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STAFF REPORT

PROTECTING U.S. POWER TO STRIKE BACK IN THE 1950'S AND 1960'S

A. J. Wohlstetter, F. S. Hoffman, and H. S. Rowen

R-290

September 1, 1956

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CONTENTS

BACKGROUND

This RAND study of the effectiveness of our strike force under atomic attack was begun in the summer of 1951 to answer questions posed by the Air Staff.

The first phase, accelerated in 1952 at the request of General Vandenberg, was completed in 1953, summarized in Report R-244-S, *Special Staff Report: The Selection of Strategic Air Bases*, briefed extensively throughout the Air Staff and at various USAF commands, and documented in detail in RAND Report R-266, *Selection and Use of Strategic Air Bases*. This first phase was limited to a consideration of our strategic force in the 1950's, before the advent of the serious enemy-strategic-missile threat. While it dealt with the protection of our strategic force in the continental United States against an atomic attack, the study stressed solutions to the problem of reducing vulnerability overseas because this was then the most critical soft spot.

The work summarized in this report was focused on problems confronting the Director of Plans, HqUSAF, and includes an analysis of methods of meeting the missile threat in the 1960's and a more detailed treatment of the protection of our strategic force in the continental United States. The component studies in support of this summary will be published in research memoranda, cited in footnotes on the following pages.

PROTECTING U.S. POWER TO STRIKE BACK IN THE 1950'S AND 1960'S

I. INTRODUCTION AND SUMMARY

RAND has just completed another phase of its continuing study of the essential characteristics of U.S. airpower required to deter general war in the 1950's and 1960's. It has been widely recognized that deterrence of general war requires an invulnerable power to retaliate. However, RAND's study shows that in fact there will be no adequate objective basis for deterrence unless U.S. defense programs and plans are drastically altered. The analysis of a large number of possible alternative enemy attacks demonstrates that even if we assume enemy capabilities to be lower than the levels estimated by the Directorate of Intelligence, and attribute to ourselves a greater capability in defense and readiness for retaliation than is suggested by tests, sensibly planned surprise attacks could prevent us from mounting a sizable retaliatory strike.

VULNERABILITY OF OUR LAND-BASED AND SEA-BASED STRIKE FORCES

Recent and expected developments in Soviet air weapons systems will more than counterbalance defense measures that the United States now plans to introduce. The Soviets have recently tested high-yield weapons of megaton yield and have begun series production of high-performance long-range bombers. These advanced weapon and delivery vehicle combinations are now being introduced into the Soviet Long Range Air Force (LRAF), and it is estimated that the Soviets will have an intercontinental ballistic missile capability by 1960–1961. RAND's *study shows that the programmed Strategic Air Command force in the United States and our land- and sea-based forces overseas with radius enough to hit*

Russia could be destroyed by the new Soviet manned-bomber systems, by the intercontinental ballistic missiles, or by both used in a joint attack.

In brief, major U.S. vulnerabilities can be described as follows: (1) Our strike force presents soft, relatively few, relatively undefended targets. This would permit a lethal attack that would be hard to recognize in time even with an improved sensing and SAC reaction system. But, in fact, (2) even our continental United States (ConUS) warning system has large holes, and (3) the response of our strike force to warning is too slow, even to permit evacuation. Finally, (4) our ability to recover and to strike with evacuated elements is limited, untried, and can be denied us by a follow-up raid.

To remedy this critical situation we need measures that will fill all the holes outlined above. The program RAND recommends, which concerns SAC in particular, is therefore a combination of measures that would (1) increase the size of raid the enemy must launch to hurt our aircraft and aircrews caught on base, and thus increase the probability of giving warning; (2) increase the amount and reliability of warning; (3) increase the speed and certainty of SAC's responses to warning. These last two measures together would reduce the size of raid that the enemy could slip through our sensing system and still catch our aircraft and aircrews on base; they would lower the critical warning threshold; and (4) they would make certain that even if an initial surprise raid caused delay, neither it nor any follow-up raid could prevent our surviving force from launching a massive counterattack on Russia.

There are plans to do something in most of these categories, but not enough in any of them. With the improvements now planned, our strike force would be vulnerable to manned-bomber raids, and, when intercontinental ballistic missiles are available to the Russians, we would be vulnerable to this threat, too.

CONCLUSIONS AND RECOMMENDATIONS IN BRIEF

In brief, the study concludes that:

First, national defense programs do not now give adequate consideration to the problem of protecting the strategic force as distinct from the

problem of force size. As planned, our force will have many major vulnerabilities.

Second, no simple device—such as merely multiplying the number of bombers or the number of bases or the quantity of active defenses in our force—will remedy this situation without infeasibly large expenditures. Given the complexity of the problem, it is not surprising that simple solutions do not work.

Third, the only economical solution is a many-faceted program involving changes not only in SAC but also in the Continental Air Defense Command. RAND recommends some fifty specific measures. These measures fall into groups that are interdependent. Each group, taken separately, is necessary but insufficient. While no substitute exists for some of the individual measures, not every detailed recommendation is irreplaceable. The program does not stand or fall on the acceptance of every detail. The most important of the recommended measures include improvements in:

- *The warning available to SAC*—in particular, by extending the continental early warning radar boundary to the south and locating SAC well inside it. The present base program leaves many SAC units substantially unwarned.
- *SAC response*—by increasing alertness for evacuation of flyable aircraft, with as many as possible combat ready, and by changes in the decision process for alerting and evacuating SAC.
- *SAC's ability to recover after an enemy attack*—by preparing alternate airfields for use in striking back after enemy attack and by increasing and extending SAC's communications and control capacity (and therefore its ability to coordinate the use of such recovery and staging bases).
- *The ability of SAC to use its bombers in the face of a ballistic-missile attack*—by a program to provide warning and shelter for aircraft and critical personnel. RAND finds that shelter exploits the essential inaccuracy of missiles. Alternative suggestions for defending SAC against the ICBM rely on unrealistic estimates of the amount of warning likely to be available and of the

proportion of SAC bombers that can be launched on strike in the minutes of warning that can be counted on.

Fourth, the costs of such a program would amount to approximately 5 per cent of the presently planned expenditures for SAC and SAC defense. The RAND study did not attempt to establish the optimum size of the SAC budget or the SAC force; therefore it has nothing to contribute toward deciding whether we need more, less, or the planned number of B-52's. It is rather a study of how best to spend whatever budget is chosen. RAND found that *at every level of budget and force size studied*, it is vital to spend about 5 per cent to ensure the survival of a significant part of the force after enemy attack.

Finally, the most urgent requirement is not that the whole program outlined be decided on, but that the long-lead-time items involving research and development, testing, construction of prototypes, diplomatic negotiation, etc., be started without delay. This entails commitments that are small in relation to the additional sums of money for SAC that have been the subject of recent discussion, and in particular in relation to the total sums of money already planned for SAC. The sum that should be committed now amounts to less than $60 million.

II. DETERRENCE

DETERRENCE AND THE INITIAL BLOW

The principal way to make a major aggression unattractive to the enemy is to assure him that it will be answered by the devastating power of our retaliatory force. However, Soviet development of a massive thermonuclear delivery capability raises the uncomfortable prospect that if the enemy strikes first, he may also strike second. Can we mount a substantial retaliatory blow after a surprise thermonuclear attack? If not, have we a deterrent?

WHAT IS A DETERRENT CAPABILITY?

The belief is widely held that a strategic air force superior to the enemy's in quality, if not numerically, provides a deterrent capability. The standard U.S. reaction to any Soviet display of a new offensive vehicle is a crash program to develop a similar vehicle or to increase quantity production of an existing similar vehicle. This is understandable. We know so little about the real offensive and defensive capability of the enemy that we must have a large strategic force composed of the best vehicles we can produce. In any case, RAND has not made a study to determine the best force size. But it is sometimes supposed that merely increasing the size of an unprotected force provides deterrence; or that deterrence results from a numerical or qualitative superiority of our preattack offensive capability. This is wrong.

In fact, RAND has examined the capabilities of SAC forces that would outmatch the enemy in quantity and quality *before* his strike and has found that the remnants *after attack* would be relatively powerless. One atom bomb dropped from even an obsolete bomber could destroy a great many modern jet aircraft.

The criterion of matching the Russians plane for plane, or exceeding them, is, in the strict sense, irrelevant to the problem of deterrence. It may even be, as has been asserted, unnecessary to achieve such parity so long as we make it crystal clear to the enemy that we can strike back after an attack. *But then we do have to make it clear.* Deterrence is hardly attained by simply creating *some* uncertainty in the enemy's attack plans, that is, by making it somewhat of a gamble. The question is, *how much* of a gamble? and what are his alternatives? On the basis of past experience, *we* would be taking a very large gamble if we assumed that under no circumstances would the enemy take risks.* If this were so, the matter would be easy and, for us, substantially costless. There are always a few uncertainties in war. But, "We must be sure," to quote Secretary of the Air Force Quarles, "that our deterrent capability is of such strength and flexibility that, even if it suffers a sudden atomic attack, it can still react with devastating power."†

Strike ability

DETERRENCE REQUIRES PROTECTED AIRPOWER

To deter the Soviets, there is no substitute for a protected SAC. It is sometimes argued that "pre-emptive" action is an appropriate counter to the growing Soviet offensive capability and to SAC's increasing vulnerability. This argument ignores the realities of the decision-making process intrinsic to our form of government. Momentous decisions require time, broad consultation, and discussions in the top military and political eche-

*We have underestimated the willingness of our enemies to assume risks in the past when we knew much more of their plans than we do of Russian plans today. For example, on November 26, 1941, at an Army Staff Conference considering the possibility that the Japanese would "soon cut loose," it was stated that the participants in this meeting "did not see this as a probability because the hazards would be too great for the Japanese. . . . We know a great deal that the Japanese are not aware we know, and we are familiar with their plans to a certain extent." It was emphasized that Japan could hardly take the risk of military operations with a powerful air and submarine force directly on the flank of their supply lines. On the other hand, beginning with April of this same year, the Japanese had been considering such matters as whether the chances for success of a Pearl Harbor attack were 60-to-40 or 40-to-60, and though the predominant opinion was on the short side, decided to go ahead. For an account of this, see a forthcoming RAND unclassified publication by R. M. Wohlstetter, *Signals and Decision at Pearl Harbor* (to be published).

†To have such a deterrent capability has been the stable intent of U.S. military policy for a good many years. See, for example, *Survival in the Air Age*, a report by the President's Air Policy Commission, January 1, 1948, pp. 20–23.

lons. The concomitant risks of security compromise and loss of surprise, and thus loss of initiative, are obvious. But preventive war, no less than a retaliatory power, would require a protected SAC—the former to deter the enemy from striking while we made ready.

Even if we could rely on blunting the enemy's counterattack, where we had the first strike, this would be no deterrent to his attempting to strike first—unless we were believed invulnerable to *his strike*. With a large but unprotected SAC, the opposite would be true. He could win if and only if he struck first. It would become imperative for him to try. We would invite his attack.

Public discussion of "the balance of terror" often suggests that mutual deterrence of an all-out war is a simple, logical consequence of the possession by both sides of the hydrogen bomb. Debate therefore centers on such questions as to whether this balance will deter small wars as well as big ones. But to deter a big war, we must prepare realistically and without self-deception—and *at some cost*—to meet the increasing threat of annihilation of our bomb stockpile or of our power to deliver it.

Both the enemy's strategic force and ours *can* be effectively protected. For this reason we cannot be sure of killing his force even if we strike first. *But the possibility of protecting our own strategic capability is, in our opinion, the most important element of stability in the military situation.*

Crucial considering that we would not strike first.

8-9

III. OUR STRIKE FORCES UNDER ATTACK

It is worth dealing carefully, and at some length even in this summary report, with the situation of our planned strike forces under thermonuclear attack. We have, in this study, taken pains to attribute to the enemy at most only those powers granted to him by intelligence estimates, and, in general, considerably fewer. This, in spite of the fact that intelligence estimates have, in the past, been found to understate the Russian rate of progress in the development of nuclear weapons and in the development of a weapon-delivery capability.

But precisely because this matter affects the root problem of national defense—the deterrence of general war—it is difficult to avoid a certain amount of wishfulness and lack of realism in its treatment. In fact, some of the war games—even those played at the highest levels—have been misleading in regard to the survival and response of our strike forces: In these games the Russian attack in general devastates the United States, but still does not prevent us from launching a devastating counterattack. Such outcomes have, therefore, been taken as reassuring confirmation that *our* plans will provide a deterrent. However, considered as devices for evaluating the performance of our strike forces under enemy attack, these games have been unrealistic—not so much with respect to their estimates of enemy capability as with respect to enemy strategy and the speed and certainty of our own response. In particular, they have been unrealistic in their assumptions on warning. These conditions, for the most part, have not been "gamed"—that is, left open to be determined by enemy tactics designed to reduce warning so far as the enemy is reasonably able. Rather, they have been fixed by assumption. Too frequently, such games have been constructed to *exercise* our defenses, rather than to *avoid* them by overflying, underflying, or simply going around them. Under certain circumstances, actual exercises using such attacks on our strong points might be a reasonable way to provide training for these parts of our defenses. However, this should hardly be taken as a reasonable objective for the enemy. Therefore, games based on such tactics must be evaluated with extreme caution. They do not yield any measure of our capability for retaliation against a sensible, uncooperative enemy.

On the other hand, a considerable number of studies* in the past few years that have looked specifically at the problem of SAC vulnerability have concluded that a feasible attack on SAC would be devastating in effect. Moreover, some of these studies used enemy force levels that later intelligence revised upward.†

It is natural to be wary of alarmism here. Such alarmism might be the result of failure to consider all of our forces available for retaliation; or it might be simply the result of more caution than we can afford. Exaggerated estimates of Russian force size, for example, might be used directly to suggest emulation. But we have already made clear that determining who has the best or second best Air Force in being in advance of attack by simply matching numbers or quality is not to the point. Those who assert that we may have fewer and perhaps inferior planes than the enemy and still have a deterrent force must also recognize that we may have more and even better vehicles and yet have inadequate deterrence.

RAND has estimated the vulnerability of our strike force conservatively by

1. Using reasonable-to-low estimates of Russian capabilities and by examining many attacks in great detail in order to take into account operational difficulties.

*See *Special Staff Report: The Selection of Strategic Air Bases*, The RAND Corporation, Report R-244-S, March 1, 1953 ; A. J. Wohlstetter, F. S. Hoffman, R. J. Lutz, and H. S. Rowen, *Selection and Use of Strategic Air Bases*, The RAND Corporation, Report R-266, April 2, 1954 ; Headquarters ADC, *Cost and Effectiveness of the Defense of the United States against Air Attack, 1952–1957*, February 16, 1953 (Top Secret); Hans Heymann, Jr., J. C. DeHaven, and R. C. Raymond, *The Soviet Intercontinental Mission through 1957: A Summary Report*, The RAND Corporation, R-281, August 1, 1954 C(3) ; Headquarters USAF Operations Analysis Report No. 25, *Capability of the North American Air Surveillance Net To Provide Warning of a Sneak Attack upon SAC*, December 1, 1954 (Top Secret); Headquarters USAF Ad Hoc Committee Report of the Air Staff Analysis of The RAND Corporation study on *The Selection of Strategic Air Bases*, September 1, 1953 (Top Secret).

†See, for example, RAND Report R-266, cited above.

2. Considering the total U.S. retaliatory force.
3. Using, on the whole, deliberately optimistic estimates of U.S. capabilities for offense and defense.
4. Assuming a willingness on the part of the United States to accept some reasonable risks even in this most basic defense capability.

The last point is illustrated by the fact that the program proposed in this report is a minimum one having a time schedule that, if anything, moves toward safety at too moderate a pace. More urgent schedules for accomplishing this critical goal could easily be argued. Any further delay would be difficult to justify. The first point, about the treatment of enemy capabilities and problems in carrying through an attack, deserves some expansion.

THE ATTACKS STUDIED

It should be plain that any assessment of enemy capabilities is extremely hazardous. We are uncertain as to the performance of his weapons and his vehicles, and we are especially unsure about the exact calendar date when he will have them. However, the requirements and probable outcomes of a great many attacks were looked at soberly by a team that included electronics and aeronautical engineers, meteorologists, physicists, and Air Force officers having field experience in bomber operations. Detailed map exercises examined enemy forces ranging in size from fifty-six to many hundreds of bombers, many routes and altitudes of flight, check points and navigation methods, and winds along these routes. Estimated Soviet forces available in 1956, 1957, 1961, and later were tried, using single and many-wave attacks. These attacks were leveled at SAC only, at all of our strike forces (SAC and our land- and sea-based forces overseas capable of retaliating against Russia), and at our strike forces, CONAD, and U.S. cities separately and in combination.

The conclusion of these map exercises is that there are a good many ways available to the Russians to disrupt and kill our planned strike forces. Sensibly designed attacks can destroy our aircraft, fuel and fuel distribution systems, air and ground crews, communications, forward bases, aircraft carriers, stockpiles of bomb assemblies, special-service personnel, and bomb loaders. Each of these essential elements is vulnerable to devastating attack, and the probability is quite high that a critically large part of the force would be destroyed. Moreover, it can be shown that by planning attacks that use follow-up waves, the enemy would not only have a high expectation of accomplishing the destruction of our strike force, he would also reduce the risks of bad luck to quite manageable proportions. Such follow-up waves could be used as a form of insurance.

