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SPECIAL STAFF REPORT
THE SELECTION OF STRATEGIC AIR BASES

March 1, 1953

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(USAF PROJECT RR 1)

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THE SELECTION OF STRATEGIC AIR BASES

THE PROBLEM

The destruction potential, the vulnerability, and the cost of a strategic bombing force depend critically on its base system and how it operates from these bases. A study has been completed[1] which analyzes major factors involved in strategic-base selection and traces the implications of this analysis for the basing of our 1956 bomber force.

METHOD OF THE STUDY

The principal factors considered are the distances from bases to targets, to favorable entry points into enemy defenses, to the source of base supply, and to the points from which the enemy can attack these bases (see Fig. 1). The analysis is concerned with the joint effects of these factors on the costs of

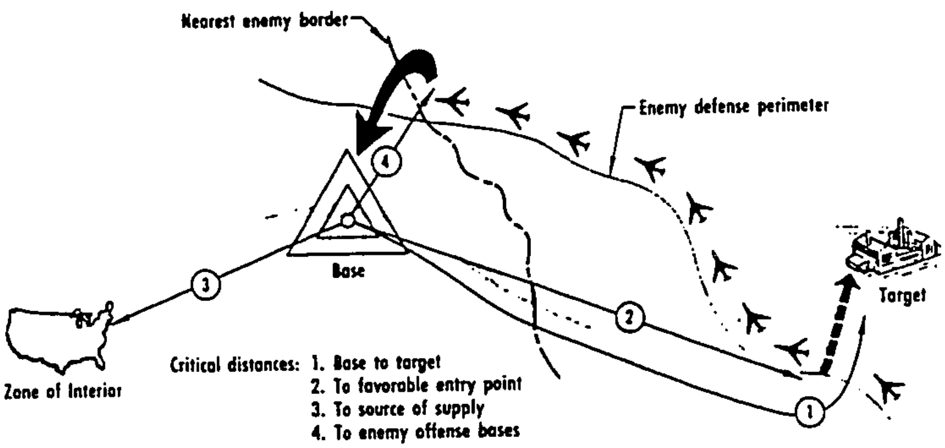

Fig. 1—Critical base relationships

extending bomber radius; on how the enemy may deploy his defenses, and the numbers of our bombers lost to enemy fighters; on logistics costs; and on base vulnerability and our probable loss of bombers on the ground.

[1] A. J. Wohlstetter, H. S. Rowen, and R. J. Lutz, *Selection of Strategic Air Base Systems*, The RAND Corporation, Special Memorandum, March 1, 1953 (Top Secret).

Several different air-base systems for a 1956 strategic force have been compared to find the system of bases likely to give maximum striking power. The programmed 1956 USAF base system was taken as the starting point. The other systems compared fall into three broad groups: (1) bombers based on overseas primary bases, (2) U.S.-based bombers operating intercontinentally with the aid of air-refueling, and (3) U.S.-based bombers operating intercontinentally with the help of ground-refueling at overseas staging areas (see Fig. 2). The programmed USAF system is a "mixed" case involving elements of each of the three types: tankers, staging areas, and primary bases both in the United States and overseas.

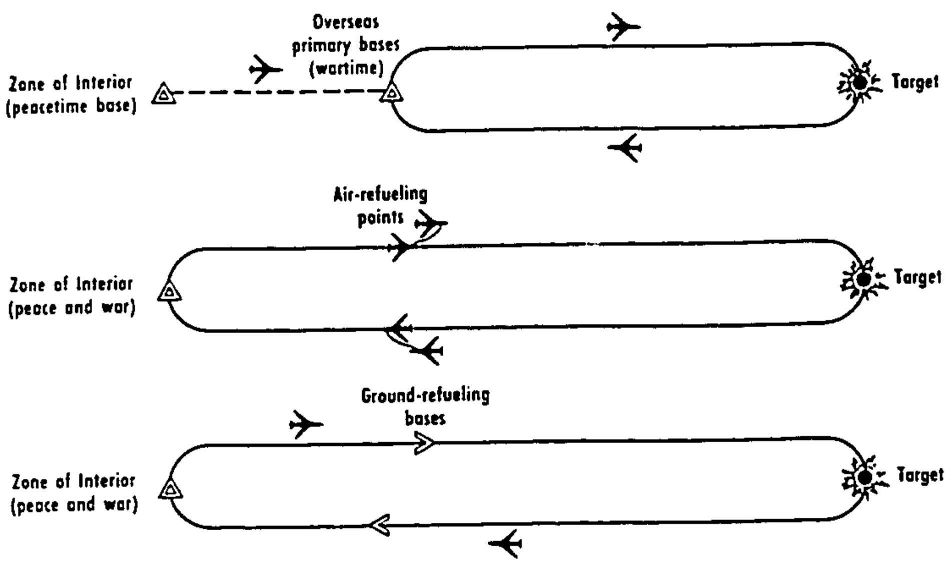

Fig. 2—Three types of base systems

The programmed system resembles most the overseas primary scheme pictured, but it has much less defense and involves elements of all three systems.

THE PREFERRED SYSTEM

Within the framework of this analysis, systems consisting of United States primary bases and overseas refueling bases appear markedly superior.

In brief, overseas primary-based systems are too vulnerable, while a U.S.-based air-refueled system would buy lower base vulnerability at so high a cost that total striking power would be drastically reduced. Ground-refueled systems can be designed so that bombers will be present on refueling bases only a small fraction of the time, and the ground-refueled system will be much less vulnerable to enemy attack than systems which rely on overseas primary bases. Such refueling bases can be provided in adequate numbers with only moderate extension and modification of our presently planned overseas base complex. Our strategic force in the United States can be protected primarily by evacuation of bombers, crews, and other essential mobile elements. The preferred system has the greatest destruction potential of the systems compared. In addition, it is the most flexible as to the size and rate of strike, proportion of targets attacked, and route of approach and flight profile.

In practice, desirable strategic air operations will combine elements of all the systems studied. The multiplicity of strategic objectives and the variety of contingencies in which our bombers may operate require, for flexibility and efficiency, a variety of bases, policies of base employment, and methods of extending radius. Some of the alternative objectives and contingencies are indicated briefly in this summary. However, for the reasons indicated in what follows, future strategic base systems combining United States primary and overseas refueling bases as their principal component will be superior.

This summary of the study will refer principally to the B-47. The analysis also considered heavy bombers, for which results are similar: ground-refueled intercontinental operation is best for them too. But in their case, the findings only confirm and suggest certain refinements in the manner of employment presently intended by the Air Force.

It is important to emphasize that the programmed base system has many elements of the system preferred in this study. For example, the specific overseas locations programmed cover most of the regions desirable for the recommended refueling-base system. (Coverage should be extended in Northeast Africa and in the Arabian and Indian peninsulas.) In the case of heavy bombers, even the method of overseas base employment resembles (with a few important differences) the method of staging recommended. In fact, taking into consideration the Air Force's previous work of negotiation, construction, etc., it appears more feasible to realize the system recommended than to carry through the one programmed.

THE PROGRAMMED 1956 SYSTEM

The presently planned base system will be extremely vulnerable in 1956. A sizeable part of the force based in the Zone of the Interior, before the planned deployment overseas, is susceptible to an air attack which is well within enemy capabilities. The forces based overseas are even more vulnerable: As programmed, the majority of the force can expect to suffer serious damage on the ground. The destruction potential of the programmed system is, as a result, smaller than that of any of the other systems examined.

IMPROVED OVERSEAS PRIMARY-BASED SYSTEMS

The vulnerability of overseas primary-based systems for the bomber force can be reduced by specific defense measures. But even so, such systems are more vulnerable than any United States primary-based system. Moreover, this comparative vulnerability increases sharply as offensive weapons of higher performance and greater numbers are assumed to be committed by the enemy to these targets. Consequently, plans for deployment of bombers to overseas primary bases in general represent a gamble that enemy capabilities, particularly atomic capabilities, will be low and remain so.

UNREFUELED AND AIR-REFUELED SYSTEMS

From the standpoint of cost, it would be exorbitant to abandon overseas bases to solve the overseas-base vulnerability problem. If high-performance unrefueled bombers of the required extreme combat radius are technically possible at all, they will almost certainly be extremely large, expensive, and vulnerable. This is likely to be the case for a long time to come, since, to counter improved enemy defenses, the technical improvements anticipated in aircraft will concentrate on speed and other high-performance characteristics rather than on increased unrefueled radius.

In the study, intercontinental air-refueled systems have been assumed to be feasible, but such systems are shown to be undesirable in situations where overseas ground-refueling is possible. It costs considerably more to refuel in the air than it does to refuel on the ground, even when full account is taken of the costs of defense, of expected enemy damage to refueling bases, and of stockpiling and protecting extra fuel to make the overseas refueling base relatively independent of problems of resupply. The more refueling needed to extend bomber radius, and the larger the proportion of refueling accomplished by tankers, the larger the cost difference. Since the short intercontinental air routes approach Russia from the north, a system employing air-refueling exclusively is ill-suited to take advantage of nighttime penetration routes and to compel dispersion of enemy fighter defenses. The study recognizes, however, the desirability of retaining an air-refueling capability as a supplement to ground-refueling and as an insurance against loss of overseas bases. The findings of this study make it possible to appreciate the costs of such insurance, and therefore to determine just what premiums can be afforded.

Outline of the Analysis

THE PROGRAMMED OVERSEAS STRATEGIC FORCE

The point of departure and frame of reference for the comparison of strategic base systems is the presently programmed strategic force and air-base complex. As projected for 1956, this will be chiefly a 1750-nautical-mile-radius medium-bomber force composed of approximately 1600 B-47B's and RB-47B's. There will be, in addition, some 300 B-36's and RB-36's, and about a wing of B-52's.

Until the outbreak of a war, most of this force will be based in the United States on 30 bases. The farthest forward of these bases are from 3300 to over 6000 nautical miles from targets in the Soviet industrial heartland. A part of the strategic force will be deployed on rotation at overseas primary bases.

