields in Central Europe, the Backfires should be able to deliver about twice the payload.

Number of Sorties Required. Tables 9 and 10 show the number of sorties needed to achieve a specified probability of runway closure and shelter destruction. We assumed that the number of aircraft delivering ordnance per sortie would depend on the type of aircraft in the regiment, as follows:

- 30 in a Fitter A, Fitter D, or Flogger D regiment.
- 20 in a Fencer A regiment.
- 20 in a Backfire, Badger, and Blinder regiment.

Table 10

Pact Capability To Attack Shelters

Aircraft Type	Munition Employed	Sorties Needed To Destroy One Hangarette			
		Sorties by Individual Aircraft		Regiment-Size Sorties	
		Visual	Nonvisual	Visual	Nonvisual
Flogger D/Fitter D	AS-10	1.0	NC	0.033	NC
Flogger D/Fitter D	Maximum bomb load	1.2	3.0	0.040	1.00
Backfire	Maximum bomb load	0.9	1.3	0.045	0.065
Fencer A	Maximum bomb load	1.0	1.6	0.050	0.080
Badger/Blinder	Maximum bomb load	1.2	2.7	0.060	0.140
Flogger D/Fitter D	Maximum rocket load	2.5	NC	0.083	NC
Badger/Blinder	Combat bomb load	2.8	5.0	0.140	0.25
Fitter A	Maximum bomb load	4.7	NC	0.160	NC
Flogger D/Fitter D	AS-7	10.0	NC	0.330	NC

NC indicates no capability.

This table shows the number of individual aircraft sorties and regiment-strength sorties needed to destroy one NATO aircraft shelter, with nine different aircraft/munitions combinations and either visual or nonvisual delivery. The entries are listed in rank order in terms of maximum destruction achievable by a regiment-size attack in visual conditions. A regiment of Fitter As or Ds or Flogger Ds is assumed to number 30 strike aircraft, all other regiments 20.

Estimated Capabilities

Our estimate of the Pact's capabilities for a conventional air attack against NATO airfields is summarized in table 11. It shows the damage we believe the current attack force could inflict, using the current tactics, and our estimate of the damage to be expected should the Pact modify its tactics. The table also shows our estimate of the potential capabilities of the same force using equipment that should be available in 1985 and using both the current and the modified tactics. Our analysis of tactics included three target options and force allocations: strike aircraft evenly divided between the runways and shelters at an airfield; all strike aircraft attacking runways only; and all attacking shelters only.

Current Capability

The Pact's current capability against NATO airfields would be little more than harassment. If the four scenarios described earlier are indicative of Pact planning, a 15-regiment attack in a single sortie would close only three or four runways and destroy about 60 sheltered aircraft. The closed runways could probably be reopened within four hours and fully repaired within 16 hours. This estimate assumes that 15 percent of the bombs dropped would hit the runway and that each of the airfields has a standard NATO rapid runway repair kit (capable of repairing three bomb craters from 250-kg bombs in four hours). Two additional sorties against the same runways would increase the damage but would probably do little to further curtail NATO's ability to use the runways.

Table 11

Capabilities of Pact Air Operation Assault

	Number of NATO Airfields Attacked	Target Option	Runways Closed	Shelters Destroyed
Attack forces of current size and composition				
Current tactics	15	Runways and shelters	4	60
Modified tactics	30	Runways only	12	0
Modified tactics	30	Shelters only	0	120
Estimated 1985 attack force				
Current tactics	15	Runways and shelters	12	165
Modified tactics	30	Runways only	25	0
Modified tactics	30	Shelters only	0	330

This table shows the damage level to be expected from an Air Operation sortie by an attack force of 12 medium bomber and three fighter-bomber regiments. In the "current" cases we assume that the Badger bomber carries a combat bomb load of 3,000 kg.

An attack of three sorties under current conditions would probably destroy no more than about 180 NATO aircraft. We assume an attack force of 1,800 aircraft, with each aircraft making three sorties. If the loss rate of this force were 3.3 percent, its losses would exceed the number of NATO aircraft it could destroy.

Potential Capability of Current Forces

The Pact could significantly improve its capability by concentrating its attacks on either runways or shelters, using optimum munitions, and spreading its 15 regiments over a greater number of NATO airfields.

The most significant increase in damage level would result from concentration on runways. With an appropriate selection of munitions, an initial assault by a force of 15 regiments should be able to close as many as 12 runways, each with some 40 bomb impacts. By repairing selected craters, NATO repair crews could conceivably reopen these runways within 12 to 20 hours. However, the damage from subsequent sorties, when combined with any unrepaired damage from the first, would probably close the repaired runway again, this time for days. (The actual repair time would depend on a number of factors and therefore is extremely difficult to calculate; figure 11 shows estimates of repair times based on three different repair techniques.) The prolonged closure of 12 runways could result in the loss of 25 to 30 percent of NATO's air strength—a significant loss, especially if the runways were those used by NATO's nuclear strike aircraft.