The focus of this study has been on devices to reduce sharply this critical vulnerability. For this reason, we shall first present results of the 1960 and 1961 attacks to indicate the inadequacies of present plans. This, however, does not mean that we have an invulnerable SAC now. We will have some evidence to present on the vulnerability of our strike force in 1956. Since no decisive changes can be effected in 1956, and, moreover, since plans for later years might very well need alteration, even if the situation today were excellent, that discussion will be, in a sense, an excursus. However, it is useful in that it indicates the urgency of changing our plans for later years.

A number of improvements are planned by the Air Force between now and 1961—

- Most of the SAC bases will have additional active defenses. In particular, there are plans for some three dozen Talos detachments, deployed one to a base.
- The number of SAC bases in the Zone of Interior will be increased from the 29 of today to 55* in 1962.

This dispersal will help to accelerate aircraft evacuation, and both it and the added active defenses will tend to force the enemy to larger raid sizes, thus increasing the chances of detection and warning. However, because these active defenses have altitude limitations and are jammable, and many of the planned 55 bases lie outside or nearly outside the planned warning system, the significance of these improvements is limited—

*The number of bases programmed at the date of writing.

- Throughout these years, the Distant Early Warning (DEW) line will be improved, both on land and over water. More offshore Airborne Early Warning (AEW) radars and picket ships and more gap-filler radars, both along the U.S. border and in the northeast heartland, will be added.

Figure 1 shows the dispersed 55-base SAC and the radar networks projected for 1961. These improvements will make some attack routes much less attractive to the Soviets than they now are—

- SAC will have bombs on base. This will ease, but will not eliminate, one bottleneck in achieving a quick response. It will also provide some degree of needed dispersal for one critical element.
- SAC will have a higher crew-to-aircraft ratio by this time, and plans to maintain one-third of the force on combat alert with the extra crews. However, without significant improvements in the size and proficiency of the maintenance forces, the increased

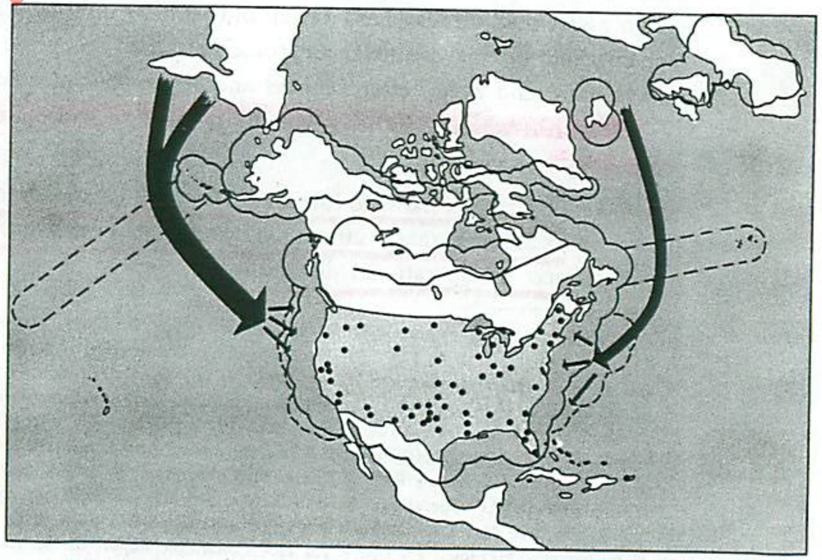

Fig. 1—Projected 1961 distant and continental early warning lines (high altitude) and straightforward Soviet attack routes

flying-hour load may preclude keeping one-third of the aircraft in combat-ready condition; and there are at present no approved plans to take some of the steps that will increase the number, experience, and skill level of critical SAC maintenance personnel.

Figure 1 shows, in addition to the radar networks, the routes of a fairly straightforward Soviet attack. This was one of many such attacks studied. Some 500 Bears (heavy turboprop bombers) and Bisons (heavy turbojets), carrying 1-megaton bombs, are detected at the DEW line. The force follows direct routes, similar to those used in routine SAC–CONAD exercises, and penetrates the continental warning line at low altitude. Winds along these routes, and the ranges of these aircraft, should permit the interval between the arrivals of most of the enemy bombers at the penetration points to be under ½ hour.

In Fig. 2, the solid bars show the penetration times to SAC bases. The average time from the first crossing of the DEW line until arrival at the

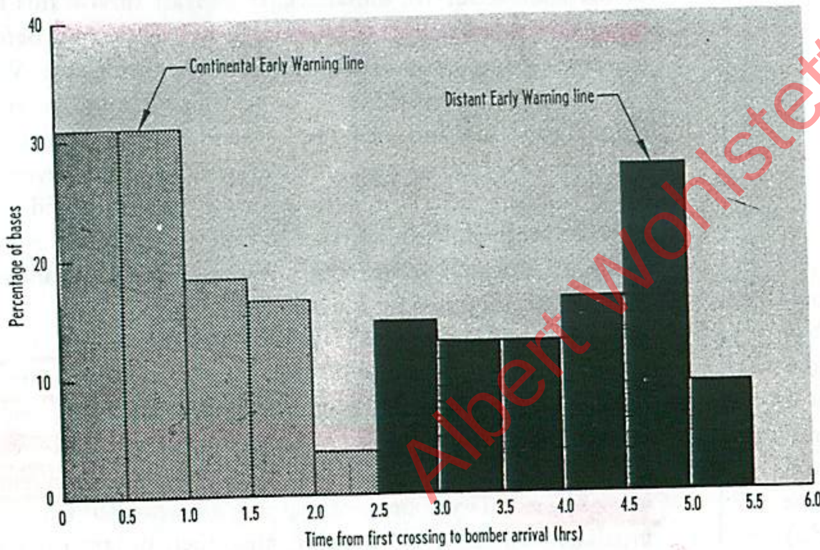

Fig. 2—Estimated penetration time to SAC bases after crossing early warning lines—programmed warning systems

bomb-release line is over 4 hours. Despite the alerting of the defenses several hours before penetration, and the assumption of an optimistic defense kill probability, about 120 enemy aircraft reach the bomb-release line.

The results of this postulated 1961 attack are shown in Fig. 3. This figure shows how much of the SAC force and its critical elements—fuel and fuel distribution, vital personnel, and bomb assemblies not loaded into bombers—survive the attack. Other strikes, which are assumed to be detected at the DEW line but penetrate our continental radars at higher altitudes with the aid of electronic countermeasures and decoys, produce similar results: they have roughly equal expectations of bombing our bases and the damage suffered by SAC depends on how much of SAC is there at the time. This in turn is a function of the warning received and the speed with which SAC can react to warning. Figure 4 shows an optimistic estimate of the current SAC response capability, assuming that there is

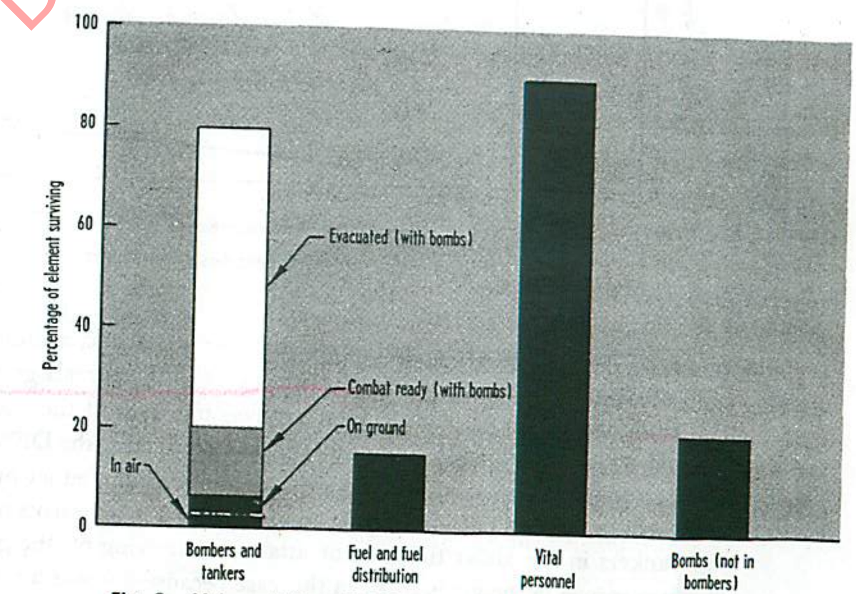

Fig. 3—Vulnerability of SAC to an attack by 500 Bears and Bisons with 1-MT bombs (attack detected at DEW line)

no strategic warning. (This response is optimistic, especially in its estimate of the time requirements for decision.) It reveals that most of the bombers would not be combat ready—which means, among other things, full crew assembled and bombing system working—for many hours after evidence of an attack. If there is no change in this response, the damage shown in Fig. 3 results.

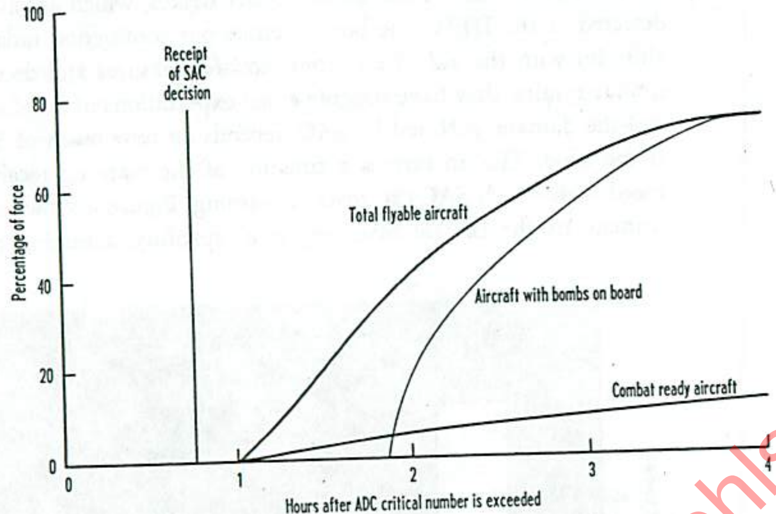

Fig. 4—Current SAC response—no alert

Under this favorable, and as we shall see unrealistic, assumption about warning and active defense, only 12 per cent of the aircraft get off combat ready. About 80 per cent in total survive, and most of these aircraft take off with bombs loaded. Since this attack is detected at the DEW line, most personnel survive this first wave through evacuation, either by air or surface transport. (The lowest portion of the first bar represents bombers and tankers in the air at the time of attack or surviving on the ground. The percentage in the air is small in this case because this was a night attack.)

This is the result assuming our current response capability. What would be the outcome if SAC were on a continuing higher state of alert or if strategic warning were received in time for such an alert to be established? There are plans for maintaining a fraction of our bombers and tankers in constant combat-ready condition. How much of the force can be maintained in this condition, and how rapidly this fraction can respond, is uncertain, given our critical personnel and maintenance limitations. Increasing the crews-to-bomber ratio will help, but this will increase the flying-hour load and further strain maintenance resources, as will possible personnel cuts and the introduction of new bombers into the force. The maximum hoped for is the maintenance of one-third of the force on alert. If we achieve this *and* receive warning from the DEW line, then slightly more than one-third of the force will get off combat ready, while one-half of the force will evacuate with bombs but will not be ready for combat.

In short, the outcome of the attack shown is clouded. In both the variants described—DEW-line detection with no SAC alert response, and DEW-line detection with a maximum SAC combat-alert response—most of the aircraft survive the attack, or at least survive this first phase. But the majority of the aircraft are not ready for combat. Before they can be launched, formidable difficulties must be overcome. Vital elements—crews, aircraft, weapons—are dispersed and must be reassembled. All aircraft need fuel and some need ground crews and parts for maintenance and a place where maintenance can be done. Many, even of the combat-ready bombers, need to rendezvous with tankers or land at en route bases or both. Meanwhile, this first enemy wave may be followed by a clean-up attack on alternate or emergency dispersal fields, or tanker bases, and on en route staging bases for the bombers.

But just to survive this first enemy wave in such quantity requires warning matched to our evacuation speed. To get aircraft ready for combat and *then* to take off before enemy bombers arrive requires still more warning. Warning, then, is crucial and it is important to examine critically the amounts of warning assumed in this strike and the means by which it was obtained. Two sources of warning are discussed here: one, indications intelligence or strategic warning; the other, distant early radar warning. How much can we rely on warning from each of these sources?

STRATEGIC WARNING

The danger of counting on strategic warning has been widely acknowledged. In spite of this, some of our plans depend on it for their success. But planning on strategic warning *is* dangerous and this cannot be overemphasized. By their nature, indicators are ambiguous. Until an aggressor has irretrievably committed his forces to the attack, or has initiated some irrevocable attack warranting war as a response, the decision to make war can be reversed. Preparations can be abandoned, forces can be recalled. Therefore any prediction of an attack must of necessity be phrased in terms of probabilities. If we are to be realistic and accurate before the event, the most positive answer we can ever expect to the question, "Are the Soviets going to attack us?" is, "Perhaps." And the answers to the other important but vexing questions, "When?" and "Where?" will be even more uncertain.

Despite this fundamental ambiguity of indications intelligence, we sometimes hear the argument that by some means we could have a near-perfect ability to obtain strategic warning, now or in the future. Among other things, this argument ignores a problem fundamental to indications provided by a hostile opponent: namely, that the enemy can alter the relative clarity with which signals of his attack might stand out against the background of confusion and "noise" that is always present whether or not such an attack is brewing. The strength of the signals could always be reduced or possibly eliminated entirely by Soviet measures increasing internal security. The normal background noise that might obscure such signals will increase as the Soviets expand their strategic air-training operations with both manned bombers and missiles. For example, forward staging bases will be exercised, and long overwater refueled missions by the Long Range Air Force may become routine. Some forms of training may be adopted specifically to mask the signals that would be given by an actual attack. Both deliberate and undeliberate activity of this kind will degrade our indications system.

Of course, contrary to what we can reasonably expect, we might have indications of an impending Soviet planned "surprise" attack, and we might have these indications days before the scheduled "surprise." The real question, however, is not only how early we will have these signals but how unambiguous they will be. We can state, unequivocally, that they will be equivocal. They might tell us a great deal, such as "A thermonuclear attack by the LRAF is probably imminent." On the other hand, they might tell us very little, such as "Something unusual is happening." This might mean there is an attack brewing. Or it might just mean that the Soviets are preparing for defense and counterattack in case the United States attacks them.

The ambiguity of strategic warning complicates the problem of decision. What actions are feasible on the basis of equivocal warning? They will depend on the degree of equivocality and on the probable frequency of false alarms. They will also depend on the gravity of the actions we might take, that is, on the cost of these actions to us. The decision to send our bombers on strike, or to launch our missiles, is the decision to wage World War III. As many studies of the problem of air defense of the United States have shown, this is very likely to involve enormous costs in terms of U.S. lives. We can hardly afford a mistaken reaction here. It should be plain, therefore, that we cannot plan on receiving strategic warning unequivocal enough to effect a U.S. war decision in advance of enemy attack.

How about less grave reactions—for example, alert preparations? Putting some forces on alert, or adding to forces already on alert, is not without costs. Today, both air and ground crews are painfully limited in number, and extending a combat alert can sacrifice training and future readiness. We should, of course, take advantage of whatever warning we can get, and later we shall discuss precisely this: the use of warning in a system of graded responses as a means of matching the seriousness of the reaction to the degree of unequivocality of warning. However, it is important to recognize that there is a problem of choice here. Before Pearl Harbor and before the fall of Singapore there were many "indicators," but none specific enough to make obvious this very choice between increasing future readiness and immediate protection. Finally, wherever an alert is critical for our survival it cannot be made to depend exclusively on the receipt of strategic warning.

If we were to alert the force *only* in response to warning, the force might not be on combat alert when the enemy struck. An Intelligence estimate has credited the USSR with the ability to mount a 250-aircraft strike in 1955 without giving prior indications. Attacks with many fewer aircraft than this would be devastating. With the combat radii the enemy's planes will have later, he will be able to start unnoticed from deep inside his territory. By 1958, as he exercises his staging bases, the size of raid he will be able to mount through his peripheral bases without our receiving prior indications intelligence is estimated by Intelligence to be several times 250.

For deterrence, one last deficiency of intelligence warning would remain even if we could be sure of obtaining it. This deficiency is intrinsic to its covert nature. To deter the enemy we must *make clear to him*, as overtly as possible, that we will have enough warning to react to his attack. Deterrence, in Admiral Radford's phrase, must be visible.

DISTANT EARLY WARNING

In an attempt to obtain early tactical warning of an attack, we are building a radar line across the far north of the continent, and, recognizing that the continental portion of this line can easily be flanked, we are planning to extend the line out into the Atlantic and Pacific oceans (see Fig. 1, page 13). RAND has examined variants of the overwater sections of the DEW line, other than that shown in Fig. 1. In particular, we have studied attempts to counter the end-run problem by connecting the Atlantic line to Europe, or extensions of the Pacific line south from Midway. The Atlantic shift might be useful (if we neglect the spoofing problem discussed below), but the end-run problem in the Pacific is made very difficult, if not to all practical purposes unsolvable, by the extremely long range of the heavy turboprop Bear bomber. Both the Pacific and Atlantic lines are troubled by their proximity to Soviet territory.