After a war begins, substantially all combat-ready medium-bomber wings will move overseas to operate from a base system consisting of about 70 bases. Roughly half of these will be primary bases and half will be staging bases. The program calls for defense of this base system by approximately 30 squadrons of USAF all-weather interceptors, perhaps 40 antiaircraft battalions, and, in some theaters, by Royal Air Force and other NATO interceptors. In addition, about 10 wings of USAF escort fighters will be available for base defense. Relatively little emphasis is given to the passive defense of this system.

The medium-bomber force will be supplemented by approximately 720 KC-97 tankers. Medium-bomber attacks will be launched from overseas primary bases with the aid of air-refueling and some prestrike forward-base refueling and by the use of poststrike staging bases. Heavy bombers will, in general, start from home bases, use overseas bases for staging, and return to home bases.

THE INTERCONTINENTAL MISSION

An intercontinental mission is only one of several means of accomplishing strategic objectives, and whether or not it is preferred must depend on its relative cost and effectiveness rather than merely on its feasibility. In assessing an "intercontinental" operation some care must be taken in defining the base geography assumed. Some "continental" bases (such as those in Alaska and Greenland) are more vulnerable to enemy attack and more difficult to support than some non-"continental" bases (such as might be located in the Azores or

Iceland). Intercontinental bases considered in this study are well within the early-warning perimeter of the United States and have the attendant advantages of logistics economy and reduced vulnerability.

Estimates of cost in this study include sizeable overseas expenses in addition to the direct costs of the strategic force (for example, the costs of ground forces needed directly for the local defense of some overseas bases). However, many of the extra costs sometimes considered (such as the costs of economic and military aid to our allies, of the Army, the Navy, and of the tactical air units) cannot properly be regarded as chargeable to an overseas strategic air-base system.

POLITICAL CONDITIONS AFFECTING OVERSEAS-BASE CHOICE

Political factors in overseas areas restrict the availability of air bases and the conditions of their use. But the choice of location is wide enough to offer considerable insurance against political mishaps. Choice between overseas and domestic systems can be made on the basis of comparative cost and effectiveness.

Political considerations reinforce certain technical and economic factors. Uncertainties of political alignment may make it necessary to distribute the bases among many distinct political entities. This dispersal, however, may have the advantage of reducing vulnerability to enemy attack. Limitations on the use of certain bases to air defense and tactical missions may be relaxed in wartime, suggesting that such base facilities might well be designed for conversion to strategic uses. Finally, the existence of limits on the manning of bases favors the strategy of considering such bases for advanced ground-refueling of intercontinental systems.

BASE CHOICE AND SYSTEMS ANALYSES

Because choice of weapons and their employment and base selection are interdependent, an exploration of the base problem may be expected to increase the dependability of weapons systems analyses undertaken to assist the Air Staff in its development program. For example, the radius from base to target may be the dominant factor affecting the choice of bomber design, including type of powerplant, etc. Radius-extension costs and overseas operating costs, varying with the base system chosen, are incurred for the sortied force and not for a force held in reserve to replace bomber losses. For some base-aircraft combinations these costs are so high, by comparison with the costs of a bomber inventory held in reserve to replace combat losses, that a policy of restricting the size of the sortied force and maintaining a large reserve appears best. For a differently based system, it may be most efficient to sortie all bombers available. Therefore, base choice affects the strategy of employing bombers.

For similar reasons, the choice of a preferred base system depends importantly on earlier estimates of the capabilities of aircraft and other system components.

LOCALITY AND LOCATION COSTS AND EFFECTS

The bombing-system costs traceable to base decisions are of two kinds. Those influenced by such particular site characteristics as weather, terrain, availability of construction industry, existing defense, etc., may be called *locality* costs. Those which pertain to such critical general base relationships as the routes from the United States to base and from base to target (including the path through enemy defenses) and to risks of enemy attack may be termed *location* costs.

The consequence of basing aircraft in the Arctic illustrates the importance of *locality* cost differences. For example, construction costs may exceed by five times or more the costs for a similar base in a different area. An Arctic operation involves *extra* costs not only in construction but also in supply, equipment, clothing, number and training of personnel, and maintenance, lower rates of aircraft utilization, greater base vulnerability, and decreased recuperability after damage. Although such a base offers certain advantages for penetrating to North Russian targets, it appears that these advantages are not enough to offset the extra costs of operating in the Arctic. If, as the study indicates, operating bases overseas are in general inferior to "refueling" bases, this conclusion is particularly true of Arctic operating bases. Although existing bases *can* play a useful role in refueling systems, other regions are better than the Arctic for future *expansion* of such a base system.

While many locality effects were taken into account by the study, attention was mainly focused on the variations in system costs occasioned by base *location*.

LOCATION COSTS AND EFFECTS

Since base location must compromise some or all of the advantages of (1) proximity to targets, (2) favorable angle of approach to targets, (3) logistics economy, and (4) remoteness and comparative invulnerability to enemy attack, the effects of system cost and effectiveness of each of these factors have been examined.

Effects of Increased Radius to Target

Distances from farthest forward overseas bases to Russian targets range from 300 to 1500 nautical miles. From the major overseas bases programmed, the targets are anywhere from 800 to 2600 miles away. From the Zone of the Interior, if we follow routes calculated to reduce losses to enemy defenses, distances to targets are from 3300 to well over 6000 miles.

- As our radius of operation increases, the cost to buy and operate our bombing force rises, and its effectiveness declines. The extent and rate of this variation depends on the bomb carrier and on the method of radius extension chosen.
- The cost to operate bombers big enough to reach targets *without refueling* increases at an accelerating rate with distances from base to target. Moreover, the cost increments due directly to growth in aircraft weight with increase in system radius are compounded by the increasing vulnerability of the larger and heavier airplanes. The exact rate of increase, in any given state of the art of aircraft design, depends on such factors as powerplant type, payload, cruise and over-target speed, altitude, etc. It is greater for turbojets than for turboprops; and greater at higher speeds and extreme (low or high) altitudes. To have built an intercontinental radius capability into a bomber of the B-47 type would have made it enormous in size, costly, and vulnerable. In fact, the heavy bombers roughly contemporary with the B-47C, for example, display larger differences in cost than they do in radius capability. None will be able to reach the whole of a Russian target system at intercontinental radius. In Fig. 3, which illustrates this point, the system cost and radius of bomber types of approximately similar performance and design date as the B-47C are represented by points in the blue region.
- An examination of the next generation of bombing systems shows that the strong influence of combat radius on system cost is not merely temporary. Supersonic and low-altitude capabilities may be sought to meet expected improvements in enemy defense. The normal advances in the state of the art will permit improvement in performance characteristics for any given weight and cost, but these, in turn, will be outstripped by the performance demands imposed by improved enemy-defense capabilities. The resulting cost-versus-radius curves will therefore show no substantial improvement. (The curve for supersonic bombers in Fig. 3 illustrates this point.) If anything, the situation appears to be getting worse: combat radius will be *more* rather than *less* critical for some time to come.

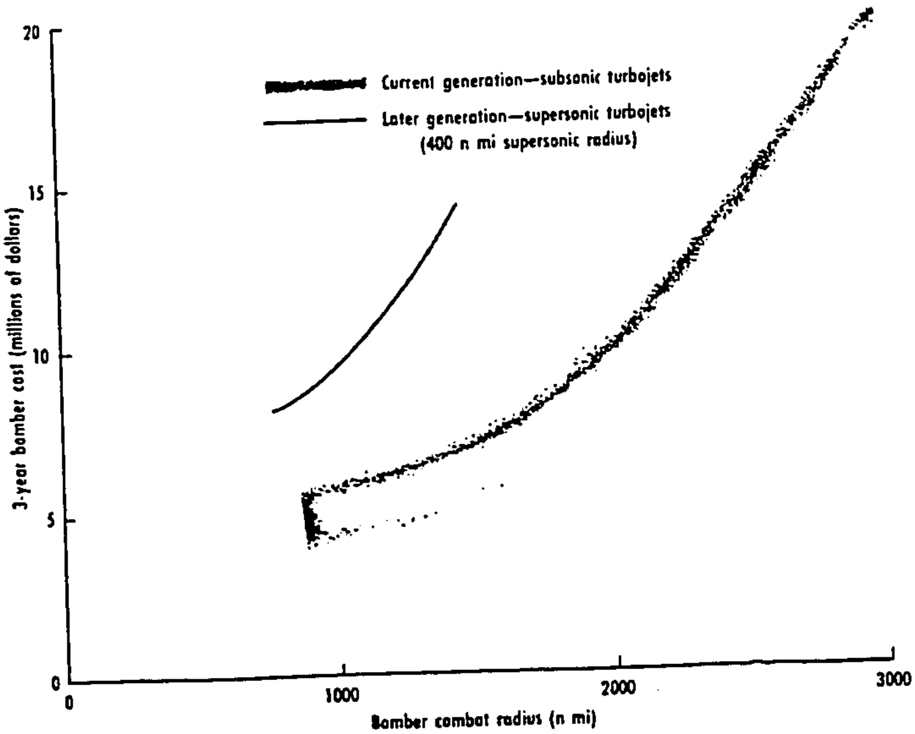

Fig. 3—Single-stage bombing system vs combat radius

Examination of nuclear-powered bombers and surface-to-surface missiles indicated that expected developments in these fields will not alter this conclusion for the next decade.