An attack concentrated against shelters only would increase the damage level almost as much. Three sorties could destroy approximately 400 aircraft, or about 20 percent of NATO's strength in Central Europe.

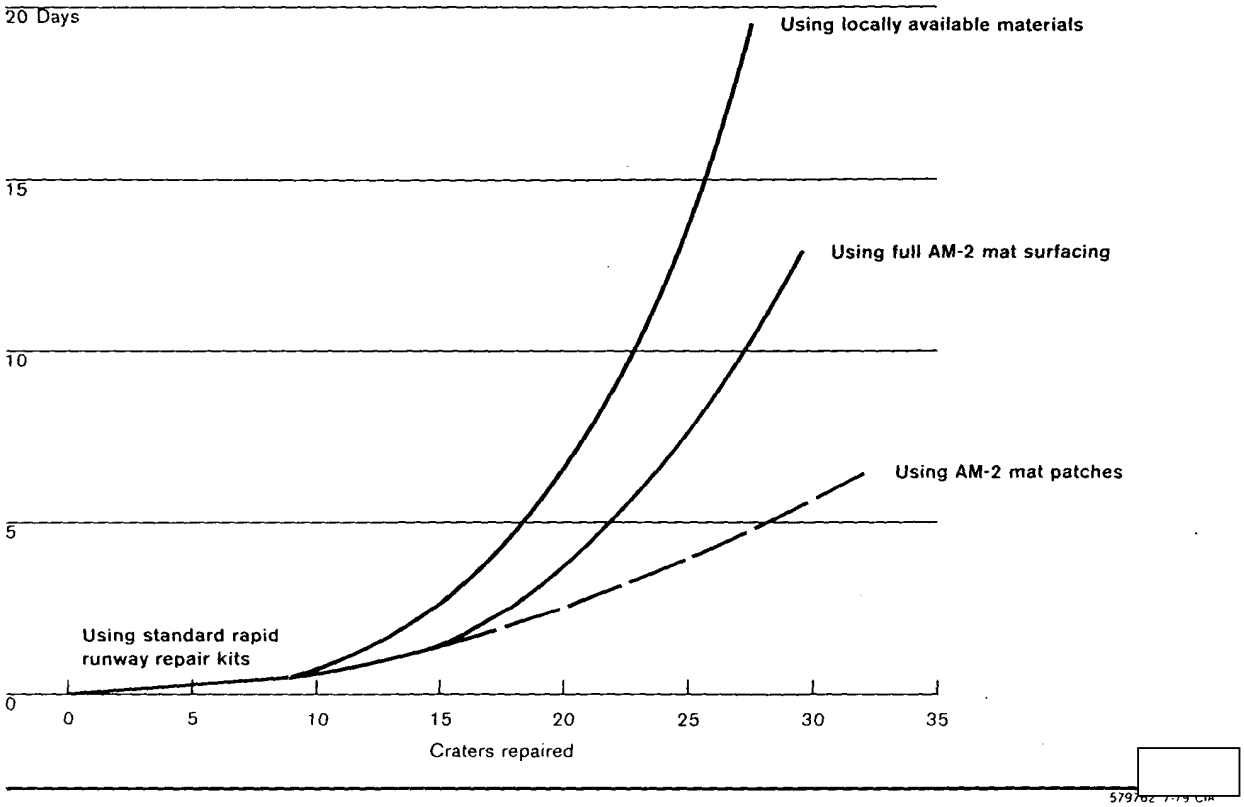
Potential 1985 Capability

The replacement of Badgers by Backfires could substantially increase the Pact capability to destroy NATO aircraft shelters. An attack by 15 regiments—12 of Backfires and three of fighter-bombers—in three sorties could destroy about 1,000 aircraft (or approximately 45 percent of NATO's aircraft in Central Europe). Even with a loss rate of 10 percent, the Pact would still achieve an exchange ratio of 1.8 NATO aircraft for one of its own.

This same 15-regiment attack force also could attack 30 runways and close over 80 percent of them. Three sorties in two days would close the runways for a period of days.

Figure 11

Time Required To Repair Runway Craters



This figure shows the estimated repair time as a function of the number of craters to be repaired for three basic conditions: (1) rebuilding of the runway, (2) using full AM-2 aluminum mat sections, and (3) using AM-2 patches. (It assumes that the first nine craters are repaired with standard rapid runway repair kits at a rate of three craters every four hours.) The curve labeled "AM-2 patches" is broken at the higher damage levels to reflect the uncertainty that the procedure would be feasible on heavily damaged sections. These calculations assume that adequate labor and equipment are available;