Closeness of the line to Soviet-controlled territory affects the ease with which an overwater radar line can be spoofed. Routine training and weather missions can repeatedly cross such a line and, where it runs close to the Soviet Union, crossings can be made in force. With the AEW equipment we shall have in use for the next few years, our ability even

to detect penetrating aircraft will be small. Sea-clutter problems, and negligible high-altitude coverage by both AEW aircraft and picket ships, make it extremely dangerous to depend on this line for SAC survival, even neglecting the end-run problem. Many of these problems will be helped by the introduction of airborne ultra-high-frequency (UHF) radar and new radars on picket ships; but for the AEW aircraft, the spoofing problem may be worsened because of the inferior counting capability of this radar. Even a small number of Soviet aircraft could generate an intolerably high number of false alarms. Interference with Soviet mid-ocean flights would be in violation of international law and precedent, and would in any case require great effort. Suggestions that we declare war on the basis of such Pacific or Atlantic traffic patterns are simply unrealistic. Possible reprisals against our own overseas military traffic, including AEW planes, make even the shooting down of intruders extremely hazardous. Finally, even if we believed this policy to be a good one, we could hardly rely on the U.S. Government's adopting this view, say, in 1961.

Our present plans for siting new SAC bases and continental radars assume that the enemy cannot skirt the Distant Early Warning lines; so also do some of our plans for using AEW aircraft off the coasts of the United States and in defense of task forces. But he will be able to do so—and if he should plan an attack, it would be a sensible thing for him to do.

DESIGN OF SENSIBLE ENEMY ATTACKS

If the enemy is intelligent in designing his strikes—and, in our planning, we must assume that he may be—he will do SAC as much harm as he can. To achieve that objective he will exploit the known limitations of our defenses. Therefore, his attacks are not to be judged apart from our defense posture.

Our SAC presents soft, relatively few, relatively undefended targets. Our warning system has large holes. Except under conditions of alert, SAC response to warning is slow, even for evacuation. And SAC's ability to recover evacuated elements and to strike is limited, untried, and can be denied by a follow-up raid.

1. WHETHER TO LAUNCH?
2. IF LAUNCH, WHEN?
a. WHAT BASIS

Until these major weaknesses in our defense posture have been eliminated, neither advanced Soviet weapon systems nor devious modes of employing the present ones are necessary. Even rather straightforward attacks will neutralize SAC. However, this does not mean that we can rest after we have reduced or eliminated our vulnerability to just these conventional attacks.

The enemy needs to limit warning if we can use it. Attacking or defending a strategic force is radically different from attacking or defending cities. The significant difference is that the strategic force may not be there when the attack arrives.

Against a moderately alert and fast-reacting SAC, an intelligent enemy must seek to reduce warning. He must not give us enough warning to enable us to mount a strike—even if this means limiting the lethality of his first raid.

A follow-up raid may be necessary. If he doesn't kill our aircraft and crews, but disrupts our strike response, a follow-up raid can still deny us the possibility of recovery and retaliation.

This is what is *sensible* for him to do. What *can* he do?

ENEMY CAPABILITIES BY 1960–1961

Intelligence estimates indicate that the Soviets will have a 3000-lb high-yield bomb in 1960. Its yield of about 1-MT will give a destructive radius of over 4 nautical miles against unprotected bombers. From the Bull's 2000-nautical-mile radius, the Soviets have progressed to a 1955 Bear, which, with a 3000-lb weapon, has a 4100-nautical-mile radius—and a refueled radius of 5350 nautical miles. Assuming engine and gross takeoff weight improvements of the same order as those regularly experienced with our own bombers, the 1960 Bear, carrying a 3000-lb weapon, is credited with a once-refueled radius of about 6200 nautical miles—or a range of about 12,400 nautical miles—enough to go half way around the earth. It is not necessary, then, to talk of improvements in aircraft state of the art that are expected in the sixties—high-energy fuels, boundary-layer control, and nuclear power.

With this range capability, the Bear will be able to end-run the DEW

line and attack the United States from the south. Figure 5 shows that it can go to Omaha by way of Mexico and all the way home by a more direct route with over 2000 nautical miles of range to spare. This extra range can be traded for extreme high- or low-altitude penetrations, or

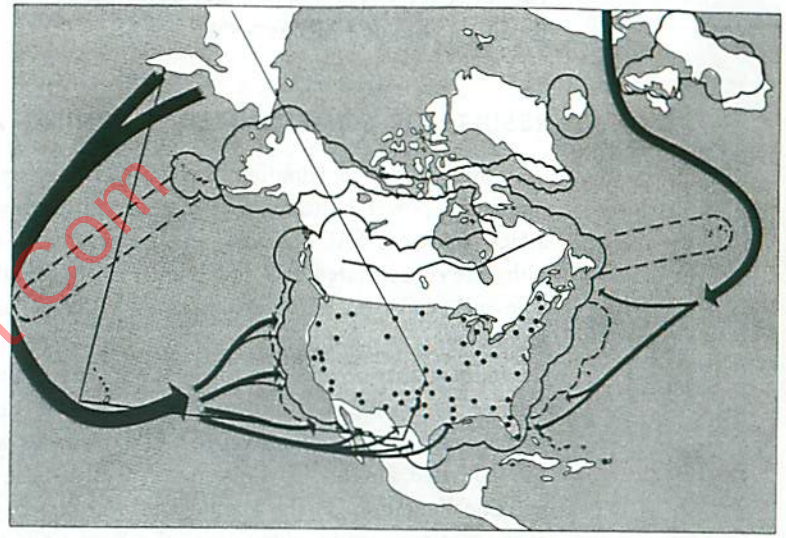

Fig. 5—Projected 1961 distant and continental early warning lines (high altitude)—end-run attack

for the use of takeoff bases deep in the interior of the Soviet Union. Moreover, if desired, even East Coast SAC bases can be attacked from the Pacific—around the end of the DEW line easiest to skirt. In any case, because these routes offer the most favorable winds, and because of the proximity of the Kamchatka peninsula, most ZI bases are best attacked via Pacific routes. In sum, the extended range of Russian bombers will make available to them just about any useful route and profile of attack.

An attack giving even more limited warning is possible with the ICBM. The Directorate of Intelligence, HqUSAF, has estimated that the Soviets will have an intercontinental ballistic missile in series production by 1960 or 1961. This early weapon may have a 3000-lb warhead, about a 5500-nautical-mile range, and may be delivered at that range with an equivalent circular probable error perhaps as low as 2 nautical miles, but more likely 5 nautical miles or greater. Its use at shorter ranges offers the alternatives of reducing the CEP, increasing warhead weight, or choosing flat trajectories. The 3000-lb warhead has been assumed in this study to produce a yield of 1 MT by 1960.

RESULTS OF SOME LIMITED WARNING ATTACKS

A study of the contribution of other U.S. forces possessing some atomic retaliatory power indicates that they are all highly vulnerable to atomic attack. Overseas SAC, tactical, and naval forces having an atomic capability are concentrated at a few points, easily found and easily destroyed. The full report on our previous study (R-266) has shown in detail the vulnerability of land-based units overseas. The present study shows that the vulnerability of overseas forces is not confined to those based on land. Carrier-based aircraft within striking distance of the Soviets cannot expect to survive a surprise attack or post-D-day attacks with more success than ground-based aircraft. The key problem of all the forces overseas is the extreme limitation on the amounts of warning available to them. However, consider attacks with either the Bear or ICBM, designed to limit warning to continental U.S. SAC bases. The situation of SAC inside the U.S. continental radars might at first appear considerably better.

The dotted bars of Fig. 2 (page 14) show the times from first penetration of the ZI radars to bomb release over SAC bases that result when the enemy uses the range of the Bear to avoid detection at the DEW line. Over half of our bases get less than an hour's warning. Figure 6 shows that slightly more than 30 per cent of the bombers survive if there is no alert, and only a few per cent get off combat ready. If as much as one-third of SAC is on alert, the survival of this part depends directly on its launch time. If it is on a 1-hour alert, at most 15 per cent of the force survives combat ready. If the response time for the alert part of SAC is as short as 15 minutes, almost all of the alert force survives,

but the remaining two-thirds is almost totally destroyed. In any case, most of the vital personnel are lost, and only about 10 per cent of the other critical elements survive. In particular, our stockpiles of bomb assemblies are almost all damaged or destroyed.

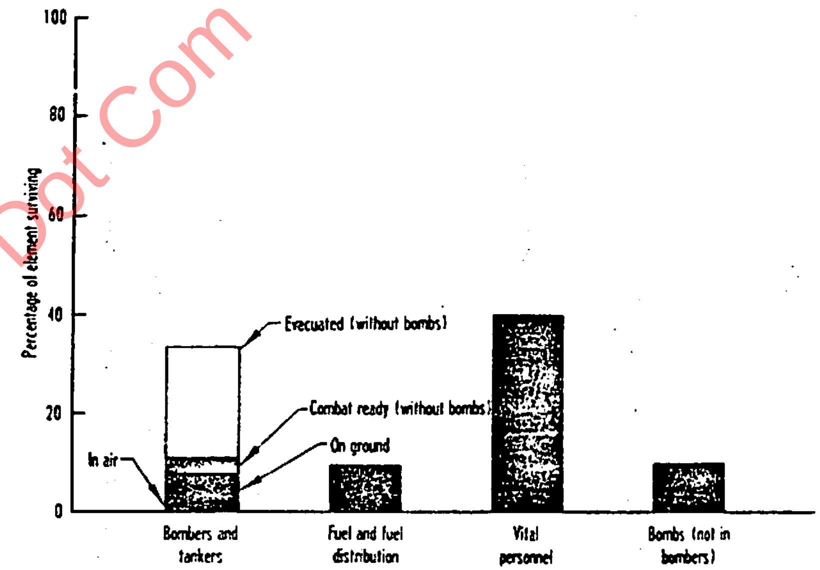

Fig. 6—Vulnerability of SAC to an attack by 300 Bears with 1-MT bombs (DEW line avoided)

Unless a very advanced degree of alertness is achieved for a very considerable part of SAC, vehicles such as the ICBM will not be needed by the enemy. On the other hand, if he does need them, he will find them sufficient. Figure 7 shows the results of a closely coordinated 1961 Soviet attack with 250 ICBM's against a SAC force, assuming the 15-minute alert. This is a missile with a CEP of 5 nautical miles and a 1-MT warhead. Even if somewhat less than half of these missiles are successfully launched and do not abort, we suffer damage to about 70 per cent of our bombers and tankers, and to almost the same percentage of the vital personnel. Other, tougher, elements fare considerably better. The lethality of this weapon, even with its poor accuracy, against such soft targets as aircraft should be emphasized. Its lethal radius in terms of damage that would prevent use of the B-47 and B-52, at least until they were repaired, is about 4½ nautical miles (at a 12,000-ft burst height). Each missile that lands in the target area has about a 40 per cent chance of damaging the parked aircraft.

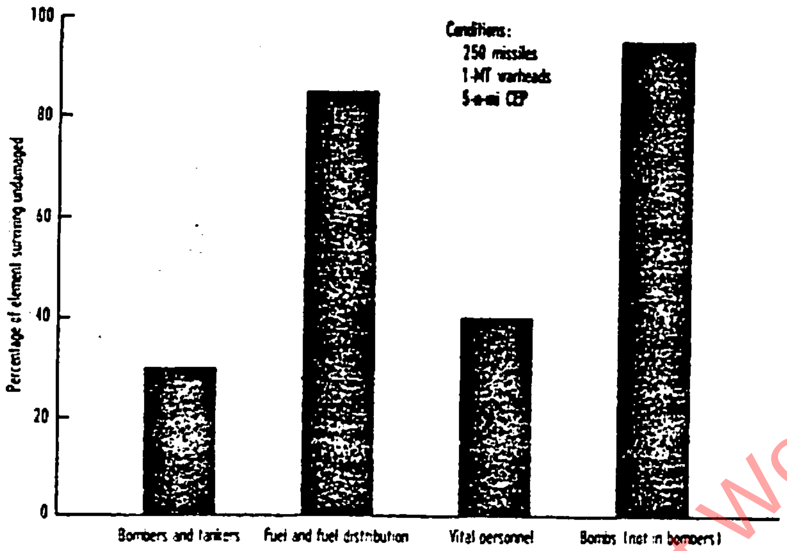

Fig. 7—Survival of SAC elements after an ICBM attack against SAC bases in 1961

Figure 7 shows that neither a large missile force nor very advanced missile performance is necessary to hurt SAC seriously. Figure 8 shows the vulnerability of SAC to three possible enemy ICBM's. With the expected early threat, already shown in Fig. 7—a Soviet ICBM with a 1-MT warhead and a CEP of 5 nautical miles—a force of 200 to 300 missiles can destroy and damage most of SAC's bombers and tankers. Better missiles, available later with better accuracy and larger warheads (or possibly the same 5500-nautical-mile-range vehicle used at shorter ranges

from Eastern Siberia) will be capable of destroying almost all of SAC with a salvo capability of *fewer than 100 missiles*.

These attacks are by no means the best the enemy could design; nor do they use mixed forces, as they might be expected to do. However, they do show that our planned defense posture makes a follow-up raid redundant—except as a form of insurance.

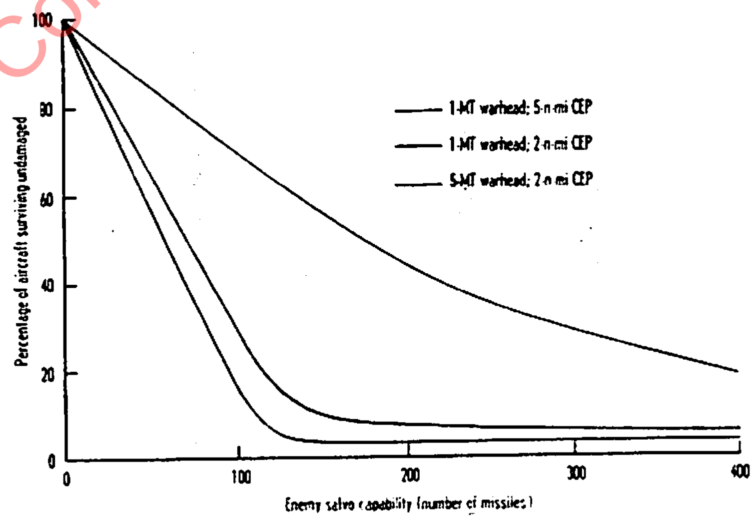

Fig. 8—Vulnerability of Programmed SAC to enemy ballistic missiles

In the 1960–1961 time period we are scheduled to start phasing ICBM's into the strategic force. Before that time, in 1959, there are plans for putting Intermediate-Range Ballistic Missiles overseas. How will these missiles change things? It is sometimes assumed that they will solve all problems—in particular, that they are intrinsically invulnerable on the ground. This is not true. The vulnerability of these missiles will be what we make it in the design of the missile system. These missiles could be more vulnerable than manned bombers if their basing were too concentrated, if they were too soft and responded too slowly.

If the initial 1960–1961 force of 120 ICBM's is not sheltered, the Soviet force needed to destroy it may be small. For example, if this force is based in three large complexes, one of which is shown schematically in Fig. 9, and if it is not sheltered, then the Soviet force able to destroy an expected 80 per cent of it need only be 24 missiles, allowing for unavailability and aborts. Alternatively, the penetration of only 12 manned bombers would destroy all of this force, and this number of bombers could be reduced by one-half or more if the Russians put more than one bomb in each bomber. The small enemy force needed in spite of the apparent

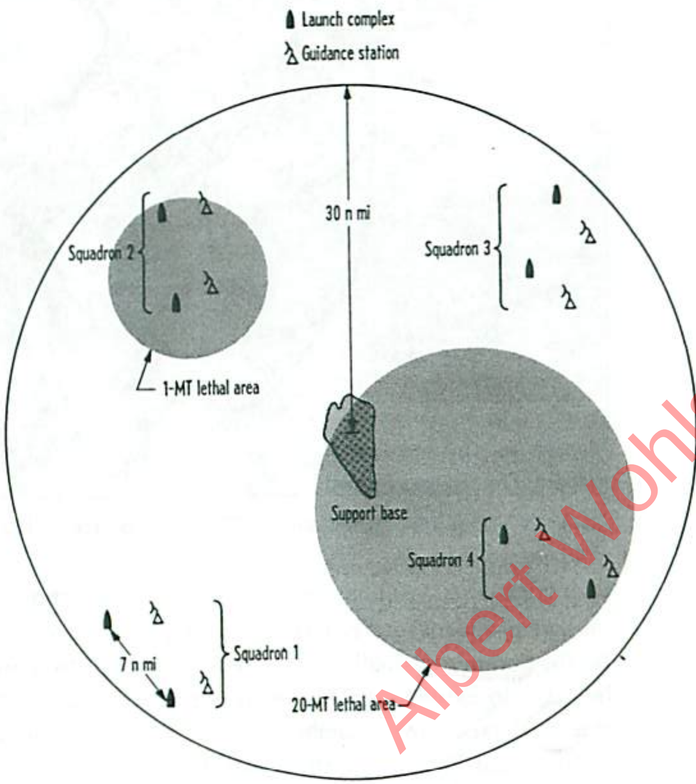

Fig. 9—Layout of an ICBM (SM-65) provisional group, and lethal areas of thermonuclear weapons against unsheltered missiles

high degree of dispersal is a consequence of the extreme vulnerability to blast of unsheltered missiles—estimated to be 2 psi. At this overpressure level, a 1-MT bomb, air burst, has a lethal radius of about 7 nautical miles. A 20-MT bomb, ground burst, has about a 14-nautical-mile lethal radius.