In air-refueled multistage bombing systems, a bomber of fixed unrefueled radius is assisted to the target by tankers. This avoids the need for bigger, more vulnerable, and more costly bombers. But the effects of radius on *system* weight or cost (including the weight or cost of the tanker as well as that of the bomber) are nonetheless very marked. Costs increase in steps (see Fig. 4), corresponding to points at which additional tankers are required. As combat radius is extended, the increments obtained by the use of additional tankers become smaller and, allowing for insurance against the uncertainties of multiple refueling, the increases in cost for a given increment of radius become steeper. For a tanker-refueled B-47B system, at 3600, 4200, and 5200 nautical miles, costs are respectively three, five, and ten times the cost at an unrefueled radius of 1750 miles. (These specific figures neglect the *extra* costs of bomber attrition and

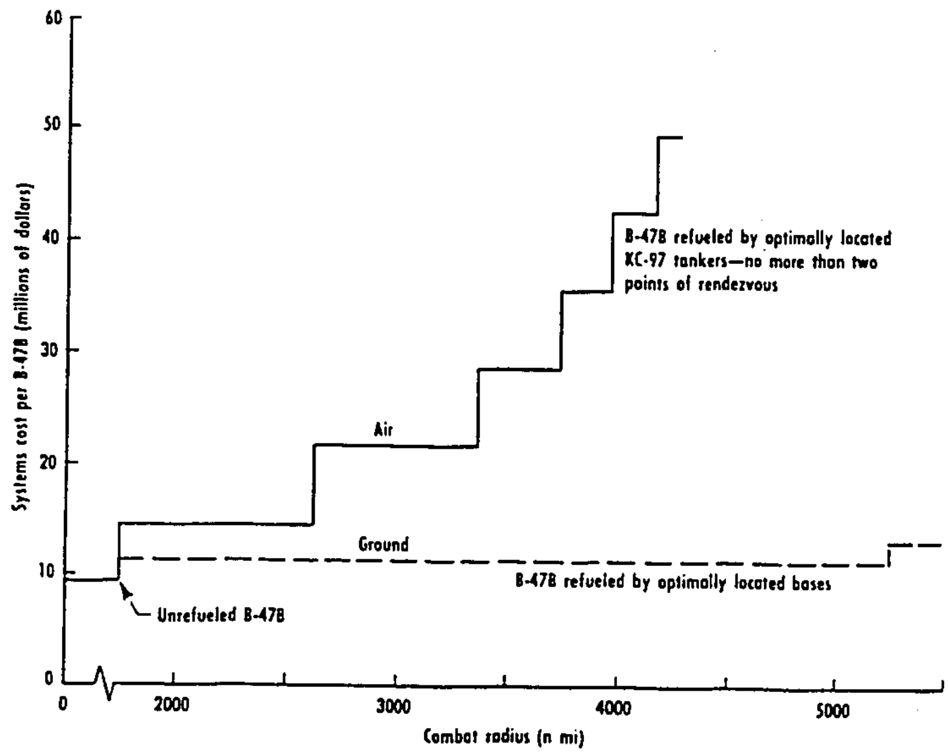

Fig. 4—Multistage B-47B systems vs combat radius

bomber aborts likely to be associated with the rendezvous problems in multiple refuelings. Such costs may very well be so high as to make multirefueled systems unfeasible.)

- One way to keep primary bases (and, so, parked bombers—the most vulnerable and valuable system element) away from enemy striking power is to extend bomber radius by a system of refueling bases. The radius extension such a system provides is very moderate in cost in comparison with the costs of a tanker system. Aside from the costs of defense and expected damage, buying, equipping, and supporting a refueling base with modern landing, take-off, and high-speed-fueling facilities adds something less than 10 per cent to the 3-year cost of buying and operating a wing of B-47 aircraft in the United States.
- Figure 4, which shows the increase in bomber costs with extension of radius, includes support costs incurred for the peak force sortied. When the costs of radius extension are very high (for example, in the air-refueled U.S.-based B-47B system), the portion of the total system cost devoted to tanker procure-

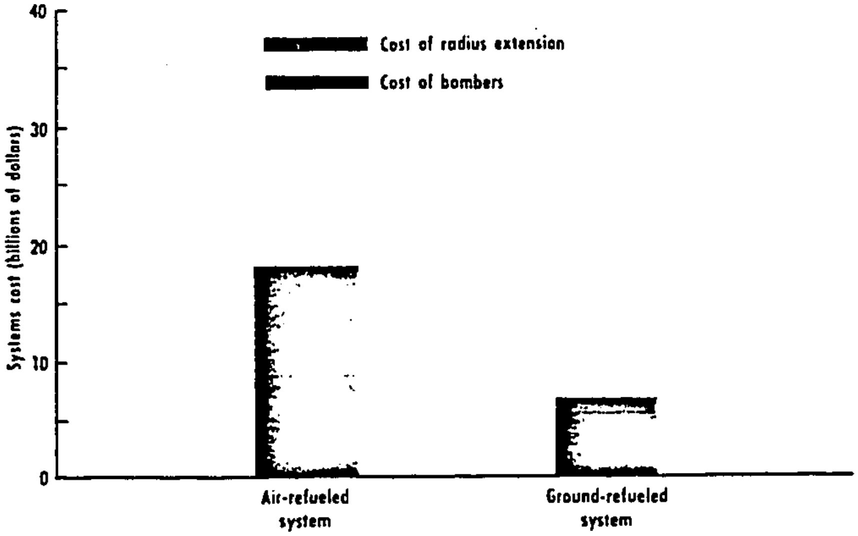

Fig. 5—Costs of intercontinental air- and ground-refueled B-47B campaigns

ment and operation can be reduced by the strategy of sending fewer than the maximum number of available bombers on each strike. The smaller sortied force means a slower initial rate of destruction of enemy targets. It also means more aircraft losses per target destroyed, but the smaller operating force will, if we consider cost alone, save more than this amount in tankers.

Figure 5 presents the comparative costs of a summer campaign to destroy 80 per cent of a Russian industrial-target complex using air- and ground-refueled systems. Unlike the costs shown in Fig. 4, which assume "optimal" location of targets and refueling points, these costs take into account the detailed geography of bases, identifiable air-refueling points, specific staging areas, points of entry into enemy defense, and paths to targets. Russian area defenses are assumed to be distributed evenly over the area of their GCI network coverage, and strike paths are relatively direct to minimize the number of tankers per bomber in the striking force. (As will be shown, both their defense and our offense tactics can be improved decidedly by adaptions to match our base system.) The bombing systems compared use identical airplanes and primary bases in the United States, but aircraft radius is extended in one case by air-refueling and in the other case by ground-refueling. The ground-refueled system uses all available bombers on each strike. The air-refueled system follows the plan of withholding bombers, which, for it, is less expensive (though this plan also imposes some inflexibility as to rate and size of strike and proportion of the target system attacked). No allowance is made for bomber attrition connected with multiple refuelings. The calculations show that

1. The radius-extension costs for the air-refueled system are about ten times those of the ground-refueled system.
2. To limit radius-extension costs even to this high level, the air-refueled system involves a considerable sacrifice in extra bombers lost (about 40 per cent of the value of bombers in the ground-refueled force).
3. Even with so much of the bombing system fixed in the comparison (the bomber type and the United States primary bases), the total base-aircraft systems costs show a very sizeable difference in magnitude.

The total cost of the system using air-refueling exclusively is two and one-half times that of systems using ground-refueling with air-refueling as a supplement.

Ten wings of penetration fighters are programmed for 1956. These may be used as escorts, as decoys, or possibly as bombers. The smaller weight, lower vulnerability, and lower cost of aircraft designed for short unrefueled radii suggest the importance of considering a mixed force of strategic bombers which would include short-range airplanes for use against the nearest targets. Sixty-five per cent of the industrial targets in the typical system studied are less than 1200 miles from the most advanced staging and forward operating bases scheduled for use in 1956. Although the short-range airplanes will be confronted with target-location (navigational) problems, and difficulties in bombing associated with weather over the target, which must be evaluated in connection with their bombing use, they can bomb visually with much greater accuracy than high-altitude medium and heavy bombers and so may accomplish greater damage with a given quantity of fissile material, particularly in a summer campaign. Aside from their smaller weight, lower probability of being intercepted, and lower procurement cost, such airplanes as the F-101 can be easily dispersed and evacuated from their primary bases, are equipped as all-weather interceptors, and can defend their own bases. Whether the escorts programmed for 1956 are used as bombers, as escort fighters, or as decoys, their strategic use appears practicable only from an advanced primary-based system or from a more distant primary-based system with overseas ground-refueling facilities. The preference for ground-refueling over air-refueling would be greatly increased by taking these components of the programmed force into account.

The Effect of Penetration Paths

The study has investigated the effect of base location on the angle of approach to targets, the distance of penetration through enemy defenses, and the hours of daylight and darkness over these penetration paths. Base-location considerations affect our choice of the route to the target and the enemy's choice of defense deployment.

- The distance traveled over enemy defenses, and so the number of bombers lost to enemy fighters, can be reduced by doglegging, but this increases combat radius (see Fig. 6). A tanker-refueled system using United States primary bases begins far out on the cost-radius curve, and additional radius is very expensive.

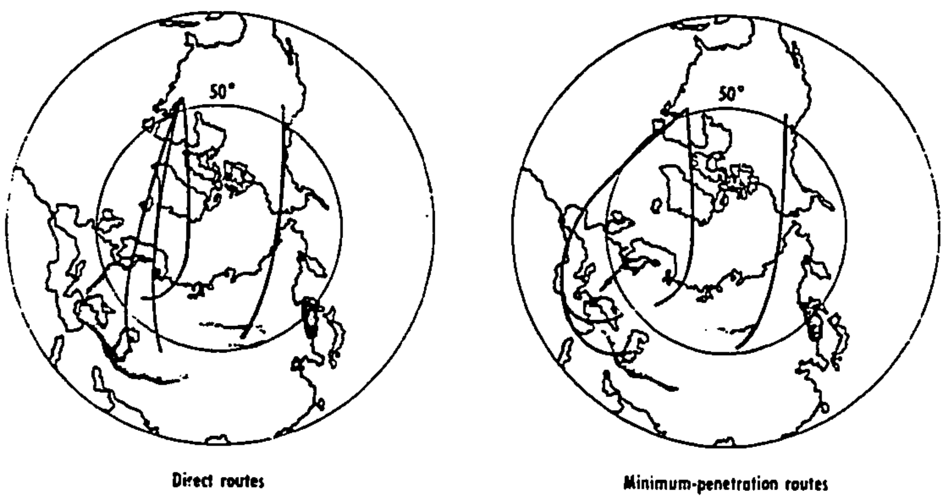

Fig. 6—Routes for intercontinental air-refueled strikes

We may distinguish three kinds of penetration routes. First, relatively direct routes, at some extra cost in attrition, minimize the number of tankers necessary for each bomber in a strike. Second, there are routes which minimize penetration distances and so reduce attrition inflicted by area defense (fighters). A third set may be chosen in summer to take greatest advantage of darkness to reduce losses to fighters. Darkness has a decided effect, since (1) the USSR is expected to have a larger number of day than night fighters in 1956; (2) few day fighters will be usable at night—for example, employing the buddy system: day fighters led by night fighters; and (3) the individual effectiveness of Russian night interceptors is expected to be much less than that of their interceptors in daylight.