This estimate of enemy requirements for destroying our projected missile force may be excessive. Camp Cooke, the first base planned, is much smaller than that shown in Fig. 9. A *single* 1-MT bomb would cover the entire base with 2-psi overpressure or more.

Overseas, there may be 120 IRBM's at 8 existing SAC bases in the United Kingdom, and this entire force could be destroyed by that number of Soviet IRBM's or light bombers. There may be some merit in having unprotected, highly concentrated missiles overseas on the chance that we may get the first strike. However, we cannot count on using them in any war started by the Soviet Union.

SUMMARY ON VULNERABILITY OF THE PLANNED 1960–1961 FORCE

The ICBM by itself will upset any plans that depend on reliable strategic or DEW-line warning. But these plans can also be upset by the manned subsonic bombers.

The limits that we have optimistically put on enemy offense routes and tactics unfortunately appear to be associated with our own weaknesses in defense and not with the enemy's capabilities for offense. If we assume that he will not exceed these limits, it is not because he cannot—but perhaps because the consequences are too unpleasant to contemplate.*

Given the expected yield of Soviet nuclear weapons, a small raid that catches us on base will probably kill us. If we depend on Soviet use of a large first wave to give adequate warning, we are assuming that the Russians will use a tactic they not only do not need, but one which is self-defeating.

*Of course, it *is* quite possible that the enemy will level his attack against our strong points. To quote Admiral de Robeck at Gallipoli, "Gallant fellows, these soldiers; they always go for the thickest place in the fence." On the other hand, we cannot count on such gallantry.

A first wave, designed to minimize warning, is not, as is frequently stated, a gamble. Nor does it preclude following through with a big direct attack that accepts detection at the DEW line. The mass-strike force detected at the DEW line gives most of our bases 4 hours or so of warning, and its effectiveness is hardly affected if the surprise first-wave force is discovered an hour before.

CURRENT VULNERABILITY

So far we have concentrated on a time several years away because we believe that actions can be taken now that will substantially improve our position by then. But what is our current position? The widely held view that the Soviets will not threaten our retaliatory capability until 1958 or 1959 is based on an estimate that only then will their Long Range Air Force match ours in number and quality. It rests on the incorrect assumption, mentioned earlier, that deterrence results from the numerical or qualitative superiority of forces before attack.

RAND has studied many attacks that the Soviet Union might try against our atomic capability in 1956. These studies show that *the probability is very high that a well-designed attack on SAC and on other atomic forces now would destroy almost all of these forces before they became airborne.*

The over-all Soviet attack strategy that would turn out worst for us, while avoiding excessive risk for the offense, combines a surprise initial blow with quick follow-up "insurance" strikes. The first blows would be aimed at our most vulnerable points—the relatively small number of occupied bomber bases in the Zone of Interior and overseas, major stockpile sites, and naval carriers on station (see Fig. 10). To take care of any of our surviving bombers, follow-up attacks would be directed against points essential for our recovery and retaliation: alternate or emergency dispersal fields, en route staging bases, communication and control centers, and target-bound naval carriers. Cities have the lowest time urgency for destruction. (However, fallout from heavy attacks on SAC would kill millions of people in cities.)

Three of the 1956 attacks studied that produce these results are discussed below. In the first, the Russians employ a force of moderate size

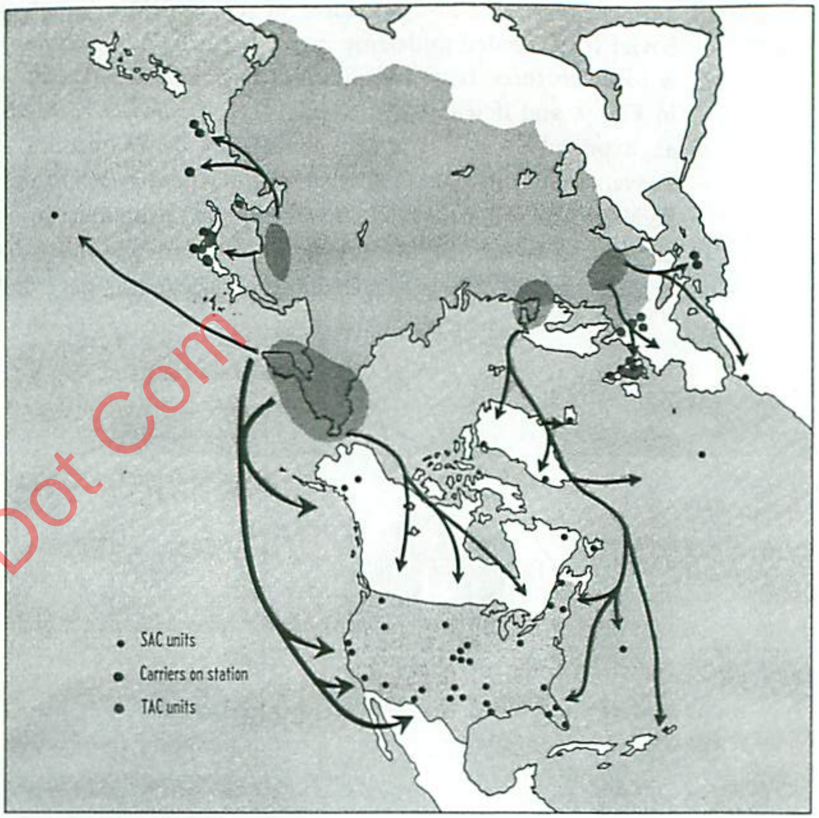

Fig. 10—Hypothetical 1956 Soviet attack on U.S. forces

and attempt to exploit weaknesses in our detection system by following routes that avoid radars and by flying at moderately low altitudes. In the second, a smaller force seeks not only to avoid radar detection but also to exploit weaknesses in our system for identifying aircraft. In the last attack, Soviet bombers follow relatively direct routes in from the Atlantic and Pacific and attack in large numbers.

Figure 11 shows the outcome of the first-wave attack in the first of these cases. In this attack, 148 bombers (about two-thirds Bulls, the

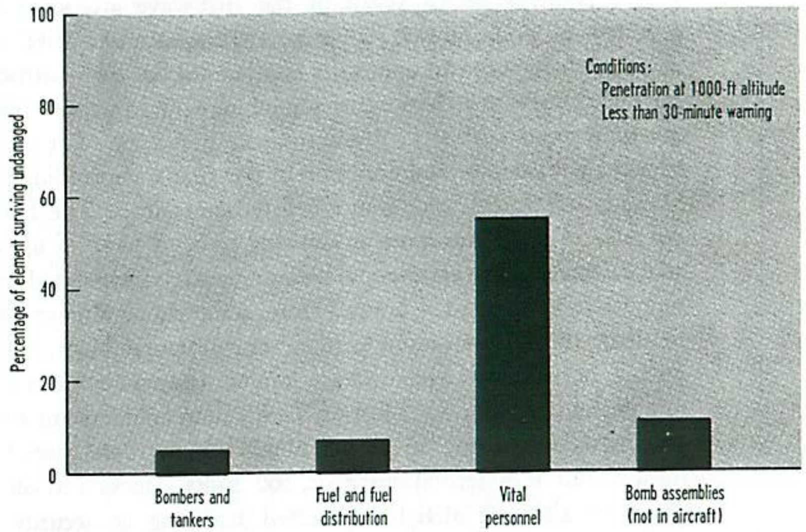

Fig. 11—Results of 1956 Soviet attack against key U.S. targets by 148 Bulls, Bears, and Bisons

remainder Bears and Bisons) attack the United States and penetrate along the routes shown in Fig. 12. (The red portions of the routes show the distance traveled over the United States while in radar cover.) The routes were selected to travel over territory that provides slightly more radar warning than the minimum possible (though still an insignificant amount) but limits the amount of warning time provided by a chance detection in the unlikely event that this should occur. In this way the results of the first wave are hedged against an unlucky detection. As another form of insurance—against operational difficulties such as navigation and bombing errors, as well as against possible losses to our defenses—the enemy sends several bombers to each target, still holding his initial wave small so as to limit possible strategic warning: for each target he assigns from three to eight bombers, depending on the target hardness and air defenses likely to be encountered en route. This assumes that at least one bomb will be delivered to each target. The bombers penetrate our radars roughly simultaneously at altitudes averaging slightly more than 1000 ft. Tail

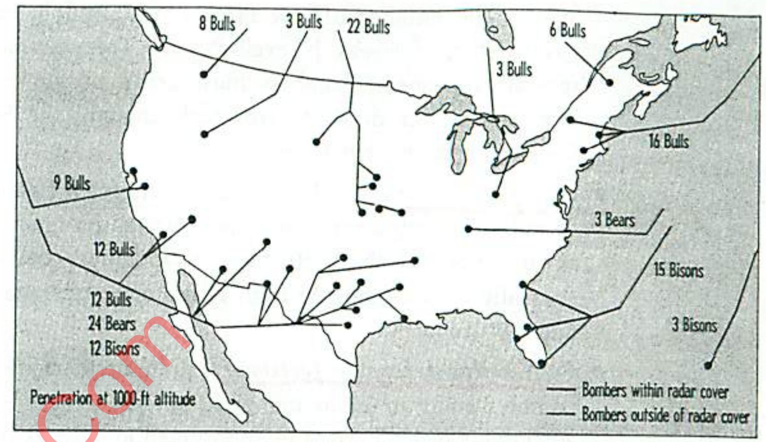

Fig. 12—Penetration routes of first wave of a 1956 Soviet attack against key U.S. targets by 148 Bulls, Bears, and Bisons

winds along these routes and the long range of the bombers make it possible to coordinate their arrival at points of penetration. However, some unplanned irregularity was allowed for. No air refuelings are necessary for this attack and routes were chosen so that bombers could reach neutral territory or rendezvous with submarines. Alternatively, this force can be regarded as being refueled and returning to the Soviet Union. After allowing for aborts, attrition, navigational errors, and bomb failures, 102 bombs are detonated over target. The expected result of this first wave is the loss of 95 per cent of our aircraft, 90 per cent of the vital personnel on base (55 per cent of vital personnel in total survive this night attack if as many as 50 per cent live off base), and damage to about 90 per cent of our bomb assemblies. The few surviving aircraft are not combat ready, are without bombs, and would have a small probability of surviving subsequent Soviet attacks and Soviet air defenses.

The basic reasons for this vulnerability are

- *Concentration of our atomic forces at a few points*: Vital elements of the Strategic Air Command and most bomb stockpiles are now concentrated at a total of 35 points in the United

States. The number of key targets presented by tactical and naval forces overseas is even fewer. This means that only several-score enemy bombers must arrive at the bomb-release line, and if our defenses are weak enough, the Soviet force launched need be little larger.

- *Insufficient warning*: The average time from first penetration of radar to bomb drop, along the routes and at the altitude used in this strike, is about 30 minutes, and many bases have substantially no warning. At high altitude the average warning is under 90 minutes.
- *Poor active-defense effectiveness*: *No* attrition is sustained by bombers going to 20 of the 35 ZI targets attacked. The others suffer very little. This estimate assumed individual fighter effectiveness about five times that achieved in the recent Exercise CRACKERJACK. Little warning, absence of defenses around SAC bases, inadequate low-altitude radar cover, and poor weapon performance at all altitudes that the Soviet bombers may penetrate combine to produce this result in the ZI, and to an even greater extent overseas.
- *Slow response*: Figure 4 (page 16) showed an optimistic estimate of current SAC response capability, assuming no strategic warning. It revealed that most of the bombers will not be combat ready—full crew assembled and bombing system working—for many hours after warning of attack. Moreover, with the radar-penetration times indicated, and allowing for decision times and communication delays, very few will manage to evacuate.
- *Softness of targets*: Most of the critical elements on air bases will be damaged and destroyed if subjected to relatively low overpressures (4 to 10 psi). The doors of the igloos storing our bomb assemblies—some of the least-soft elements—will be ruptured at 30 to 40 psi. Bombs of 1-MT yield, delivered with moderate accuracy, are large enough to destroy most of the vital elements on our ground bases. And aircraft on carriers, like aircraft parked on concrete, are extremely vulnerable to blast.

This is the *expected* result of the first-wave attacks. However, the expected does not always happen. Although conservative estimates of Soviet performance and optimistic estimates of our own performance have been used, there is a chance that something will go wrong. But some risks can be insured against in the design of the attacks. For example, what happens if there is visual detection of the first wave leading to a decision to ready our forces some hours before bomb drop? The first wave was designed to make this quite an unlikely piece of luck for us: it is a night attack, traveling over unpopulated or sparsely populated regions. But suppose it is detected 4 hours before bomb drop? Figure 13 shows the result of this first wave under these circumstances. Most of our aircraft get off, but at most 12 per cent are combat ready. The others must proceed to an alternate base, and most of the medium bombers among the 12 per cent must land at one of a small number of en route bases before penetrating. But if a second wave of 100 Bulls attacks probable SAC dispersal or alternate airfields (selected assuming no security leaks) and

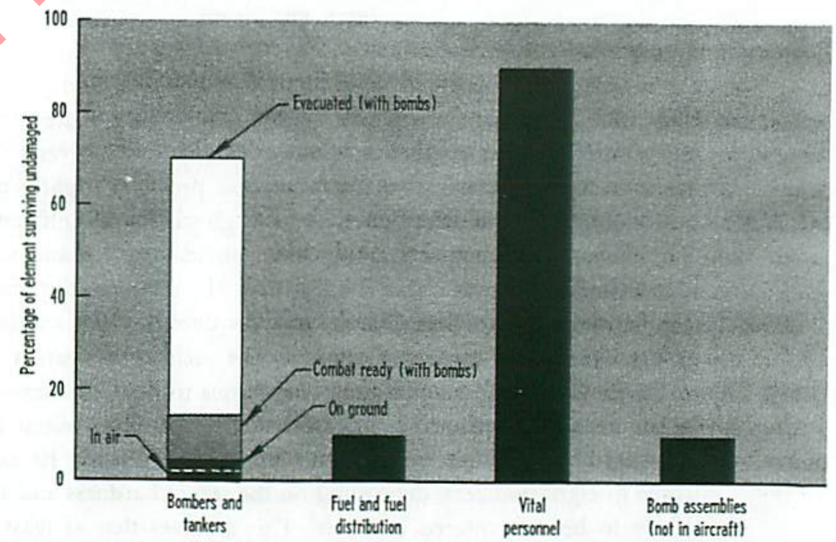

Fig. 13—Results of first wave of a 1956 Soviet attack against key U.S. targets by 148 Bulls, Bears, and Bisons—4 hours tactical warning

en route bases overseas, our efforts to ready SAC and deploy overseas are totally disrupted.

Even in the absence of such a follow-up wave, our ability to recover and ready aircraft on alternate bases is extremely limited, and days would probably elapse before a substantial strike with evacuated elements could be launched. A follow-up Soviet attack during *this* period would destroy most of the surviving force if it elected to remain on the ground, or it would destroy the strike preparedness of that part succeeding in evacuating once again. Finally, a series of small follow-up attacks would dissipate this surviving force.

The outcome of this attack shows that the ability of the Soviet Union to strike effectively against the United States does not depend on Soviet possession of a large force of long-range bombers or an extensive refueling capability. This attack involved only a small part of the LRAF sent on "one way" flight. As we have indicated above, the one-way flight is not necessarily a suicide mission and most of the crews escape to Mexico or to submarines. Nor does it involve throwing away the Soviet strategic force—it takes only one aircraft over a base to destroy 65 on the ground. For example, only one-fifth of the estimated Soviet force was sent in this case. Finally, it would be foolhardy of us to depend on assumed limits to Soviet capability that are hardly warranted by our knowledge of these capabilities or by our record in predicting advances in them. The succession of surprises we have received from the rapid Soviet achievement of the A-bomb, H-bomb, advanced jet engines, the Bear, airborne intercept radars, and large-scale fissile-material production, for example, should save us from overconfidence.

Other forces besides SAC in the ZI are capable of early retaliation against the Soviet Union and have as a consequence a high priority for attack. Figure 14 shows all U.S. bomber units that are capable of striking against Soviet Union targets within the first 12 hours of war. Only a few points overseas would be urgent targets: on the date of this attack, 4 SAC targets, 6 naval targets, and 18 USAFE and FEAF targets. Other naval and tactical air forces are too far away to constitute a threat to the Soviets on the first day of the war.

A surprise attack by 150 shorter-range Soviet Beagle and Badger me-

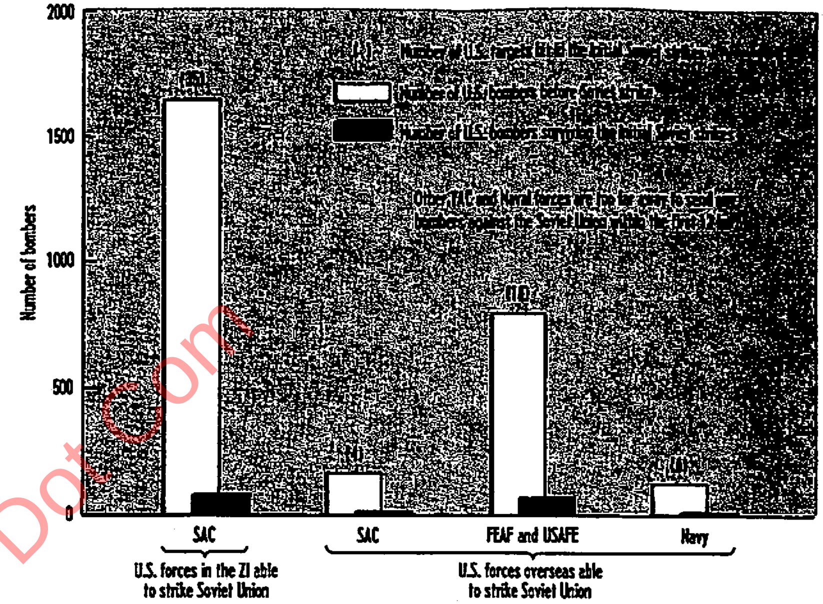

Fig. 14—Destruction of U.S. forces able to strike against the Soviet Union within 12 hours (1956)

dium bombers timed to enter overseas radar cover shortly after penetration of U.S. continental radars would catch most of our overseas forces on the ground or on the carriers (see Fig. 14). And of the small number of bombers (between 5 and 10 per cent of the original force) surviving the initial Soviet strikes, only a few would be combat ready.