Figure 7 compares a system using routes minimizing distance flown through enemy defenses with a system using direct paths which minimize tankers per bomber sortied. This comparison is shown for air-refueled U.S.-based B-47B's in a multistrike summer campaign to kill 80 per cent of the Russian industrial-target system selected. The system flying minimum-penetration paths loses fewer bombers to enemy fighter defenses, and so reduces the size of the force needed to insure an acceptable crew-survival probability. Finally, although the system has more tankers per bomber, it has fewer tankers in total, reducing even the radius-extension costs for the campaign.

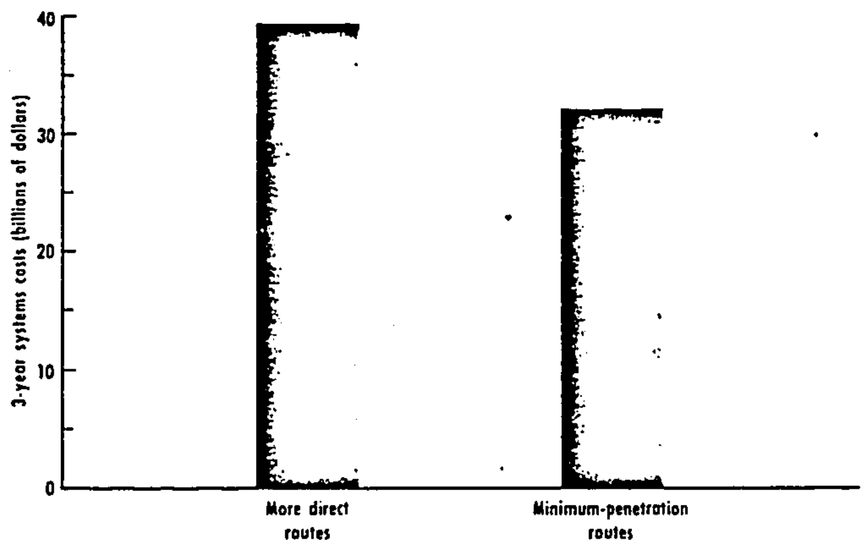

Fig. 7—Costs of intercontinental air-refueled B-47B campaigns

Base systems which permit entry from the south can take advantage of the cover of darkness with little or no extra-extension of radius. Since the ground-refueled U.S.-based system has many staging areas to the south, its short-route system is largely protected by darkness and is one that nearly minimizes attrition. Bombers flying direct routes in summer suffer no more attrition than bombers flying minimum-penetration doglegs without the advantage of darkness.

- The enemy, in turn, may improve his defense by matching our offense capability. Against systems flying the shortest routes from the United States primary bases, he might concentrate fighter defenses as shown in Fig. 8. Systems using peripheral primary or ground-refueling bases would compel dispersal of enemy defenses as shown in Fig. 9.

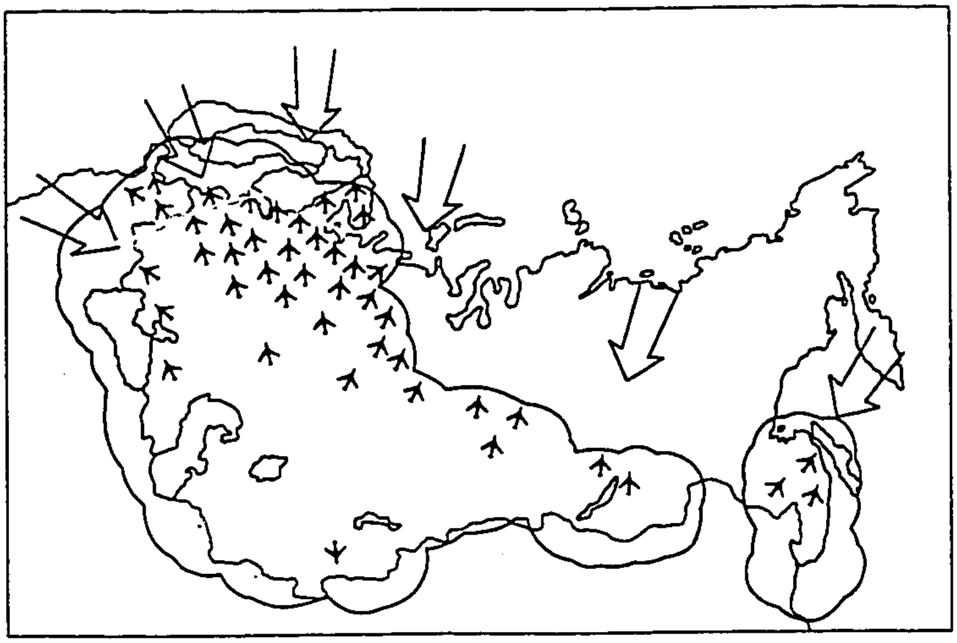

Fig. 8—Russian fighter deployment against direct intercontinental air strikes

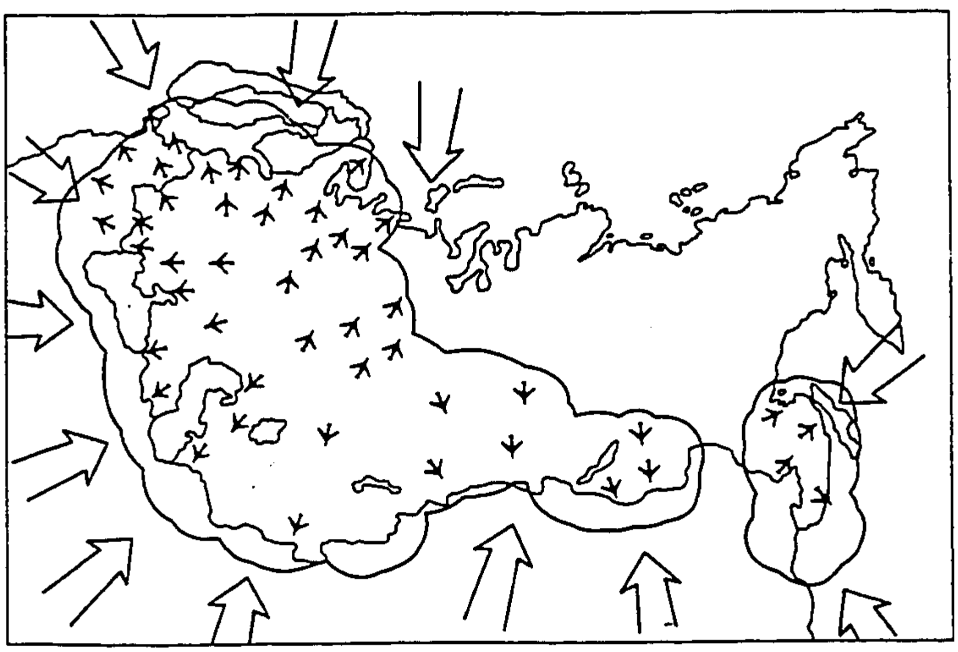

Fig. 9—Russian fighter deployment against strikes from overseas bases

The campaign results presented in Fig. 10 indicate that if the enemy concentrates day fighters in the north and takes account of the greater density of targets in the west, he can do better than when he distributes fighter defenses uniformly. Such a redeployment is also assumed in Fig. 7.

The Russian area defenses so reoriented will exact a higher attrition against all bombing systems but in particular against the exclusively air-refueled intercontinental systems. Russian defenses further improved by specific tailoring to meet each of our base systems could do still better, especially against an intercontinental system with relatively concentrated avenues of approach to the targets. Limitation in the number of night fighters available makes it difficult for the Russians to improve their fighter deployment very much against attack from peripheral overseas bases (primary or refueling).

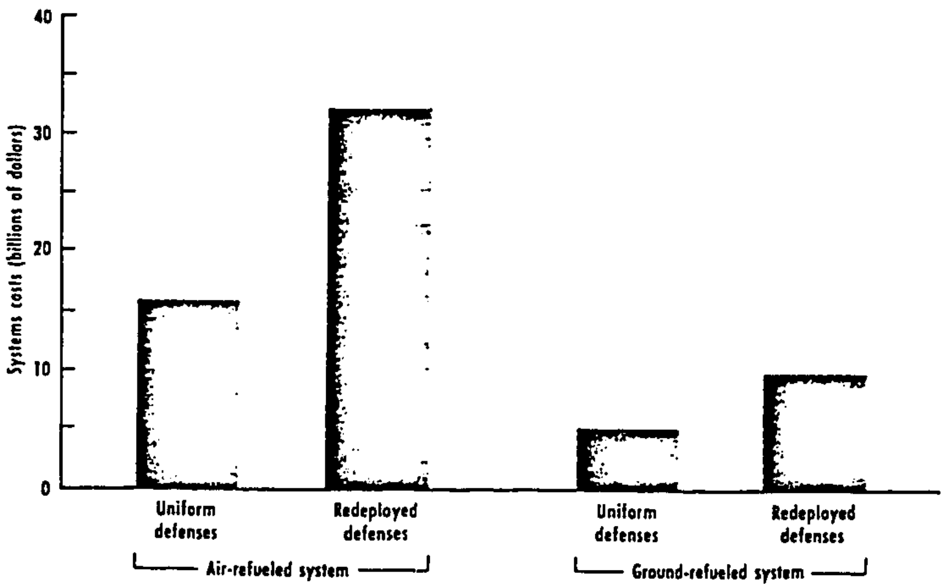

Fig. 10—Costs of B-47B campaigns against uniform and redeployed area defenses

The Effects of Supply Distance

The peacetime cost of buying and maintaining a wing of bombers in the United States must be increased by about 50 per cent to cover the additional cost of operation from primary bases overseas. This extra cost is incurred for additional bases, theater support, and airlift. However, the differences among overseas base systems do not increase substantially with supply distances in peacetime. Transportation, travel, and stock-level costs are only moderately affected by increasing distance, even when these distances vary up to 10,000 surface miles. (*Locality* considerations, on the other hand, as distinct from *location* considerations, do entail substantial extra costs for peacetime resupply in the Arctic.) Except for the case of a system using refueling bases, the extra costs involved in wartime resupply and pipeline attrition have not been investigated in detail. For a refueling base, the prestocking of fuel at moderate cost frees the base from the problem of losses in surface transport during the early months of a war.

The Effect of Proximity to Enemy Striking Power

Consideration of the first two critical factors (target radius and penetration routes) stressed the advantages of being close to the target and close to favorable points to enter enemy defenses. Unfortunately, when we are close, not only is our power to attack the enemy very great, but so also is his power to attack us. (The rings in Fig. 11 indicate the steps in which the enemy's striking power diminishes with distance from his border.) The most obvious disadvantage of an overseas base system is its increased vulnerability (see Fig. 11).

The analysis of base vulnerability covers (1) the size and the type of air attack that the enemy can launch against various base systems; (2) the likelihood that attackers will penetrate our base defense to bomb, and their capacity to reattack; (3) the elements at risk on the base at the time of bombing; (4) the physical vulnerability of these elements and the damage resulting from bombing; (5) the consequences of damage in terms of base operations. These factors correspond to the successive phases of attack.

- ***United States Primary Bases***

The most vital and easily damaged elements of a strategic force based in the U.S. Zone of the Interior will not be very vulnerable *if* the aircraft, personnel, and essential matériel evacuation plan of the Strategic Air Command is carried out. *However, a large number of United States bases are too close to the perimeter of our projected 1956 radar net to have even marginally adequate warning against air attack.* Moreover, since the Russians may complement the threat of air attack with a short-range submarine-launched A-bomb carrier, no future extension of the radar network is likely to provide adequate warning for coastal bases. Figure 12 shows the effects of a single high-altitude mass Russian strike against United States targets, including strategic bases. It takes account of their estimated stockpile of bombers, expected operational aborts, attrition

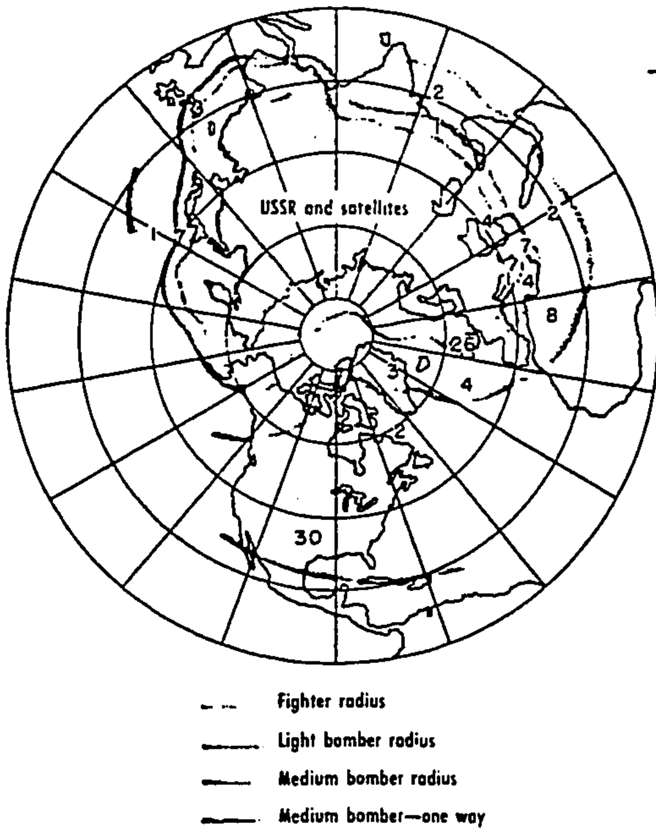

Fig. 11—Base locations relative to USSR striking power

exacted by our programmed 1956 defenses, etc. It illustrates expected ground attrition of strategic aircraft on United States bases in 1956 for a range of A-bombs allocated by the Soviets to the task of neutralizing this force, and for a range of probabilities of their delivering the bombs allocated. The delivery probability depends on the number of bombers assigned to the task and the effectiveness of our fighters—which, in turn, depends on the likelihood of Russian countermeasures, etc. The lower limit of the shaded areas in Fig. 12 (and also in Fig. 13) represents probable values of enemy bomber assignment and effectiveness of our fighters. The upper limit indicates the result of assuming a higher enemy offense capability and lower effectiveness of our own defenses.

The decidedly lower percentage of aircraft lost on the ground shows the benefits of evacuation. In addition, fly-away kits and operating personnel

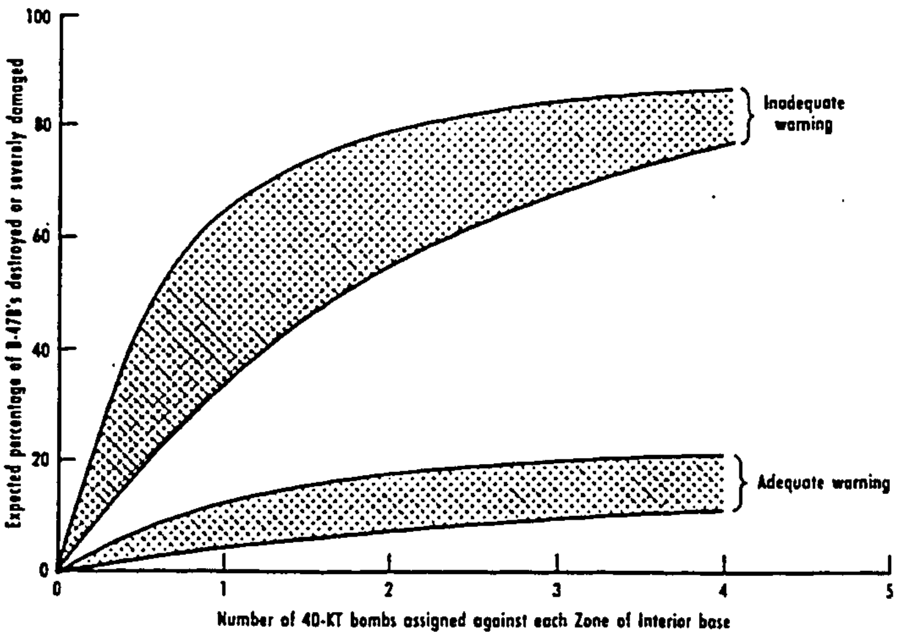

Fig. 12—Attrition on programmed Zone of the Interior strategic bases vs enemy bomb allocation (one high-altitude strike)

would be protected by the execution of the SAC evacuation plan. Figure 14 (page 22) illustrates the net disadvantages of dispersed operation in the United States, where a large proportion of the bombers are evacuated. Wherever possible, measures (for example, addition of radar, reduction of time required for evacuation, and transfer of wings from the periphery to the interior) to provide adequate warning and to facilitate evacuation of critical elements of the striking force appear to be more effective and less costly than initially dispersed operation as a means of defending primary bases.

In particular, it appears important to modify the SAC evacuation plan by (1) separating the plan for evacuation from the plan for deploying bombers for attack, and giving higher priority to the essential job of saving the striking force; (2) for at least the interim, keeping minimum evacuation crews on base at all times; (3) providing egress taxiways, wherever possible, to permit the taxiing or towing of nonflyable aircraft off base. Other critical defense measures, besides evacuation, are discussed below. (With these modifications, the probability of evacuation is high enough to make the extra insurance of operating bombers in many units of less than wing size excessively costly. However, forms of dispersal other than dispersed operation may be of considerable importance, for example preparation of alternative United States sites for emergency use and local dispersal.)