The many-wave attack outlined employs one of several strategies useful to the enemy in the destruction of our retaliatory force. Other tactics for the first-wave attack against continental U.S. bases deserve at least brief mention because they exploit, and therefore reveal, other defects in our defense system.* The 1956 raid described above illustrates how, even with

*For a more detailed discussion of this second type of raid, see M. Arnsten, L. D. Attaway, P. M. Dadant, M. R. Mickey, and W. P. Stillman, *Vulnerability of Continental U.S.-based SAC Forces to Soviet Attack in Mid-1956*, The RAND Corporation, Research Memorandum RM-1763 (to be published) (Top Secret).

routes of penetration chosen to hedge against early chance detections by casual observers, the expected time in radar cover of a relatively large number of enemy bombers on their way to hit our strike force could be reduced to insignificant numbers.

In the second attack, the Russians attempt to penetrate initially with just enough bombers to cripple us and to minimize warning from Intelligence sources, radars, the Ground Observer Corps, and casual observations. One of the smallest target systems presented by our strategic retaliatory force is made up of 29 SAC bomber bases. (Compared with the previous attack, this one excludes the separate stockpile sites.) Seventeen of these bases can be hit with ½ hour or less of penetration over the United States or through radar cover. This attack is designed especially to get bombs to the 12 deep bases with too little warning to permit evacuation. Several characteristics of our warning system make this possible:

First, radar coverage in the south at altitudes of 1000 to 5000 ft is so sparse that most of the 12 deep bases can be reached by bombers penetrating at these altitudes without entering radar cover more than 5 or 10 minutes before arrival at target.

Second, the GOC in many areas is so undermanned that it is ineffective. Most deep SAC bases can be reached easily by the Bear along routes where the GOC is in a standby status. Even where it is operating, its potential for identifying a Soviet bomber as such is largely confined to daytime. For these deep bases, it is possible to penetrate in darkness at an altitude of 5000 ft, remain out of radar cover, and still penetrate during hours of moderate background traffic.

Third, the Air Defense Identification Zone system does not completely encircle the SAC basing system, and single aircraft flying outside ADIZ areas at conventional speeds and altitudes during hours of moderate traffic are not identified. In particular, the tracks of aircraft penetrating from the Gulf of Mexico are not reported as "unknowns" to ADC division level and higher.

Finally, this attack would reveal itself to our surveillance system by only a small increase in the normal number of unknown aircraft over the U.S. Such signals of a raid are too ambiguous to lead to immediate

SAC reaction and come too late for effective SAC action to be taken.

In sum, most of our interior bases are "deep" only in the geographic sense and not with respect to our warning barriers.

The infiltration or sneak raid shown in Fig. 15 is designed to exploit these weaknesses of our defense. Fifty-six Bisons and Bears are launched in the first wave against the United States. Two bombers are originally scheduled to attack each base. Of the two bombers going to two of the deep bases, only one of those still not aborted at penetration time proceeds into the U.S. All other bombers fly singly in their approaches to the U.S. The raid is designed so that only three bombers penetrate radar cover early enough to give any part of SAC usable warning. Of these three, only one enters an ADIZ. The other two approach via the Gulf of Mexico, and never enter the cover of any one radar station. Two other bombers

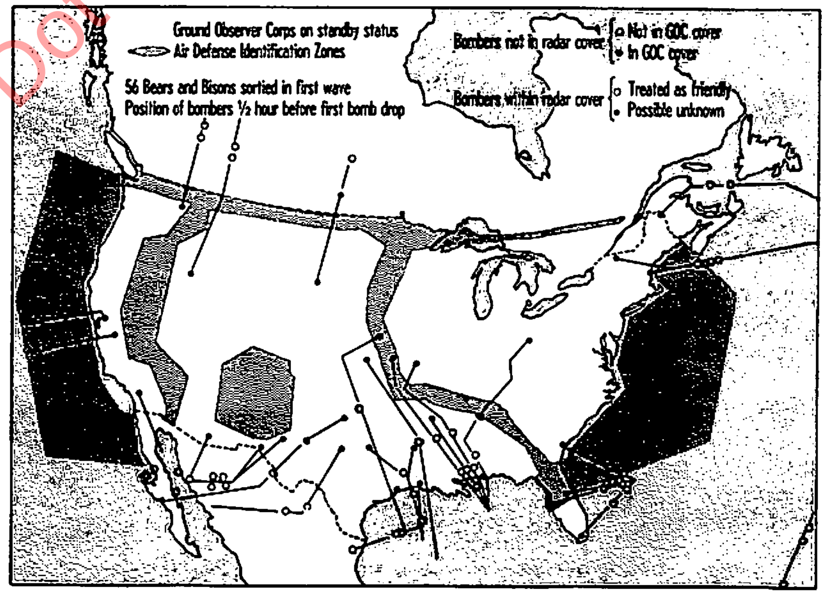

Fig. 15—1956 Soviet sneak raid against key U.S. targets, showing position of bombers ½ hour before first bomb drop (56 Bears and Bisons sortied in first wave)

enter ADIZ's, but not radar cover, early enough to give SAC forces usable warning; but darkness at altitude and ineffectiveness of current GOC identification capabilities ensure that these aircraft will not provide warning. All other early penetrations are in darkness and at such altitudes that casual detection by ground or airborne observers is extremely unlikely. Thus, only one unknown would be in the system early enough to provide warning, and it is extremely improbable that such an event would trigger an alert. Even so, it would be at least 1 hour before the first SAC bomber would take off, and the unknown could have been detected *at most* 50 minutes before the first bomb was scheduled to go off.

Casual detection could occur outside the United States. However, by choice of routes avoiding possible areas of detection (for example, those normally occupied by the New England fishing fleet), by keeping the force few in number, and by having all but four of them fly singly and very high in their approaches to the U.S., this probability is minimized.

The calculated result of such a sneak attack is damage or destruction to 86 per cent of our SAC bombers and to lesser portions of other vital elements—64 per cent of base fuel systems, 35 per cent of vital personnel, and 30 per cent of bomb assemblies. The only SAC aircraft surviving are on bases that were not attacked because of aborts and gross navigation or bombing errors.

These attacks were carefully designed but seem well within Soviet capabilities. Even if less intelligent tactics are used, they make out well. In the 1956 attacks shown so far we have credited the Soviets with tactics that exploit evident weaknesses in our warning and active defense system. What happens if a straightforward and considerably less thoughtful attack by 300 Soviet bombers is launched along the routes shown in Fig. 1 (page 13)? At the present time, of course, there are no seaward extensions of the DEW line. *Even when no attempt is made to exploit our warning weaknesses* (except what can be done easily by avoiding routes over Alaska, Iceland, and parts of Greenland), *we fare badly: Only 37 per cent of the force evacuates and, as has been shown before, hardly any of these aircraft evacuate in combat-ready condition.*

The attacks described here, and many others studied, clearly indicate the present vulnerability of our strike force. They do not, of course, imply

that a Russian attack is imminent. Nor do we think it is. That is a matter of Soviet intention rather than Soviet capability, and such intent would be affected in the first instance by Soviet knowledge of our vulnerability and in the second place by the comparative gains and risks of alternatives to central war. Nonetheless it is a painful fact that the risks to the Soviets of attempting a surprise attack on the United States are much lower than are generally estimated. We would like this course of Soviet action to be a worse alternative to almost any other they might contemplate—including, for example, the acceptance of defeat in some limited or peripheral war. But sober and careful scrutiny of the present vulnerability of our strike force to feasible Russian attacks, and realistic tests of the plans for its future defense, show the seriousness of the problem. What can be done to remedy it?

IV. WHAT CAN BE DONE?

PRINCIPLES OF DEFENDING SAC AGAINST AIRCRAFT ATTACKS

First of all, we must recognize that the defense of SAC is not only different from the defense of cities but (fortunately) much easier—

- Soft, fixed, urban targets require essentially leakproof active defenses.
- For a quick-responding SAC, warning has importance quite apart from active defense.
- The leakage of some enemy vehicles to target in a limited attack is not fatal if there is sufficient warning to get the aircraft and crews off base before a significant number of enemy bombs arrive and if the essential ground-support elements have been duplicated and hardened.
- In the event of a mass raid against our cities, even 90 per cent attrition is not enough. Much smaller levels of attrition can help a protected SAC to survive, recover, and strike back in force.

In this summary report of the study we must limit ourselves to only a brief description of the large number of specific remedies we recommend. These recommendations have been separately submitted to the cognizant Air Force offices and are, in some cases, already being implemented. Here, we will give the sense of these measures and sketch the results of some of our tests of their effectiveness. Appropriate limits on the amount of each type of defense will be indicated.

The proposed measures fall into four broad interdependent groups. We shall treat them in the order in which they have previously been listed: first, measures designed to increase enemy raid requirements; second, measures to increase the amount and reliability of warning; third, measures to speed up SAC's initial response and make it more certain; and fourth, measures to improve SAC's recovery and strike capability. We shall discuss defenses against manned-bomber attacks first, then against ICBM attacks, and finally against joint ICBM–manned-bomber attacks. The interdependence of these groups of recommended measures is extremely important and will be discussed subsequently.

INCREASING ENEMY RAID REQUIREMENTS

The primary purpose of these measures is to increase the probability of getting warning of an enemy attack by forcing him to increase the size of his raid.

The proposed increase in the number of SAC bases from 29 to 55 has been mentioned earlier and will be a useful measure, particularly if the extra bases are located well within our radar warning net, as we are recommending. It is important to recognize, however, that dispersal alone will not provide adequate defense for SAC. Even greater dispersal—to 330 bases as was proposed last year—is not enough. We cannot attempt to match the enemy's stockpile of bombs by building bases. It would be an expensive race that we would surely lose.

Many degrees and all of the forms of dispersal shown in Table 1, and others, have been studied. A moderate degree of dispersed operation turns out to be useful by increasing enemy raid size enough to aid raid recognition, but it does not do well as a principal method of defense.* (Dispersed operation, ranging from two wings per base down to one flight per base, has been tested for cost and effectiveness.) The dispersal of cheap, hard, fixed elements (for example, runways, fuel) is much less costly and is essential for recovery of evacuated aircraft.

We have mentioned the extreme vulnerability of bomb assemblies throughout the period studied, in spite of the expected dispersal. Although the number of points at which bombs will be found increases, the number of vital aiming points increases much less because most of the additional sites are at SAC bases—already targets of the highest

*See L. D. Attaway, M. R. Mickey, and W. P. Stillman, *The Availability and Use of Tactical Warning against Sneak Attacks on the U.S. Zone of the Interior, 1955–1960*, The RAND Corporation, Research Memorandum RM-1789 (to be published) (Secret).

Table 1

FORMS OF DISPERSAL

	System Elements				
Forms of Dispersal	Bombers	Heavy Maintenance	Flight-line Maintenance	POL and Standard Runways	Emergency Runways and Parking
Increased force size	X	X	X	X	X
Dispersed operation	—	X	X	X	X
Satellite dispersed operation	—	—	X	X	X
Dispersed recovery and staging bases	—	—	—	X	X
Dispersed recovery bases	—	—	—	—	X

X = system elements increased.
— = system elements remaining unchanged.

priority. The chief value of the on-base storage program is reduction in bomb-loading time, not dispersal. However, we can increase the enemy force required to knock out our bombs and bomb assemblies by a combination of more shelter and more dispersal. We therefore recommend:

- Greater dispersal of bomb assemblies to other Air Force bases, especially those of the Air Defense Command. The location of additional sites near complexes of alternate SAC bases, possibly by using existing ordnance depots, should be investigated.
- Redesign of the doors of existing storage igloos; and the design of new igloos to resist much higher overpressures than they will resist at present.

We are recommending aircraft shelters, and more will be said about them below. They are an essential element of defense against the ICBM. But shelter is *not* sufficient against manned-bomber attacks. Although shelters increase enemy aircraft raid requirements somewhat (40 per cent for a 10-MT-bomb 3000-ft-CEP combination, or more if the CEP's are larger—for example, if the bombers are supersonic or use air-to-surface missiles), they will not protect against attacks that combine the advantages of the large lethal radii of megaton bombs and the aiming accuracy of subsonic bombers.

The Air Force intends to provide SAC with additional active defenses by 1961 in the form of Talos detachments, one at each of about 36 bases. Local-defense missiles can be useful in protecting against small attacks if they have an all-altitude capability. But we must also recognize the limitation of active defense and plan accordingly—

- A small attack, designed to strike targets roughly simultaneously, would reveal itself to our warning system over a period of time. Such an attack would be difficult to recognize prior to bomb drop. The sneak raid described earlier is an example. It would be a real problem to decide whether to unleash lethal defense missiles against an aircraft that might be one of our own. Even more than SAC when faced with the problem of deciding to evacuate, an extremely lethal defense missile system must hesitate because its very lethality will seriously penalize a mistaken reaction.
- A mass enemy attack can saturate active defenses, especially if it uses countermeasures.

We do not mean to imply that active defenses are useless. Local defenses can use any spread in bomb arrival time to afford some protection against a sneak attack. And in an attack planned to penetrate radar cover simultaneously, enemy aircraft would arrive at targets over a period of time. The first bombs on peripheral bases would offer unambiguous warning to the rest of SAC, *if an effective bomb-impact alarm system were provided. Local defenses could then be put into a "guns free" condition.*

An enemy attack that keeps the raid size small (and thereby reduces the likelihood of early recognition) by assigning more than one bomb and target to each bomber, also involves a spread in bomb-release times because targets are attacked in succession. In this case, too, the bomb-impact alarm could set the local defenses "guns free" in time to fire.

Being able to fire is not enough, however. To protect SAC against even a small but sensible attack, our local-defense missiles must have all-altitude capability in the face of electronic countermeasures. Therefore we should

- Make sure that active defenses programmed by CONAD for SAC bases have at least a small all-altitude capability. Make sure that radars for these units are well elevated and that the system is capable of providing coarse range information in the face of jamming.
- Initiate a program to divert incoming friendly aircraft from SAC bases and provide a "guns free" condition for these defenses upon receipt of raid warning or bomb-impact alarm.

Active defense could also ease the problems of SAC recovery if it were able to exact a moderate level of attrition from massive follow-up attacks intended to deny us recovery bases. Even a modest active defense capability, together with a large number of alternate bases, would make it much harder for the enemy to be sure that there remained after the attack no significant set of bases from which retaliatory strikes could be launched.

How much would it cost to implement this program designed to increase enemy raid size? For a 6-year period, the total cost of the measures in this group is estimated to be about $1.75 billion.* Most of this expenditure would be for the aircraft shelters needed for defense against the ICBM (see page 76, below). While shelters are useful against manned-aircraft attacks, they would not be recommended if the ballistic missile were not a threat.

The function of this category of defense measures is not so much to disperse or to shelter, or to raise our active defense kill potential, as to bring enemy manned-bomber force requirements beyond Soviet force potentials. While, as we will show below, hardening *can* outstrip the Soviet capability for a "pure" ICBM attack, no such simple method is feasible against mixed forces of ICBM's and aircraft, or even against pure bomber forces. The function of the defense measures in this group is only to raise the size of an aircraft raid enough to bring its signal level above the threshold of an improved warning system.

*This 6-year cost was calculated for protecting the force as projected in May, 1955. The exact cost will vary with the size of the force to be protected. In particular, changes in the number of bombers will directly affect the costs of the shelter program.

INCREASING THE AMOUNT AND RELIABILITY OF WARNING

The earlier discussion of a strategic warning showed that it is not likely to be available and, in any case, cannot be relied on. What about other types of warning?

By 1961 we will have a series of detection barriers (see Fig. 2, page 14), including the DEW line, overwater AEW, ships at sea offering casual detection possibilities, offshore AEW, and the continental early warning open to the enemy. We have mentioned the defects of the outermost of these barriers, the overwater portions of the DEW line. This line cannot be relied on to provide us with a sufficiently low false-alarm rate to permit SAC evacuation or in fact to provide any warning at all of circuitous attacks. RAND has looked at feasible further extensions of the seaward DEW line, both intermittent and solid. Because of the great expense of buying and operating AEW aircraft, budgets of reasonable size—for example, of a size comparable to the amount that RAND is recommending be spent to provide reliable southern warning—extend this DEW line very little and extend enemy bomber missions still less. No such extensions provide even moderately intermittent detection capabilities for distances that outrun the range capability of the refueled Bear. Spending the entire sum proposed for the southern warning line on nearly continuous DEW extension south of Midway Island would add no more than 400 nautical miles to missions against the United States. And such measures would do nothing to reduce the spoofing problem or to meet the submarine threat.