- *Overseas Primary Bases*

Evacuation does not appear feasible for most overseas bases because of the very short warning times and the high enemy capability for frequent air attacks and feints. (The inadequacy of warning time is emphasized by the threat of submarine-launched attacks.) Five-sixths of these projected overseas bases are within 100 miles of the sea. The vulnerability of units deployed to such overseas bases would be high. Figure 13 depicts the consequences of a Russian A-bomb air attack on the whole of the projected 1956 overseas primary-based system with the projected defenses. This illustration clearly shows that only small numbers of A-bombs are needed to eliminate the majority of the force surviving attack in the United States. (Although expected destruction of aircraft is used as a measure of vulnerability in Fig. 13, the combat effectiveness of the force would be further reduced by loss of personnel, bombs, base facilities, fuel,

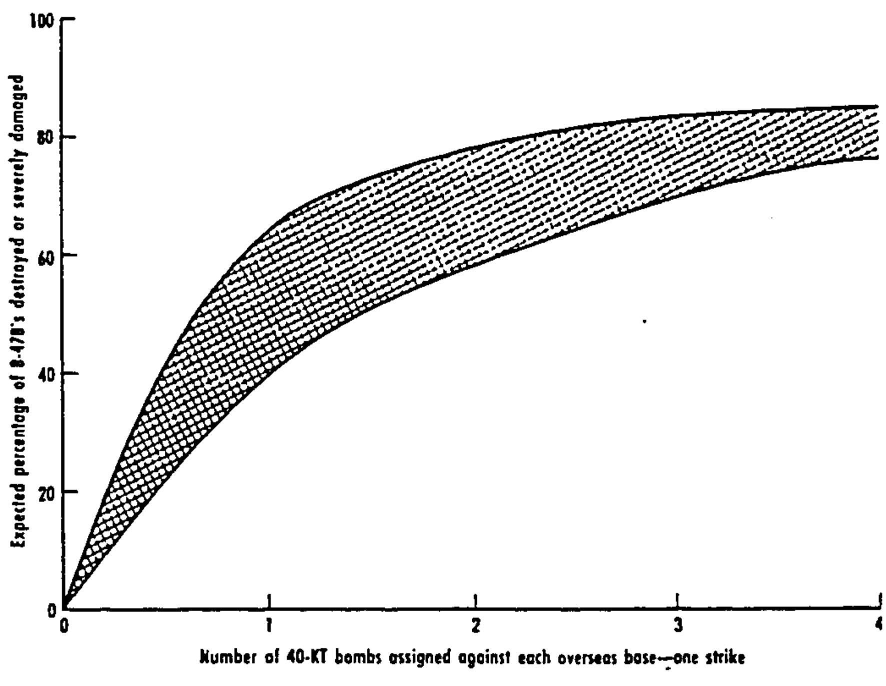

Fig. 13—Attrition on programmed overseas operating bases vs enemy bomb allocation (no aircraft evacuation)

supplies, etc.) The high vulnerability indicated for rather moderate investments of Russian bombs results from (1) the concentration of our strategic forces on relatively few bases, (2) inadequate radar coverage and defense weapons effectiveness, especially at low altitudes, and (3) the high physical vulnerability of system components likely to be on the ground on overseas bases at the time of attack.

After the outbreak of a war, the initial vulnerability of wings deployed overseas will be critically dependent on the period of exposure before the mounting of the first United States strike. Measures can be taken to reduce the period of exposure before our first strike, but after that, our B-47's scheduled to operate from overseas bases will be exposed to repeated attacks by enemy aircraft carrying high-explosive and atomic bombs. Units on rotation overseas at the outbreak of hostilities can expect to suffer great damage immediately.

In our final comparison an improved overseas base system is considered. Under the next two headings, two classes of passive defense measures are treated. They involve multiplication, separation, and toughening of vital system elements to force an increase in the number or size of bombs required to destroy these elements. The first—large-scale changes in the base system as a whole—forces an increase in the number of bombs required; the second—local changes—forces an increase in the size of bombs.

The vulnerability of the projected overseas base system to even a quite low level of enemy attack can be reduced significantly. By allocating more of our strategic budget to the purchase of active and passive defense, rather than bombers, we can increase the total number of our bombers likely to survive all but fairly high levels of enemy bombing attack.

- ***Passive Defense: Multiplying Operating Bases***

Since evacuation is generally not feasible overseas, multiple separated bases should be considered. Protecting the *bombers* by this means requires multiple *operating* bases. The cost (in extra base facilities, equipment, and personnel), compared with the reduction in aircraft ground attrition from a single enemy strike for three degrees of operating-base dispersal, is shown in Fig. 14. Over a considerable range of possible Russian bomb commitments against our strategic force in 1956, there would be a net gain in the number of aircraft surviving after combat, even if the extra cost of separated bases resulted in fewer aircraft being procured. However, we have no reliable knowledge of what Russian capabilities will be in 1956. It must be noted that if the number of bombs available and allocated to this task is higher than estimated, dispersed operation will buy very

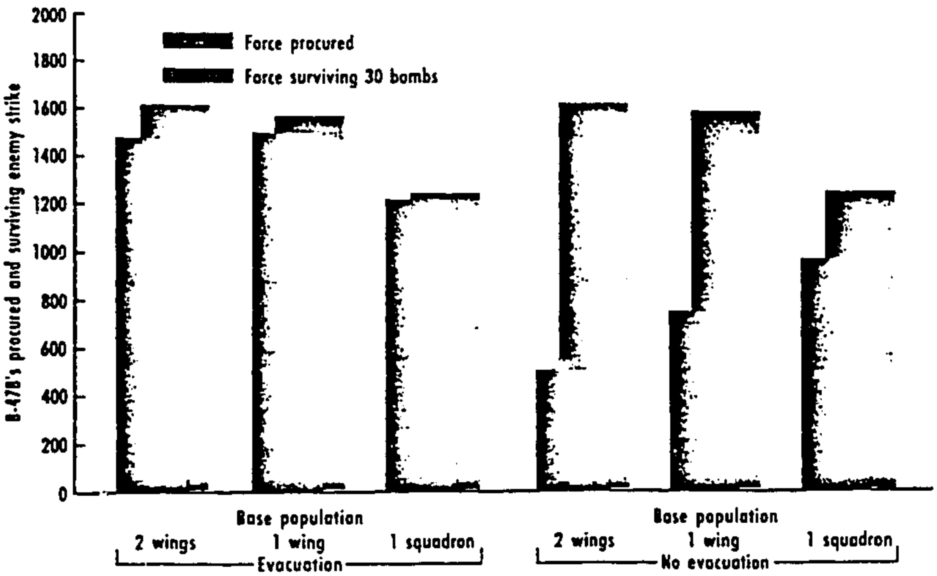

Fig. 14—Evacuation and dispersal

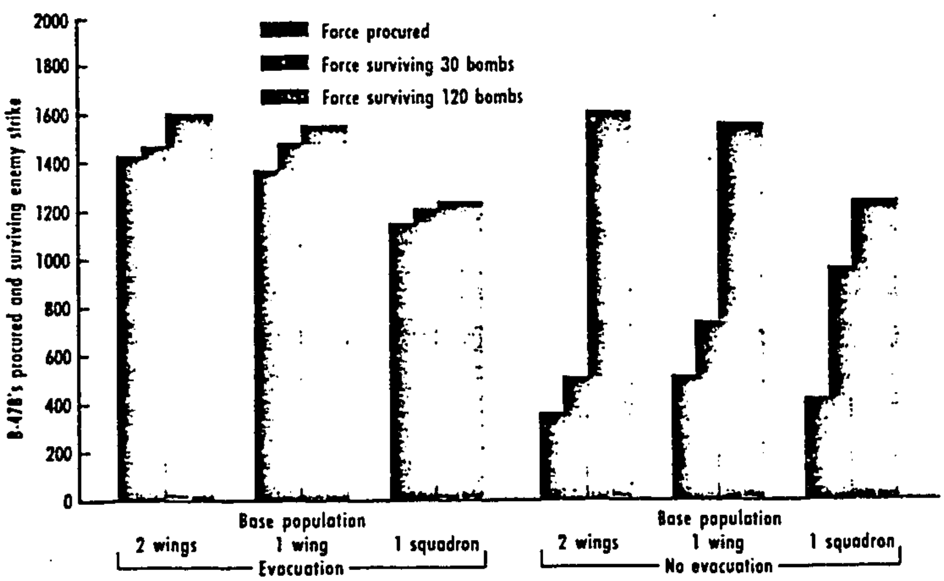

Fig. 15—Evacuation and dispersal: sensitivity

little defense (see Fig. 15). And we can expect the Russian capability to increase rapidly as time goes by.

- *Passive Defense: Changes within a Base*

No strategic base has yet been specifically designed to reduce damage from atomic attack. A medium-sized (40-KT) bomb dropped with a 4000-ft CEP is expected to result in destruction and serious damage ranging from 80 per cent to almost all the aircraft, structures, supplies, and personnel exposed on Zone of Interior bases and most overseas bases. Damage to many base elements can be reduced by local dispersal and blast-protective shelters. Parking aircraft on the perimeter of our large French Moroccan bases rather than the use of *area* dispersal (now employed overseas for protection against high-explosive attack) would reduce expected aircraft destruction and serious damage by about one-half in the case of an attack with a 100-KT bomb. Although these defense measures are quite sensitive to the size of the bomb used, they are relatively inexpensive and insure against the use of only medium-sized bombs.

- *Active Defense*

The effectiveness of scheduled active defenses can be improved somewhat by added radar coverage, especially at low altitude. Over-ocean coverage is inadequate and, as has been stressed, most of the projected forward operating bases are within 100 miles of the sea. Achieving a *high level* of defense by adding more defense weapons of the type presently scheduled would cost about as much as it would save. Ground attrition *would* be significantly reduced by the use of weapons not likely to be available for the defense of overseas bases in 1956 (Nike and Loki local-defense weapons, etc.). However, in all cases, the effectiveness of the active defense of the overseas bases is critically dependent on the performance and number of carriers, tactics, and countermeasures employed by the enemy. In view of the uncertainties as to the effectiveness of various active defense measures, it appears risky to defend bases primarily by active means. This is particularly true of bases that can be reached by high-performance jet aircraft (IL-28, EF-150), which the Russians may have in large numbers.

- *Recuperation Plans*

Recuperation plans can drastically reduce the impact of physical damage on base operational effectiveness. In the case of an A-bomb attack on a base, a large number of the aircraft may require replacement of those parts likely to be damaged by blast (for example, control surfaces, bomb-bay doors, external plastic surfaces). These are not parts normally requiring replacement in quantity, and so are not stocked in quantity at bases. However, such stocks would not be expensive, and failure to stock them could mean weeks and possibly months of inactivity.

Other measures examined and found useful include duplication of vital base facilities, the training of damage-repair teams, and provision for emergency construction to replace facilities destroyed.

No single defense measure will suffice for the defense of an overseas base system. Combinations of active and passive defenses are required. At present, manning and real-estate constraints act to restrict the range of choice available. Figure 16 compares the programmed overseas base system with a system modified to reduce vulnerability. It shows the increase in number of bombers available for combat when extra funds (out of a fixed budget) are spent for additional active and passive defense measures, including local dispersal and blast protection, augmented interceptor and local defenses, and ground and AEW radar coverage. Although the cost per bomber procured is increased by 30 per cent, the cost per bomber *surviving for combat* (along with supporting elements) is decreased by 35 per cent. It should be noted that this combination of defense measures is not regarded as optimal and that there are wide variations in preferred measures for different overseas base areas.