While the seaward DEW line cannot be counted on to provide warning of a lethal sneak attack, it may impose some restrictions on the size and timing of the follow-up raid. Even the spoofing, if it is intermittent, may furnish some information that is usable in the improved raid-recognition system discussed below, and for the partial alerting of SAC.*

All of these barriers have a fairly high peacetime noise level (which the enemy can make higher), and all leave holes open to the enemy. The least-leaky barrier—the continental warning line—is too close to too many SAC bases to provide adequate warning.

*By the use of jamming, the Russians might be able to raise the peacetime noise level more or less continuously at moderate cost. On the other hand, U.S. counters may be possible that would make it prohibitively costly to maintain *continuous* noise levels high enough to mask sizable raids. This is under investigation now.

The measures recommended below are primarily concerned with changes in the continental warning perimeter, in the location of SAC relative to it, and in the way we use information provided by the system as a whole. The bomb-impact alarm system referred to earlier would be extremely useful, simple, cheap, and reliable.* RAND recommends that the Air Force—

- ***Provide a bomb-alarm system, using bomb-detector devices tied into the SAC communications systems.***

Each SAC base and other vital facilities should be equipped with fail-safe bomb-alarm devices and with sufficient communications to ensure that all other SAC bases, as well as CONAD, are notified immediately in case of a bomb drop anywhere in the system. Evacuation plans would then be put into effect, standby communication lines would be established between SAC and its dispersal airfields, and local defenses would be set free to fire. In addition to the detection devices tied into SAC communications facilities, a long-range detection system could be operated by CONAD to locate bomb drops on targets other than SAC bases. In the ICBM era such a system would be able to exploit any raggedness in the ICBM volley. In doing so, it might provide a small amount of warning that would be a large fraction of the warning time made available by radar sightings of the ballistic missile.

The objective of the bomb-alarm system is somewhat different from that of the bomb-detection schemes that have concerned other agencies of the government, such as the Federal Civil Defense Administration. These agencies are interested not only in the fact that the bomb has been detonated but in such other information as the exact location of the weapon, its yield, height of burst, wind conditions, etc. SAC and CONAD

*See F. R. Eldridge, *Communications between SAC and ADC in the 1960 Period*, The RAND Corporation, Research Memorandum RM-1774, October 1, 1956 (Secret— ; see also W. H. Culver, *Bomb Alarm System*, The RAND Corporation, Research Memorandum RM-1776, September 18, 1956 (Secret).

need only to know that a bomb has been detonated. But they must establish this swiftly and unequivocally and transmit the information with great speed. Other types of information might be used, but the purpose of the system is essentially to establish the alarm unequivocally. The SAC alarm system will, of course, be of use to FCDA and others.

The telephone system already possesses a rudimentary built-in "bomb alarm" device. Long line circuits are operated by modulating high-frequency carriers to reduce the size and expense of equipment. This is true of both microwave systems and coaxial cables. Ordinarily the carrier is transmitted continuously. When a circuit break occurs, the carrier is lost, and an alarm is rung at the principal toll-center offices connected to the line. The loss of any principal toll center in a network will ring alarms at all principal toll centers to which it is connected.

This feature of the present system is obviously not sufficient for an infallible bomb alarm but may possibly serve as a starting point for this type of network. In order to rule out natural disasters such as wind, fire, earthquakes, etc., other types of detectors should be added to the system. For instance, a photoelectric device might be used. Other detectors that could be employed are simple neutron or gamma-ray counters, or pressure gauges. Clusters of these bomb detectors might be located at and around vulnerable areas and could be connected at toll centers to the terminal lines. If six detectors were used for the surveillance of each SAC base, the total number of detectors in the network would be 336. The initial cost of this type of bomb-alarm system would be about $3 million for research, development, and installation, with an annual cost of about $300,000 for maintenance.

With the use of enough detectors, this type of bomb-alarm system could be made to give almost unequivocal evidence of a bomb blast. A more ambiguous type of bomb alarm could be provided by a so-called "inverse LORAN" system. This would provide more extensive coverage and would be useful in detecting bomb blasts in target areas other than those near SAC bases. An inverse LORAN system might be operated by CONAD. Such a system would require about 10 stations capable of sensing seismic signals, air-pressure transients, and low-frequency electromagnetic radiations given off by nuclear explosions. One of these stations might be

located within 100 miles or so of each CONAD combat center. In addition, two others might be installed in the west and southwest areas of the United States, near Air Defense Direction Centers. The Direction Centers at Stead AFB, Nevada, and Williams AFB, Arizona, might be selected. It is estimated that the total cost of the system, including installation, would be about $18 million. The system would employ CONAD communications and computer facilities.

The other measures summarized below would increase the reliability of *earlier* warning, that is, before bomb impact.

- *Tighten the continental warning line against low-altitude penetrations.*

The current concept for low-altitude radar cover calls for the establishment of this coverage down to at least 500 ft all around the country. It appears, however, that the minimum altitude at which aircraft can fly on bombing missions varies widely at various parts of the U.S. boundary. The flat country in Louisiana or Georgia, for example, presents different (and much less difficult) problems for low-altitude navigation from those offered by the mountainous approaches to Davis-Monthan AFB in Arizona. The 500-ft altitude specified, while adequate as a "floor" in some regions, appears inadequate in others.

This has been confirmed by detailed map exercises that examined several points along the U.S. perimeter.* Segments of the early warning line were studied, first, to determine the extent of radar coverage obtained below the 500-ft minimum aimed at in the current program, and second, to determine (on the basis of an analysis of navigation errors, available check points, etc.) the approximate heights of feasible low-altitude bombing missions penetrating in these regions. We have concluded from these exercises that the 500-ft concept should be replaced by a new scale of low-altitude detection "floors" that vary around the perimeter. These "floors" should be estimated for each segment on the basis of actual flight tests designed to determine how low a penetrating bomber might

*See W. P. Stillman, *Protecting U.S. Strategic Retaliatory Power: Assumed Plans for U.S. Air Defenses*, The RAND Corporation, Research Memorandum RM-1738, June 26, 1956 (Secret).

fly at different points in the perimeter. Sufficient radars should be added to the program to ensure detection at least down to this variable "floor." It is estimated, on the basis of preliminary work (but without benefit of these flight tests), that approximately 25 to 30 additional gap-filler-type radars (FPS-14, FPS-18, or CPN-18) will be required. These gap fillers should be installed as soon as possible. We estimate the cost of these gap-filler radars at from $30 million to $38 million over a 6-year period.

- *Increase our ability to count and tag aircraft.*

The perimeter radar coverage outlined above will have fairly poor resolution characteristics. Furthermore, peacetime traffic at the lower altitudes will be much greater than that now viewed by radars at the higher altitudes. It should also be possible for some types of enemy bombers to simulate the flight speeds of much smaller craft, so that identification by means of radar data alone might prove very difficult. A complete ring of Ground Observer Corps posts, manned around the clock 7 days a week and equipped with acoustical aids, could improve raid recognition by flight-plan matching, by identifying jets and high-altitude aircraft, and, ultimately, by tagging intruders by number, engine type, and even aircraft type. The GOC function should be changed from that of providing vectoring data, which it now does badly, to the simpler and more important task of raid recognition.* If the GOC cannot do the job, additional gap-filler radars (about 200) and the relocation of some interceptor squadrons may also be needed to increase the probability that fighters will be able to intercept and inspect incoming unknowns.

These measures should be taken:

Test the low-altitude perimeter radar requirements by actual flight at intervals along the U.S. boundary. On the basis of these tests, establish new and varied minimal coverages and add the gap-filler radars indicated.

Test acoustic aids for ground observers to determine if ability to tag aircraft as to type—and perhaps number—of engines can be attained by GOC. If these devices are effective, equip the GOC with proper aids and test a band of the GOC to determine the required depth and spacing of posts for "tagging" aircraft around the continental U.S. perimeter. Provide incentives to secure 24-hour manning of posts and establish additional GOC posts as needed.

If GOC "tagging" is not satisfactory, obtain an intercept "tagging" capability by filling in a band of low-altitude radars around the perimeter of the continental United States and by moving some interceptors to perimeter areas. Test methods for intercept tagging at night and in bad weather. Install equipment on perimeter interceptors as needed. If the GOC can do this job, the cost of this measure will be trivial. If, however, the additional gap fillers are necessary, the cost will come to $200 million on a 6-year basis.

- *Extend the radar perimeter southward to provide coverage against an end-run and add sonars to detect submarines entering the Gulf of Mexico.*

Several extensions of the continental radar warning system have been investigated.* Two of these lines are shown in Fig. 16. The most promising Mexican line would consist of a line of radars along the west coast of Lower California, thence down the coast of Mexico, across Mexico, and along the northern coast of Yucatan to Cuba and Florida. To prevent submarines from entering and loitering in the Gulf unescorted, barriers should be placed in the Straits of Florida (4 bottom-mounted active sonars), the Old Bahama Channel (a Continuous Wave doppler system), and the Cuba-Jamaica-Nicaragua line (two 1-kc active sonars inshore, 5 bottom-mounted sonars, 4 CW doppler barriers, 1 magnetic loop, 6 "Texas Tower" evaluation stations). If diplomatic negotiations with Mexico should be unsuccessful, other radar lines are under study at RAND that avoid Mexico and, for example, run through Guatemala.

*A RAND research memorandum on the subject of the GOC by M. H. Davis will be forthcoming.

*See L. L. Giller, *A Study of the Continental Early Warning Perimeter*, The RAND Corporation, Research Memorandum RM-1788, September 1, 1956

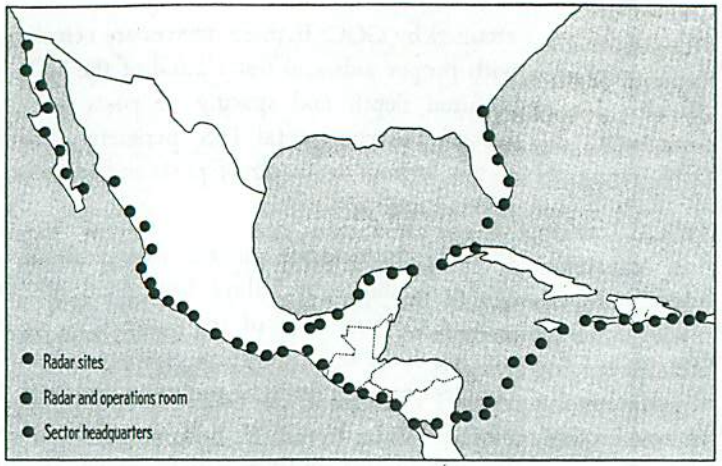

Fig. 16—Proposed southern early warning lines

These alternatives, while more expensive than the Mexican line, are superior in cost and performance to long mid-Pacific extensions of the DEW line. Without increased coverage to the south, SAC bases in the south and southwest would have inadequate warning to permit evacuation. The alternative to a southward extension of the continental radar is relocation of SAC bases in the southwest. However, over a period of years the cost of providing additional warning time by moving bases from the southwest would be greater than the cost of the radar extension. The radar extensions, of course, would have other values not offered by SAC relocation; for example, warning would be provided to southern cities that otherwise would have little or none.

• *Disperse and relocate SAC units farther inside the warning ring.*

A large part of SAC is vulnerable to attack by manned bombers because of inadequate warning. Even if the recommended improvements and extensions of the warning system were carried out, and if the Air Force dispersal program were implemented, the warning situation might be expected to develop as shown in Table 2. The terms "adequate," "marginal," and "inadequate" warning as used in Table 2 here refer to zones

Table 2

WARNING FOR SAC BASES

(Number of Bases)

Warning	1957	1958	1959	1960	1961	1962
Adequate	7	7	7	8	23	28
Marginal	8	10	10	13	13	13
Inadequate	15	16	17	19	11	14
TOTAL	30	33	34	40	47	55

that are respectively more than 450 nautical miles from the line, between 300 and 450 nautical miles from the line, and less than 300 nautical miles from the line. The warning measurements are based on the assumptions that AEW can function to provide reliable low-altitude coverage and that the submarine-launched threats can be disregarded. A base-relocation program to alleviate these inadequacies of our warning line, but using these optimistic assumptions, must be regarded as a minimal program. Such a program, costing about $550 million over 6 years, is as follows:

Accelerate the 55-base dispersal program by increasing the funding in early years.

Relocate units now on, and scheduled to remain on 7 of the bases with inadequate warning.

Reprogram units scheduled to move to 8 new bases with inadequate or marginal warning.

Provide extra emergency runways to speed takeoff at bases wherever necessary.

Choose new base sites within the relocation area to facilitate strike routing.

The results of this program are shown in Table 3. Even this situation is not completely satisfactory. A substantial number of bases remain in the "marginal" category. Moreover, 7 of these bases would have to be classified as having inadequate warning if the optimistic assumptions on

Table 3

WARNING FOR SAC BASES WITH MINIMAL RELOCATION PROGRAM

(Number of Bases)

Warning	1957	1958	1959	1960	1961	1962
Adequate	7	7	8	15	36	43
Marginal	8	10	10	13	12	12
Inadequate	15	16	16	17	2	0
TOTAL	30	33	34	45	50	55

AEW or submarine-launched threats were abandoned. To provide a greater measure of safety, therefore, an additional program costing $250 million should be undertaken. It should include measures to—

Relocate units currently on, and scheduled to remain on, 4 bases that depend on AEW detection for even marginal warning.

Reprogram units scheduled to move to 3 new bases that depend on AEW detection for even marginal warning.

Figure 17 shows how the warning situation for SAC is improved by the relocation of new bases and the addition of the southern radar extension. The average time from first crossing of the radar boundary to bombs on SAC bases increases from 45 minutes with the system as planned to 2½ hours with the recommended changes. The 6-year cost of the minimal program suggested is estimated at something over $500 million.

This recommended move of home bases away from the Atlantic and Pacific coasts might suggest a disadvantage in the form of "crowding" at the center of the country, perhaps adversely affecting the active defense of SAC bases and also their physical vulnerability to a given number of dropped bombs. Both "crowding" and its "adverse effects," however, are more apparent than real:

First, the coastal areas subtracted represent only 30 per cent of the area of the United States; this leaves a very large area for location of SAC.

Second, the active defense of SAC bases, which will be largely local,

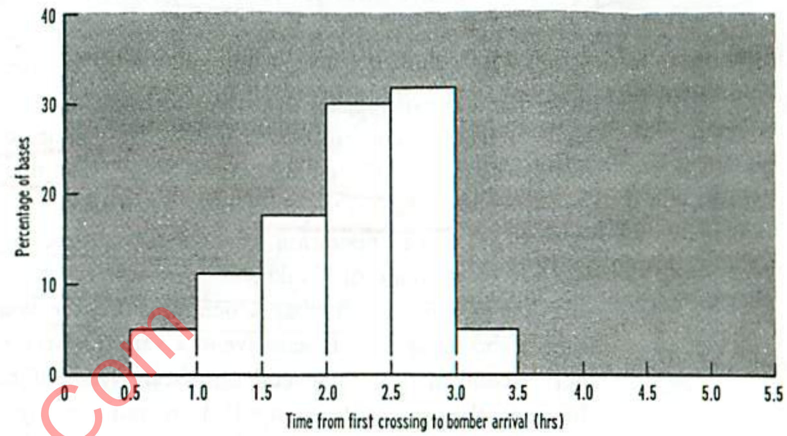

Fig. 17—Estimated penetration time to SAC bases after crossing continental early warning line—improved warning system

would hardly be affected by concentration of the points defended. (Sufficient concentration would mean overlap in the areas covered by missile defenses, enabling more than one missile site to fire on a bomber going to a given base.)

Third, the relocation area is far too large for bases to be subject to overlaps in the lethal radii of bombs. Nor is fallout any worse in this case. To prevent evacuation of the home bases immediately after bomb drop, fallout radiation must reach high levels, and these are found only fairly close to the ground zeros of the bombs. On the other hand, the long-range deposition of radioactive material endangering recovery and staging after evacuation is not affected by the recommended location of *home* bases. Although bases for recovery and staging away from the periphery are preferred because of the threat of follow-up enemy attacks, airfields any place in the country may be chosen.

While the move away from the coasts is primarily motivated by the need to obtain warning against manned-bomber attacks and attacks by submarine-launched missiles or sub-launched aircraft, it should also be observed that it does offer moderate advantages in obtaining reliable radar warning of ICBM's.

- *Improve the rules for raid recognition and response.*

Response to tactical warning is made difficult by quite innocent-looking configurations of traffic that may turn out to be enemy bombers. On the other hand, what appears suspicious to the warning system may turn out to be friendly. Therefore we need a systematic, objective method of evaluating quickly the ambiguous evidence presented by our sensing system and of linking this to SAC's initial responses.

CONAD has in operation a numerical raid-recognition procedure that consists of a count of "unknown" aircraft currently under surveillance and shown on the Combat Operations Center board. This system is simple and cheap, and is sensitive to a variety of raids. However, it would not respond in time to several significant types of raids. It exploits very little of the information supplied by our sensing system, but its use is nonetheless severely limited by a rather high frequency of false alarms.

Our present sensing system tells us not only that there are unknowns showing on the COC board but also when and where each unknown first appeared, its estimated speed and altitude, the length of the track, whether or not it faded from the system (in which case it is simply lost under present counting procedures), and, if it was subsequently identified as unfriendly, the manner in which this occurred. The improvements in "tagging" described earlier for the GOC and interceptors should also supply increased information on aircraft types.