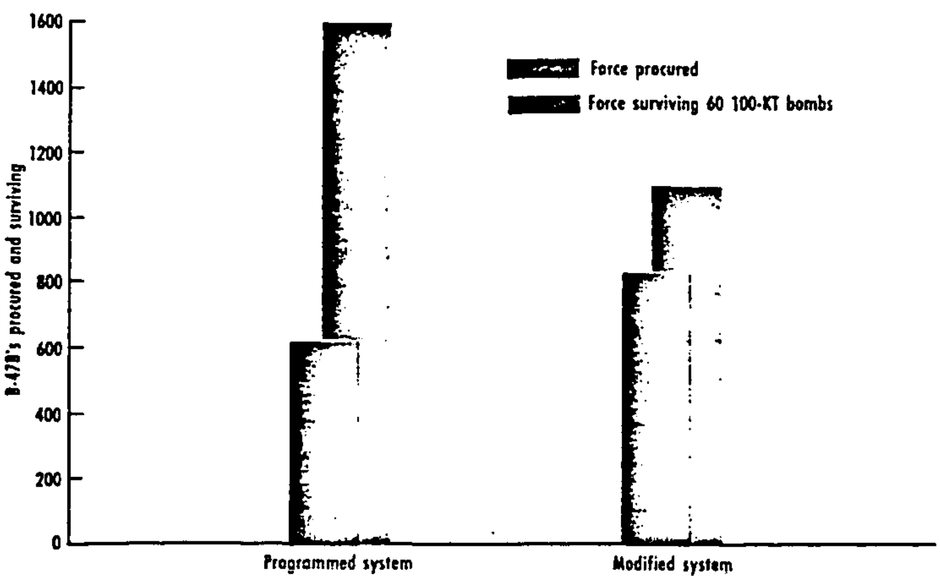

Fig. 16—Effect of augmented overseas-base defense (overseas primary systems)

PREFERRED DEFENSE MEASURES

• It appears that the vulnerability of SAC before deployment to overseas primary bases is moderate for units stationed on bases likely to receive adequate warning of attacks. While many units are not now scheduled to have such warning, it may be provided by the means suggested. The cost of this measure is small in comparison with the damage that it would avoid.

By 1956 the vulnerability of SAC after deployment is likely to be so high that it may be unable to carry out its mission unless major changes are made in the planned base complex and the policy determining its use. It is possible to reduce the vulnerability of SAC by applying the measures described above to an overseas base system which is essentially a modification of the projected medium-bomber system. But the success of such defense measures depends critically on enemy capabilities. It is also possible to reduce vulnerability by an essentially different strategic base system: one using primary bases in the United States in conjunction with overseas refueling bases. Like evacuation measures in the United States, this ground-refueling system overseas makes it improbable that our bombers will be caught on the ground. The likely success of such measures, which reduce the probability of our being on base when enemy bombers reach the bomb-release line, is comparatively unaffected by a wide range of possible increments in enemy capabilities.

• *Defense of Overseas Refueling Bases*

The study examined a strategic system with refueling bases as the sole overseas element. For the purposes of this summary, the refueling system has been assumed to include all the bases now scheduled for use as either refueling or operating bases.

Detailed study of overseas refueling bases showed that defense may be achieved economically by (1) having many more bases than are demanded by traffic requirements; (2) reducing the period of exposure of aircraft on bases (2 hours to refuel the entire part of a wing using any given refueling base) and employing a base-use pattern that would make it improbable that the enemy would find the bases occupied; (3) dispersal, multiplication, and blast-protection of minimal facilities to reduce physical vulnerability; (4) active defense even when the bases are unoccupied (10 wings of interceptors, 35 battalions of Loki weapons), and, when some of the bases are occupied, concentration of fighters (and addition of 10 wings of fighter escorts) at the points of occupancy; and (5) establishing a damage repair and recuperation capability. The multiplicity of these bases, the physical toughness of the few fixed installations, and their considerable active defense would make them unprofitable targets (even assuming quite large Russian stockpiles of A-bombs and long-range bombers) so long as the bases were unoccupied by bombers.

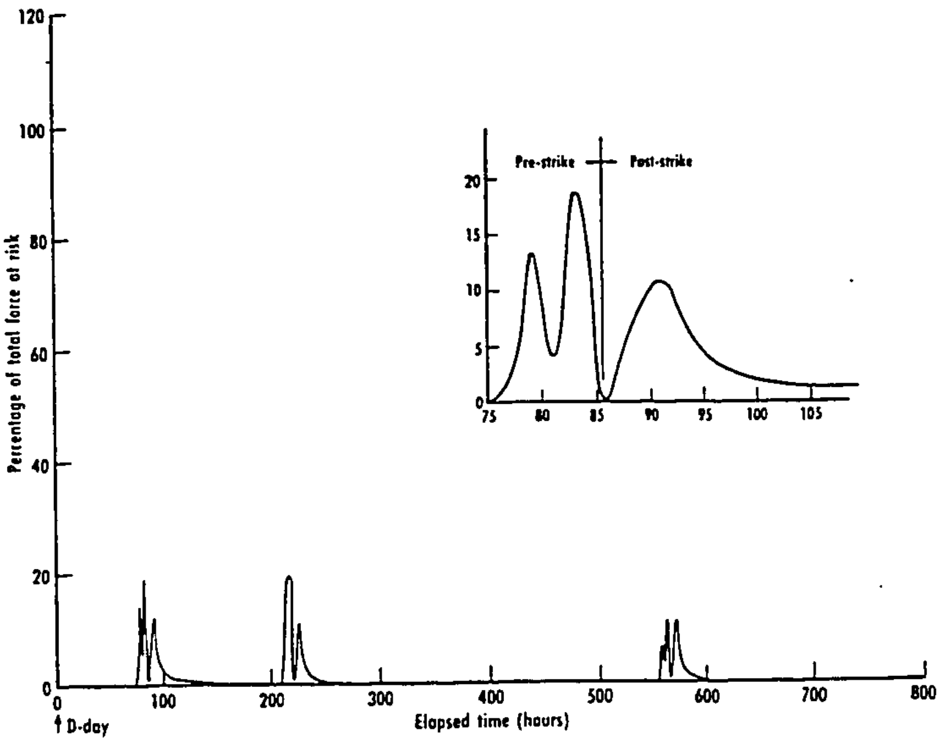

Fig. 17—Refueling-base occupancy

Figure 17 (which shows, for one attack strategy, the percentage of the total bombing force at risk in the refueling-base system at various times during the first month after D-day) illustrates one of the most important features underlying refueling-base defense. Even if attacked at precisely the hour of maximum concentration, only a quite small percentage of our force is risked (a percentage comparable with the unevacuable part of our force on interior United States bases having adequate warning). Moreover, even allowing for extensive intelligence information on the part of the enemy, we can, by using feinting tactics, random strategy, and the like, make his expectation of finding us considerably less than that indicated at the hour of maximum concentration. The feints, supplemented by such devices as B-47B dummies on the refueling bases and by the strong active defenses assumed, could mean a very substantial waste of enemy bombs and bombers. Finally, the attack strategy yielding the refueling-base occupancy shown in Fig. 17 may be improved to reduce still further the maximum system concentration.

A U.S.-based bomber force operating through an overseas refueling-base system so defended would suffer extremely low ground attrition compared with an overseas-based force. The projected 1956 system of primary and refueling bases would require only moderate extension and modification to adapt it to such use. A strong overseas refueling-base system would be tactically as well as politically feasible. Moreover, refueling bases (like United States primary bases, but unlike the primary overseas bases) would not increase sharply in vulnerability with even rather large changes in the number of bombs and carriers the Soviets might commit to an attack on the United States strategic force.

- ***Summary of Base Defense and Expected Damage***

1. As presently programmed, SAC will be extremely vulnerable in 1956.
2. While SAC cannot be made invulnerable, its vulnerability can be reduced by a variety of measures which save more than they cost. No one measure suffices for the defense of the strategic force; many are required in combination.
3. The best of these combinations of measures involves as a major component the absence of the critical vulnerable elements when bombs are released over the base. This means measures enabling evacuation in the United States and measures reducing and making irregular the time spent on base overseas.
4. With such measures it is feasible to preserve the majority of our strategic bombers from enemy bombing attacks, even assuming very high enemy offensive capabilities and commitment to the task of destroying SAC.
5. Defense methods which leave our bombers on base at the time of attack depend very much for their success on limitations in the enemy capability. This is true of the augmented defenses examined for overseas primary bases.
6. In comparing the destructive power of the three broadly different alternative systems for basing the B-47B, it is important to include both the costs of appropriate base-defense measures and also the specific effects of enemy bomb damage on each system.

COMPARISON OF BASE SYSTEMS

The effects of the operational distances (base to target, base to enemy border, etc.) have been discussed separately. In reality, they interact. The joint effect of these operational-distance variables has been studied in a comparison of several widely different strategic base and aircraft combinations. Three of the systems compared are the ones described earlier: (1) an exclusively air-refueled intercontinental B-47B system, (2) a ground-refueled intercontinental B-47B system, with a tanker supplement, and (3) a pure B-47B overseas primary-based system somewhat like the one now programmed (but modified by local dispersal, more radar and active defense, and having no refueling bases). In the comparison, the following assumptions were made: (1) The enemy redeploys his defenses to take into account concentrations of targets and the effect of darkness. (2) The air-refueled bombers follow minimum-penetration routes which reduce both their bomber losses and tanker support costs. (3) All three of the systems have been assigned the appropriate defense measures, and in all three the United States bases are well within the early-warning network. Appropriate additional defenses for the overseas primary and refueling systems have already been described. The costs both of these defenses and of the ground damage to be expected for various Soviet bombing force and bomb assignments have been included in the total cost required by each system to destroy the Russian industrial-target system.