Our investigation indicates that it is possible to reduce the false-alarm rate and to increase the likelihood of detecting a sneak raid.* This can be achieved by using more of the detection information available and statistical techniques (likelihood ratio sequential tests) that have already proved themselves in application to control of quality in manufactured products. (The improvements suggested in the use of data, however, must go hand in hand with the recommended increase in the quality of the early-detection and classification data.) In addition, a series of threshold

*See L. D. Attaway, M. R. Mickey, and W. P. Stillman, *The Availability and Use of Tactical Warning against Sneak Attacks on the U.S. Zone of the Interior, 1956–1960*, The RAND Corporation, Research Memorandum RM-1789 (to be published) (Secret).

limits must be introduced to permit more graduated responses. Measures should be taken to—

Institute an improved raid-recognition system, for surveillance of penetrating flights, and to link it to a routine system of graded SAC responses.

Increase the timeliness of the warning available to SAC and the SAC aircraft-position data available to CONAD by providing a closer tie-in between SAC and CONAD at SAC Air Division and Air Defense Direction Center level.

The total 6-year cost of the measures recommended to improve the amount and reliability of warning is estimated to be about $850 million. We are not recommending expensive extensions to the overwater portion of the DEW line or the addition of tracking radars to increase active-defense kill potentials. Our goal is to increase the completeness and quality of early detections, and to improve their systematic use for speeding SAC's response.

SPEEDING SAC'S RESPONSE

At the present time, SAC's initial response to warning is tied to CONAD declarations of Air Defense Warning Red, Air Defense Warning Yellow, and Air Defense Emergency, all of which were devised for a purpose unrelated to SAC's mission. According to official evacuation plans (SAC Regulation 10-55), the Commander-in-Chief, SAC, will decide whether to *prepare* for SAC evacuation *after* one of these alerts has been declared by the Commander, CONAD. Thus SAC is connected only loosely with raid recognition and begins to react at much too late a stage in the process.

These alerts are so costly for the civilian economy that they cannot be declared frequently, which means that they can be declared only on quite unambiguous evidence. Given the current deficiencies in our warning system, it is unlikely that a sensibly planned enemy attack will yield unambiguous evidence before bomb release. Therefore SAC's response is unlikely to be triggered in time.

Fail Safe

If its reactions are to be fast, SAC must follow the signals of a raid more closely and respond at early stages in the development of threatening aircraft patterns. Because the cost of SAC's initial response to warning is substantially less than the cost of its reactions to a Red or Yellow Alert, SAC can afford to respond more frequently than the civilian economy. These decisions must be made separately and on the basis of evidence with different degrees of equivocality.

"Initial response," as the term is used in this study, does not include launching a retaliatory strike without the possibility of recall, nor does it include firing ICBM's. These actions are *final*. They are not likely to be taken on the basis of ambiguous evidence such as that provided by an ICBM warning system. Their cost is the cost of World War III.

Initial decisions are of a preparatory nature. They include: deciding to prepare for evacuation, in skeleton condition or in strike condition; readying of missiles; takeoff, from peripheral bases or from all bases; and evacuation in strike condition with a fail-safe return procedure. By a fail-safe procedure we mean one in which the bombers will return to base after reaching a predesignated point en route—unless they receive an order to continue. (Without a fail-safe procedure, this initial decision comes close to being a final decision; without recall, it *is* the final decision.) If SAC response is to be speeded, SAC must make these preparatory decisions early and on the basis of ambiguous warning.

Unfortunately, responding to ambiguous evidence means responding to false alarms. *However, if SAC does not respond to false alarms, there is no guarantee that it will respond in time to an actual enemy attack*. This means that SAC must respond to some false alarms with decisions for preliminary actions, but not with a final decision to strike or launch ICBM's. In addition to practicing crew assembly, and readying aircraft, the decision process must be exercised.

The following recommendations are designed to increase the speed and certainty of SAC's response:

- *Provide an alert procedure*, matched to warning time of manned-bomber attack, for all flyable aircraft.
- *Provide for aircrew availability* within the allowable time from receipt of warning—

Build on-base housing to ease alert problems, with aircrews receiving highest priority for such housing.

Study nonduty-hour availability for quick assembly of personnel living on base.

- *Increase readiness of SAC aircraft*—

Maintain in combat-ready status as large a part of the force as possible consistent with training requirements and the flyability of nonalert aircraft.

For aircraft other than those on combat alert, determine what kinds of maintenance can be performed within the warning time available and what can be done in alert shelters.

Schedule maintenance to minimize the number of aircraft in a state of maintenance disabling them from flying within the warning time available. Also, minimize the number being worked on outside the alert shelters.

Implement SAC's incentive plan for increasing re-enlistment, or a modification of this plan designed to achieve the same ends.

- *Provide for additional pilots* capable of evacuating SAC aircraft—

Determine the extent of transition and proficiency flight training required to enable rated noncrew officers in combat units to evacuate tactical aircraft.

Provide such training (*a*) if the costs are substantially less than those of maintaining an equal number of fully proficient combat crew pilots; or (*b*) if, owing to an interim lack of base housing or sufficient combat-crew pilots, the alert program is lagging.

Provide on-base housing for all evacuation-proficient pilots, with priority second only to combat-crew personnel.

- *Provide for 24-hour availability of ground crews and operations personnel*, capable of starting aircraft and directing traffic on duty, either by—

Increasing the number of such personnel, or

Building base housing for such personnel, but with lower priority than for aircrews.

• *Establish a system of graduated responses* to ambiguous evidence of attack, which lowers the rate of false alarms as the cost of the response increases, and consequently speeds reaction as compared with an all-or-nothing response system.

To reduce the substantial time needed for bomb loading, bombs should be stored nearer parked aircraft, probably inside aircraft shelters. Alert bombers should have bombs on board. Additional bomb-storage sites near complexes of alternate fields would ease this initial response problem.

With the warning measures described earlier and such an improved response procedure, SAC's vital elements would survive a wide variety of bomber attacks, including some more sophisticated than any shown here.

The cost of improving SAC's initial response capability is estimated to total about $350 million over a 6-year period.

IMPROVING SAC'S RECOVERY AND STRIKE CAPABILITY

An improvement in recovery capability is essential because most evacuated aircraft will not be combat ready, will not have full crews, a full fuel load, access to undamaged bombs, and appropriate strike plans. Without this capability only a small fraction of our striking force can be used. Moreover, for the fraction of aircraft that evacuates combat ready, even when a final decision to strike has been made, it *may* be desirable to wait until a larger, coordinated raid can be mounted, or for a more favorable penetration time. A recovery capability leaves the Commander of SAC free to send the ready aircraft off at once or to stage them through recovery fields, depending on circumstances.

Two groups of measures are recommended to ensure SAC's recovery and strike capability. The first of these includes the following:

• *Prepare to use emergency alternate airfields, civil or military, in the ZI or overseas:*

Give SAC highest priority for emergency use of all airfields, military and civilian.

Determine the capacity of existing fixed facilities.

Increase the number of usable strike bases in the United States by extending airfield pavements built to emergency standards.

Supplement the existing fuel available to strike-staging bases and prestock necessary materiel at strike-staging bases where it is needed. Provide air transport for other materiel and equipment.

Construct fallout shelters on bases to be used in recovery and strike-staging.

• *Prepare for rapid flyaway from home bases:*

Provide a simultaneous engine-starting capability for our bombers and tankers. This capability should be planned for in the design of the recommended protected alert shelters.

Modify B-52 and KC-135 tail-folding mechanisms to permit non-manual unfolding of the tail within 2 to 3 minutes.

Investigate other possible causes of delay from the time of shelter opening to takeoff.

• *Prepare for recovery and striking:*

Investigate the possibility of providing the B-47 with a modern engine to increase its ability to use short runways on alternate bases with no reduction in range, or, alternatively, to increase its range and lessen its dependence on vulnerable en route and overseas bases for prestrike staging and to permit greater flexibility in choice of routes to target.*

Provide B-52 and KC-135 aircraft with assisted-takeoff devices to increase their ability to use alternate bases with short runways.

A number of engines will be available over the next few years that will increase the range of the B-47 by about 35 per cent. Among these

*See R. J. Lutz, E. P. Oliver, and L. R. Woodworth, *Suggested Engine Replacement for the B-47*, The RAND Corporation, Research Memorandum RM-1679, April 1, 1956 FOUO are the Westinghouse J-54 engine and the Pratt and Whitney J-52 engine. On a maximum-gross-weight mission, a B-47 with the J-54 engine, supported by a KC-97, could reach 93 per cent of a typical Soviet target system with *no stop en route*. Compared with 18 per cent that can be reached by the B-47E with the J-47 engine, 30 per cent of the targets could be reached with no refueling. Alternatively, takeoff with a ground run as short as 4500 ft would be possible with no decrease in present combat radius. B-47's are planned to be in the force in large numbers for a decade; and with a modern engine that could be installed by 1960, they can be made more effective in the face of the growing Soviet offensive capabilities and our own tanker limitations. If necessary, for those B-47's scheduled to remain in the force for several years, it would be possible to stop operating their KC-97's and use only part of the savings from discontinuing the tanker operation to buy new engines for the B-47. This would *increase* SAC's range capability. And SAC's strike operations would be greatly simplified. The total 5-year cost of operating a KC-97 is about $1.5 million, and this tanker extends the B-47E radius to 2650 nautical miles. The estimated cost of providing a B-47 with a new engine (J-54) giving over 2800-nautical-mile radii is only two-thirds as much, $1 million (including spares). This does *not* mean that we are recommending that the KC-97's be given up, since the 3500-nautical-mile combat radius provided by a B-47 with one of the new engines and refueled by a KC-97 is very useful.

The possibility of providing the B-47 with a new engine has been considered in the past and has been rejected largely because earlier proposals involved extensive depot modifications that would have removed B-47's from operation for extended periods. However, it appears that at least one of the engines suggested could be installed at base level. The Air Force should support this engine-modernization program (1) by releasing one or more B-47's on bailment to the engine manufacturers for demonstration by actual installation of the field change and (2) by accelerating the engine development and test program. The cost in the first year of a program for accelerating engine development and installation tests would come to $15 million. The total cost of equipping 11 wings of B-47's would come to about $550 million.

If only a small number of bases were available to SAC for staging a strike, their use might be denied us by an enemy attack that cratered runways. But cratering a runway is a very difficult task. It can be accomplished only on a small number of fields, and even then it requires a large force. In the critical period immediately following a large-scale enemy attack, fallout is a greater threat than cratering, if SAC can use only a small preselected set of bases.

Figure 18, however, shows that there are many bases having sufficiently long runways to serve as full-strike bases. The terms, "full strike," "limited strike," and "recovery only," refer, respectively, to bases with sufficiently long runways to permit takeoff, under emergency conditions, with full fuel load, more-than-half fuel load, or less-than-half fuel load. (The number of airfields in each category is based on aircraft ground-roll requirements and excludes the effect of our recommended aircraft changes: a new B-47 engine, and assisted takeoff for the B-52 and KC-135.) Recovery-only bases afford a place to wait for radiation on other fields to decay. In this estimate, we have allowed for temperature and elevation.

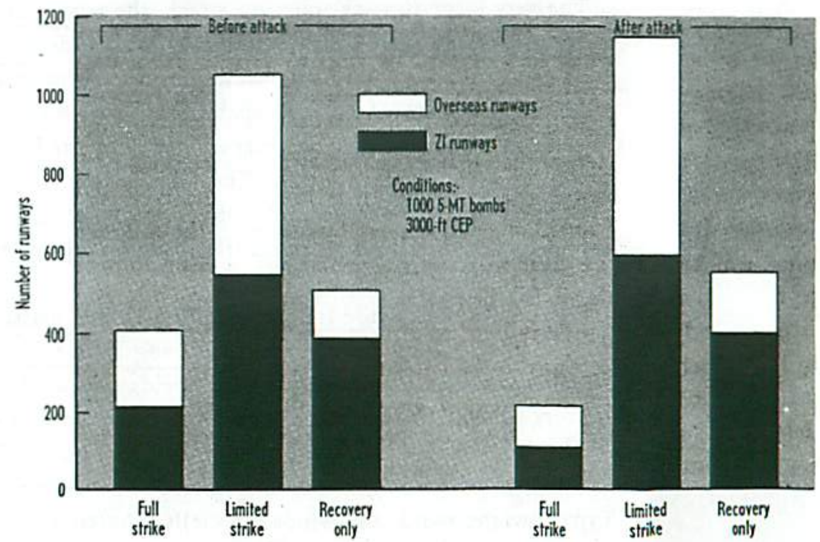

Fig. 18—Effect of cratering attack on number of usable runways worldwide

The effective runway lengths were normalized to National Advisory Committee for Aeronautics standard sea-level day conditions, assuming that the actual temperatures were typical of June.

Existing stocks of jet fuel have also been looked at. Table 4 shows how many full-strike airfields, including the 55 SAC bases, now have jet-fuel storage capacity of the given amounts within 5 miles of the airfields.

Table 4

Jet-fuel Storage Capacity (B-52 sorties)	Number of Airfields
Over 50	83
15 to 50	21
1 to 15	63
TOTAL	167

If there were no usable existing fuel storage at all, the cost of providing a sufficient amount for one strike, distributed among staging recovery bases, would be approximately $80 million.

The very large runway-cratering attack, the results of which are shown in the right-hand set of bars of Fig. 18, fails to deny us more than half the bases available for full-strike staging use. This attack represented a pessimistic estimate of enemy capabilities, from the U.S. point of view. The enemy force is larger than that estimated by the Directorate of Intelligence for a single-wave attack. The CEP is low for the type of target considered, and the attrition estimates are favorable to the attacker. Figure 18 makes it quite clear that airfield denial by cratering runways can be made an infeasible job for the enemy.

Local and countrywide fallout, resulting from a massive attack, is likely to be a much greater threat to SAC recovery than runway craterings. Figure 19 shows the contamination of airfields estimated to result from the delivery of 200 10-MT bombs. This particular pattern of contamination results from winds that might occur in June, but in the course of the study other meteorological conditions and target systems have been tested. Typical winter winds and winds especially selected to hinder recovery were tested. The results were not significantly worse than those shown.

From Fig. 19 it can be seen that a substantial number of full-strike fields are left with low-radiation levels 6 hours after the attack. Moreover, these results are pessimistic, assuming an infinite-plane dose and no shelter. Decay is rapid, and 24 hours after the attack the dose rates would have fallen to roughly one-fifth the values shown. However, Fig. 19 does indicate the need for choosing, *on the basis of postattack information*, which recovery airfields to land on. It shows that if recovery fields are chosen before the attack, or without knowledge of how the attack affected them, the likelihood of landing at a seriously contaminated base will be great, and many of the surviving aircrews will become casualties. It is important to be able to choose, on the basis of postattack information, not only appropriate bases for routing bombers on the way to target but also appropriate targets to attack. In order to make a sensible

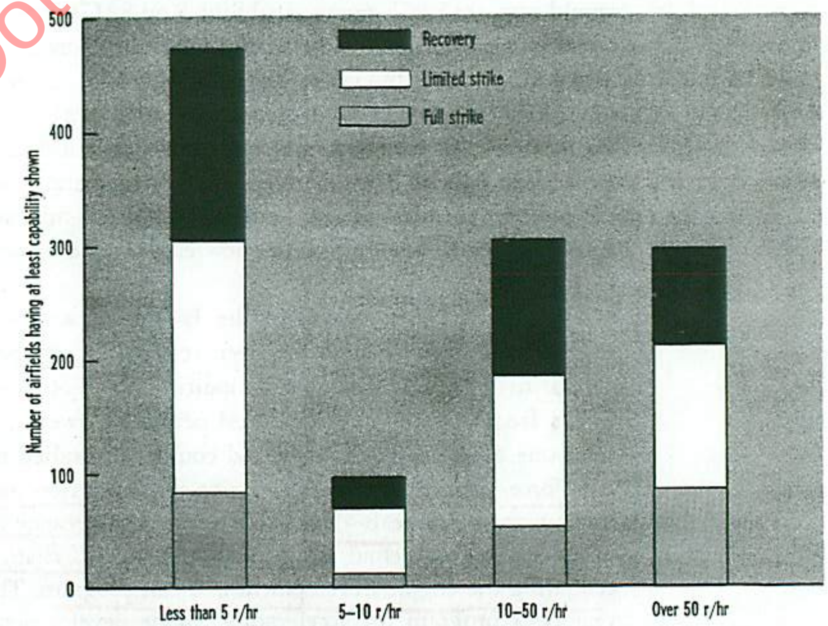

Fig. 19—Contamination of U.S. airfields 6 hours after an enemy attack on SAC, ADC, and cities, with 200 10-MT bombs

decision we need, for choice among preferred strike plans, gross data on what is left of the enemy force to attack, what is left of SAC to attack with, and what is left of U.S. cities to defend. Otherwise, after a massive attack in which the enemy uses most of his force, we can spend what remains of our SAC in attacking facilities he no longer needs in defense of U.S. cities that no longer exist and leave him essentially unscathed.

These information requirements suggest the need for the other group of recovery measures—

- *Establish communications connections within the complex of recovery airfields and command posts:*

Provide SAC bases and dispersal sites with a remote radiation-monitoring system for measuring fallout.