The results of the comparison of these systems are presented in Fig. 18. Although the bombers and the United States primary-base locations are the same in all the systems compared, the differences are striking. The intercontinental exclusively air-refueled system is decidedly inferior to the intercontinental ground-refueled system. The overseas primary-based system studied is, assuming a low enemy commitment against SAC (30 100-KT bombs and 200 TU-4's), intermediate in effectiveness between the two intercontinental systems. However, its cost and effectiveness are very sensitive to the assumption regarding the number and size of enemy bombs committed. Given a higher enemy commitment (120 100-KT bombs and 400 TU-4's), its cost approaches that of the intercontinental air-refueled system. (Both the relative standing of the overseas primary system and its sensitivity to differences in enemy offens would be shown to be worse if Fig. 18 included the indirect effects of ground attack as well as the direct damage to bombers.) These results apply to a campaign in which the air-refueled and overseas primary systems withhold bombers to cut support and ground-loss costs, etc. If, in accordance with Air Force doctrine, nearly all combat-ready bombers were used, the inferiority of both the air-refueled and overseas primary systems would be even more marked.

- ***Uncertainties in Enemy Defense and Offense Capability***

Since all systems use the same bombing aircraft, the results are unaffected by wide alterations in the *total* enemy defense capability. The results are affected

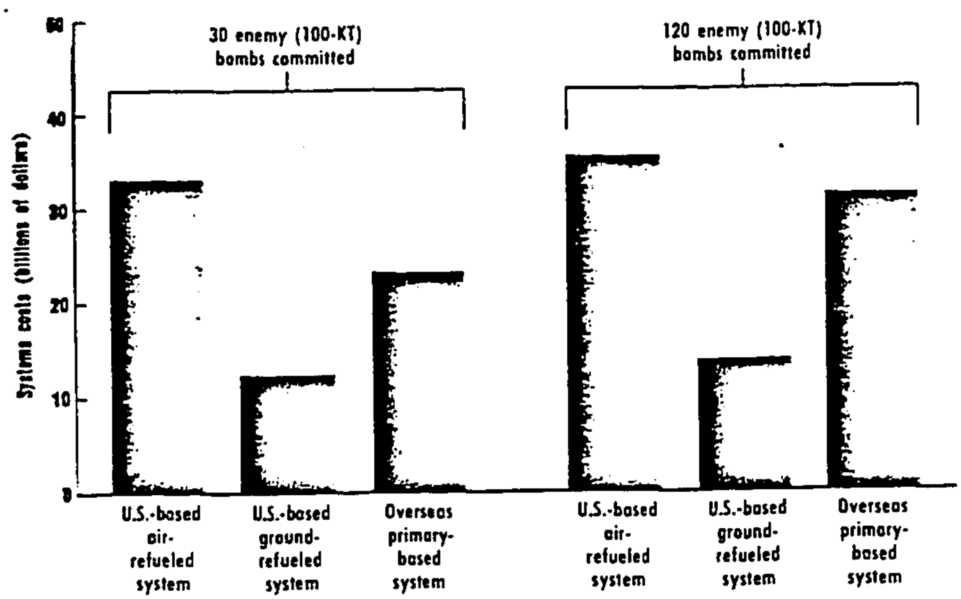

Fig. 18—Intercontinental and overseas primary systems: cost to destroy an industrial-target system in the face of enemy A-bomb attack

somewhat by the allocation of enemy defenses between area and local defense. The assumed local defense may be high relative to the assumed area defense, but a downward adjustment would worsen the relative position of the air-refueled system still further and so would not change the results. It has already been demonstrated that the effectiveness of an overseas primary-based system is likely to vary markedly with the magnitude of enemy offense capability (for example, A-bomb commitments to attacks on our bases), whereas that of a ground-refueled system is relatively unaffected.

In studying campaigns conducted with reserve against both air and ground losses, it was assumed, as is the custom, that the losses to be exacted by the enemy were known in advance. Even in the tests summarized in Fig. 18, where a range of enemy capabilities and resulting attrition was tried, correct anticipation of our losses is assumed in each case. Adjustment for the realistic uncertainties of preparing for a campaign against an enemy about whom we have imperfect intelligence would worsen further the situation of all systems which show a large difference between reserve and operating costs, for it could no longer be assumed that precisely the correct reserves could be stocked (see Fig. 19). It should be stressed that this would be an adjustment for the im-

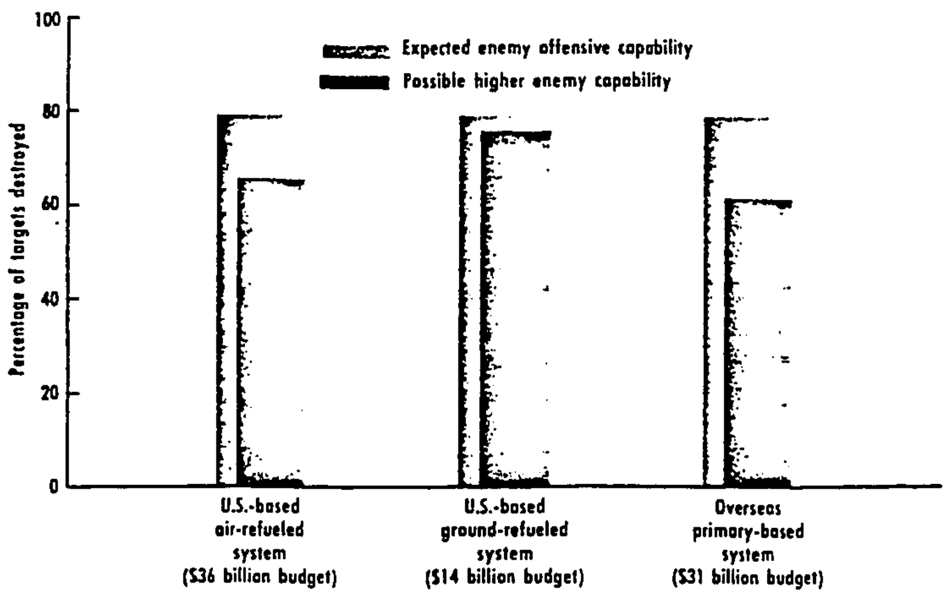

Fig. 19—Target destruction potential and uncertainty in enemy capability

perfectness of our intelligence about future attrition rather than for differences in attrition itself. Figure 19 illustrates the differing degradations in the percentage of targets destroyed by each of the systems if they all prepare for a specific enemy offensive capability (the same as the one assumed in the right half of Fig. 18) but the enemy capability turns out in fact to exceed somewhat our expectations.

- ***Feasibility***

The preferred system is more feasible than the air-refueled system which, to destroy the same target system, would involve more bombers, many more tankers (1400 KB-36 type), more United States bases, and more construction money than is programmed. The preferred system requires roughly the number of bombers programmed and somewhat fewer tankers. The overseas refueling bases assumed use the sites programmed; and these are easier to obtain and to keep exclusively for refueling use than for their programmed use. The improved overseas primary system is less feasible than that programmed, since it presupposes primary-base operations in many areas not scheduled for this purpose. It also involves a great many more bombers than the ground-refueled system.

* *Flexibility and Campaign Time*

Bombing aircraft operated at intercontinental distances are expected to have lower sortie rates than those operated from advanced bases. In the case of a ground-refueled system this does not mean a longer campaign than for an overseas-based system. In both the overseas primary and air-refueled systems, the strike rate, using a tactic of holding bombers in reserve, is limited by the operating support force (available tankers in one case and overseas primary bases and logistic support and active defense in the other). To increase the support force to the point where all the available bombers could be sortied in one strike would be extremely expensive. For the ground-refueled system the extra cost of providing support for the entire force would be moderate. Inexpensive extra support would increase the potential strike rate of the ground-refueled system and permit it to finish a campaign not only at lower cost but also in as short a time as any other system. In short, a ground-refueled system has a marked advantage in flexibility of strike size, rate of strike, and proportion of the target system attacked. It also has greater flexibility in choice of route and in choice of flight profile.

LIMITATIONS AND FLEXIBILITY

The results presented here have been derived from campaign comparisons in which many elements were varied and some were fixed. The study analyzed, in the context of campaign, only the programmed medium and heavy bombers. Only one target system was used in the analysis—a Russian industrial-target complex. It is natural to ask whether the demonstrated superiority of a ground-refueled home-based system would be confirmed by additional analyses in which these other fixed elements were also varied realistically. The composition of our potential bombing force is increasingly variable when later time periods are considered. And although Russian industry is the most familiar target postulated for our strategic force, it is not the only objective: Long-range interdiction, and the destruction of the Russian long-range air force, are other prominent objectives.

Against long-range interdiction targets, the overseas primary-based systems have an advantage in coordinating the bombing schedule with rapidly changing requirements for retardation. And, even for industry bombing, there are circumstances in which they would appear in a more favorable light. Some of the difficulties in achieving our counter-air objectives are suggested by the possibility that the Soviet Union may use methods for protecting its strategic air force analogous to those we have found capable of keeping our own force largely intact. Nonetheless, if the Soviet atomic-delivery capability can be destroyed, or if it should turn out to be much smaller than is expected, then, once this is known, overseas primary bases could be more favorably regarded for industry bombing.

However, one of the merits of the recommended system is its adaptability. Refueling bases could be converted to operating bases if desired and might be combined with a certain number of overseas primary bases used in connection with retardation targets. Similarly, the ground-refueled system is quite flexible when considered in connection with possible alternative compositions of our bombing force. The ground-refueled system would permit the economic use of smaller aircraft against some strategic targets. This would hardly be feasible for the air-refueled case considered. And, for heavy bombers, it would provide greater flexibility in the choice of speed and altitude capabilities and possible large payload demands in connection with the advent of H-bombs.