Our studies indicate that even small attacks on key cities would disrupt SAC telephone communications within the United States and from the United States to overseas bases. Coordination between SAC and CONAD would be impaired and SAC's ability to recover and counterstrike would be seriously delayed. Moreover, SAC's high-frequency radio backup network is vulnerable to attack, to jamming, and to enemy passive surveillance. In any case, a large part of it would very probably be blacked out, during the critical period right after attack, by the H-bomb effect on the ionosphere.* This leads to the following recommendations—

Develop and procure mobile ground headquarters and control centers that can be relocated at intervals before an attack and, if necessary, moved during the recovery phase. These units should carry both ground-to-air ultra- and very-high-frequency radio facilities, as well as medium- and high-frequency transmitters and receivers.

Provide, at each SAC base for protection against the ICBM, sheltered control rooms and protected terminal lines, both designed to withstand at least 200-psi overpressures.

*See A. K. Harris, *Effects of Nuclear Detonations on Ionosphere*, AFSWF ITR-929, May, 1954 (Secret).

Provide a number of mobile microwave relay vans and long-range communications vans stationed at dispersed locations, away from target areas, for purposes of backup and restoration of service in damaged areas.

Intensify research and development on the following items: (1) mobile relay vans using forward scatter and meteor-burst communications; (2) airborne relay communication centers for SAC; (3) a USAF forward scatter grid network serving the continental United States.

Figure 20 illustrates, schematically, a possible SAC communications net. The essential elements of such a system are the many command posts on SAC bases, hardened against attack, and mobile backup communications for emergency use to supplement the peacetime net. With mobile ground radio backup links, the communications system can be extended quite cheaply, including the cost of exercising it in peacetime. We have included the cost of full-time circuits. But even these costs are small on the scale of SAC expenditures.

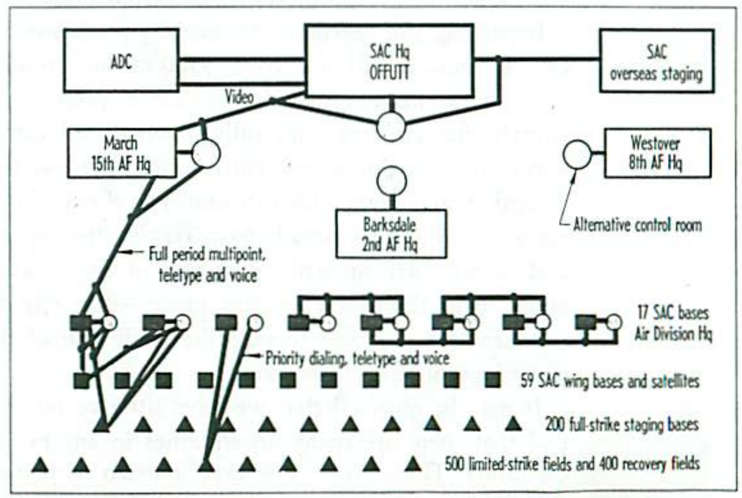

Fig. 20—Proposed communications network for SAC recovery (typical circuits)

So far we have discussed the use of alternate bases for recovery. What are the possibilities of using SAC wing bases for recovery after these bases have been attacked? There are some clear advantages to their use: They have long runways, jet fuel, communications, and essential and costly ground equipment. Moreover, many base elements will have to be sheltered against ICBM attack. If we provide some additional protection, the probability of our being able to use SAC bases for recovery after manned-bomber attack can be substantially increased for a considerable range of bomb sizes and aiming accuracies. The use of SAC wing bases for recovery, while it cannot be counted on with high confidence, would be a useful supplement to the alternate-base system.

Peacetime exercises are absolutely essential for all parts of the recovery plan. Without realistic exercise of the system, we can have no assurance that the complex task of mounting a strike can be carried through. This is one of the positive virtues of the response scheme discussed above: The randomly occurring false alarms that would result from the operation of such a system would provide realistic exercise for all phases of SAC's response, including recovery. If SAC could not recover from an exercise, it is unlikely that it could ever recover from a raid!

Improving and speeding the recovery process is comparatively inexpensive. In total, it will cost about $500 million over a 6-year period. A recovery capability is essential if we are to preserve the strike potential of aircraft that are less than fully manned and completely ready for the strike mission—the largest part of the force—at the time they are most needed. And it gives added flexibility to the SAC Commander-in-Chief in his use of the combat-ready part. Having the capacity to recover aircraft and launch them on strike does not, of course, compel all of an initial attack to go through a recovery phase—it merely makes it possible. The commander can choose to send the ready part of the force at once or as part of a coordinated later wave.

It may be objected that we have little or no recovery capability now and that there are many uncertainties in any program to obtain such a capability. This is true. The exact portion of planes not fully ready and manned when the enemy attacks but that can be recovered after attack will depend on many events, only some of which can be planned for. But

it is also true that we have no alert force ready for combat now, and the exact portion we can hope to have ready and on its way in the short warning times to be counted on is also extremely uncertain. But we do know that the combat-ready part of the force that will take off will be only a small part of the total, and a minority that will be subject to chance variation. A recovery capability is needed because:

> First, it provides the *only* chance to use the large part of the force that will be less than fully ready at the time of attack;
>
> Second, it offers a second chance to use any alert bombers that did not in fact get off combat ready; and
>
> Third, it gives SAC added flexibility in the use of its ready force.

A recovery capability represents a net addition to an improved alert capability, an addition particularly to be valued in the light of a frank appraisal of the uncertainties of the alert.

DEFENSE AGAINST ICBM ATTACK

How will the advent of a Soviet ICBM affect the vulnerability of SAC? It hardly worsens SAC's current position, but the ICBM will change things. A program designed to decrease our vulnerability to aircraft attack could very well be inadequate against the ICBM. This would be true, for example, of a program that omitted aircraft shelters. While shelters are useful against manned-bomber attack, they are essential against ICBM attack.

Studies made at RAND and elsewhere indicate that decoys and countermeasures make a leakproof defense against the ICBM even less attainable than against the manned bomber. This does not mean that active defenses have no importance, and there are some useful interactions between active and passive defenses, but the most important component of an anti-ICBM defense for SAC is shelter.

Provide Warning

The Air Force is considering distant early warning against the ICBM. "Distant" in this case is intended to mean some 15 minutes of warning of incoming ICBM's. A number of critical actions are being taken on the assumption that this amount of warning can be relied on. For example, the proposed SAC Combat Alert has been referred to as a "15-minute alert." Concepts of operation of our own ICBM and of the Navaho are being formulated with a 15-minute-readiness requirement.

But can we count on getting 15 minutes of warning of an ICBM attack? Such warning might come from (1) surveillance of ICBM launching sites; (2) a distant network of special radars intended to detect ICBM's in flight; (3) a distant airborne infrared detection system; (4) differences in the time-of-firing of an ICBM volley.

The first of these has the limitations of strategic warning discussed earlier plus the problem of extremely short transmission time.

The second source of warning is subject to important limitations that make it clear *that it cannot be relied on to provide 15 minutes of warning*—

> Little is known about how the very small meteors will look to the large ICBM-detection radars, but some of their trails will resemble some ICBM trajectories. A minimal-altitude ICBM trajectory might pass confusingly close to the region of meteor trails. Meteor-trail echoes in the side lobes of the radar pattern would be particularly harassing.
>
> It is known that when the sun is within many degrees of the main radar beam it will "blind" these radars. This would happen regularly to far-northern radars looking at the northern horizon.
>
> Antiradar coatings (such as those now being considered for our own ICBM) might reduce the detectability of enemy ICBM's.
>
> Induced noise might be produced by placing small decoys in satellite orbits. (Such a tactic would also interfere with Soviet radar detection of our ICBM's, but the Soviets would clearly have better alternative sources of warning from intelligence.)
>
> Perhaps the most effective countermeasure for the Soviets would be the jamming of our radars from aircraft and ships well outside U.S. and Canadian territorial boundaries. Intermittent jamming could produce an intolerably high false-alarm rate if SAC's only response were the launching of the alert force.
>
> Finally, the development and installation of radars that would provide *any* useful warning of ICBM's depends on several major technical advances. The possibility cannot be excluded that this development would take considerably longer than the crash schedule now projected and that in fact it might not work at all.

The third source of warning is infrared detection of the hot exhaust flame of ballistic missiles during powered flight. It may be possible to detect missiles at a range as great as 1200 nautical miles from aircraft equipped with infrared detectors flying at 40,000 ft.* Development of such detectors raises the possibility of stationing AEW aircraft around the borders of the communist bloc and maintaining a constant infrared search of peripheral areas. However, this system, while useful, cannot be counted on for certain and unambiguous warning, since it will not be able to detect launchings from remote interior areas and it may be susceptible to Soviet spoofing.

In any case, the USSR can reduce *total flight time* to many ZI bases from the usually assumed 30 minutes to 15 minutes or less by modifying a 5500-nautical-mile-range missile and launching it at the shorter ranges possible from points in Soviet territory nearest to the U.S. and by following low, nonextremal flight paths. The resultant flight times to SAC bases in the United States and times from detection to impact are shown in Fig. 21. The time required for interpretation of infrared or radar returns, communication of the warning, and decision to act would further reduce these short times. Moreover, warning from an infrared or radar detection system would not be available if the enemy used end-run tactics. Sea-launched missiles could flank a northern line, and a *closed* warning ring would be essential.

*For a more detailed discussion, see W. W. Kellogg and Sidney Passman, *Infrared Techniques Applied to the Detection and Interception of Intercontinental Ballistic Missiles*, The RAND Corporation, Research Memorandum RM-1572, October 21, 1955 FOUO

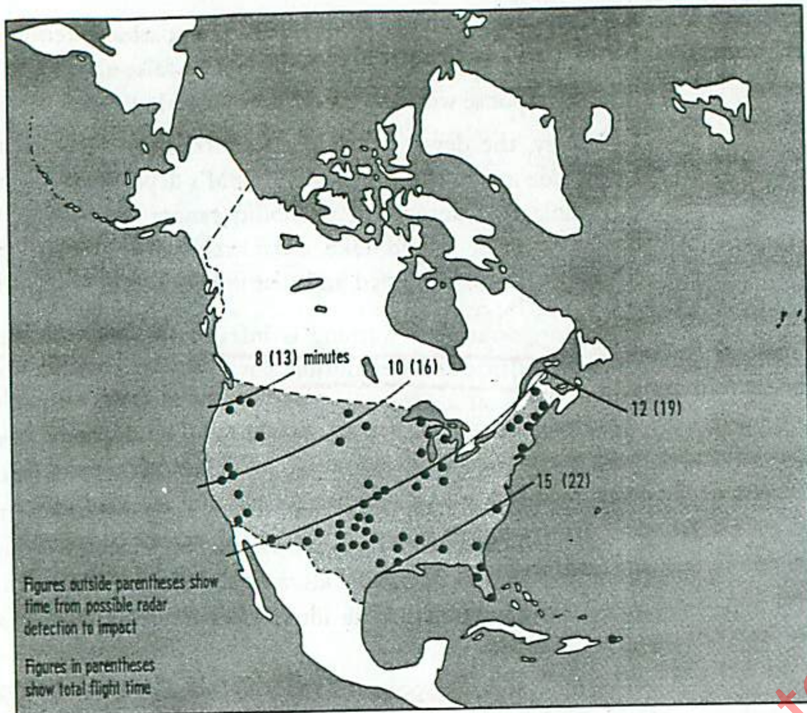

Fig. 21—ICBM launched from the Soviet Union—times from detection to impact (low trajectories)

The bomb-alarm system we have recommended on page 49 in connection with sneak bomber attacks takes on a new importance in the light of the uncertainties of radar warning of ballistic missiles. It presents a much less formidable requirement both in cost and in the technical problems of carrying it through. And it guarantees at least a brief interval of warning against even the ICBM. But *how* brief this interval will be depends on the degree to which the enemy can limit the irregularity of ICBM arrival times at fifty or so separate points. This brings us to the fourth source of warning listed above.

Reliance on the fourth type of warning, a lack of simultaneity in the

enemy's salvo, offers a powerful incentive for him to achieve simultaneity. It appears probable that such warning could be reduced well below 15 minutes if the enemy planned to ready missiles for launching, hold them in this state as long as feasible, and then fire only those ready to go at a prearranged time. This would mean building, at some extra cost, more missile-launching sites than would be required if timing were not critical. But if this enabled the Soviets to destroy SAC, the extra expenditure would be worth while. In short, while this fourth source of warning—a bomb-alarm system—is important and should be pushed, it cannot be counted on to supply 15 minutes' notice.

None of the sources for the estimated 15 minutes of warning against ICBM attack offers a reliable basis for defending SAC. They all depend on the enemy's not taking a course of action that is advantageous and feasible for him. But even with 15 minutes of ambiguous warning, it is doubtful that many SAC aircraft could fly off, and very much more unlikely that the final strike with SAC bombers, or the decision to fire the ICBM or Navaho, would be made on this basis.

While 15 minutes of warning cannot be relied on, even 3 to 5 minutes of warning would be useful. It would permit SAC personnel to dive into nearby shelters. With the bomb-impact alarm system mentioned earlier, any lack of simultaneity in the ICBM volley would increase the amount of warning. This leads to the following proposed measures:

- ***Improve our ICBM raid-recognition capability.*** Investigate the feasibility and cost of close-timing an enemy ICBM volley, making use of our ICBM development program for this purpose.

- ***Develop a detection device suitable for giving at least 3 to 5 minutes of reliable warning of an ICBM attack***—one that can be operational by 1960. If investigation shows that we cannot reliably get this much warning from the raggedness of the volley, procure the detection devices to provide 3 to 5 minutes of warning. Such detection devices would, in any case, be a part of any active defense system against ICBM's.

- ***Accelerate development of distant radar and infrared detection systems.*** More warning than this minimum is valuable, and development of systems providing more, if less reliable, warning should be pushed with somewhat lesser priority, provided always that the false-alarm rates achievable will permit some useful response. If we get more warning, of course, we should use it. In fact, the fast-acting alert shelters described in the next section would help to exploit any delays between warning and ICBM impact long enough for flyaway. But their utility is not dependent on these longer warning times.

Provide Alert Shelter for Aircraft and Vital Elements

Figure 22 shows how blast-resistant shelters sharply increase the survival of aircraft, personnel, and other vital elements given an ICBM attack. The attack shown, postulating 4 hits in each of 55 target areas,

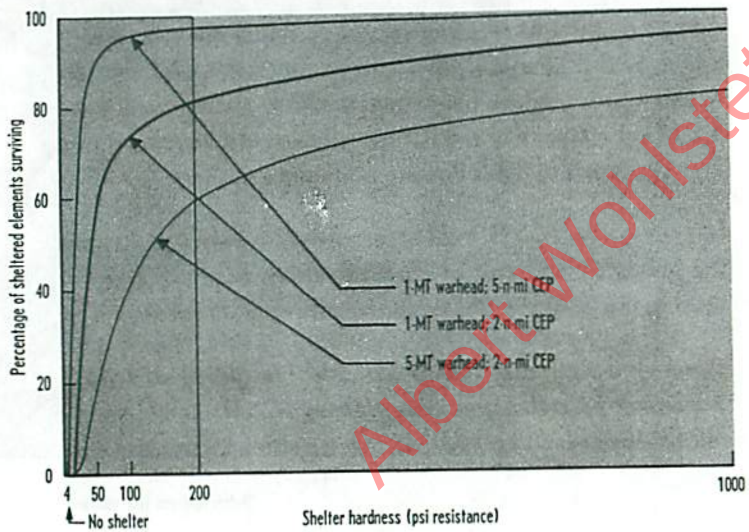

Fig. 22—Effectiveness of shelters against ICBM attacks (4 ICBM hits per target area)

is a large one and corresponds to an enemy salvo-launching capability of about 500 missiles. With shelters designed to resist a pressure level of 100 to 200 psi, it is clear that a missile with a 1-MT warhead delivered with 5-nautical-mile CEP is ineffective. The 1-MT, 2-nautical-mile-CEP vehicle is somewhat more effective, but even against an ICBM having a 5-MT warhead and a 2-nautical-mile CEP, 200-psi shelters do quite well. Shelter, unlike dispersal, does more than match the enemy's delivery capability with a U.S. target one for one. It gives disproportionate benefits. For example, the enemy would need 16,800 missiles with 1-MT warheads and 5-nautical-mile CEP to kill 80 per cent of a SAC force protected to 200 psi. This should be compared with the 250 missiles capable of destroying this part of an unprotected force.* Analysis has made it clear that protection against overpressures of the order of at least 200 psi is vital. And, as recent work has shown,† resistances of at least this order are feasible. Structures with higher than 200-psi resistances are under investigation, and it may be desirable to build stronger shelters. Even in the range already investigated, further exploration of ways of getting any specific degree of blast resistance is needed.

*The factors determining these results may be suggested by the following: The lethal radius of a 1-MT bomb airburst against an unsheltered bomber is about 26,000 ft. Even with very large inaccuracies—for example, a CEP of 5 nautical miles—the ratio of lethal radius to CEP is little less than 0.9. If we apply the familiar method for determining the probability of destroying a point target, the resulting estimate of the single-shot probability of destruction is about 0.4. Of course our bomber bases are not points. They occupy a considerable area. But the "point coverage" calculation suggests the outcome of an area-coverage experiment. Given, for example, 65 adjacent "points," that is, tankers and medium bombers on the parking aprons of the planned one-wing B-47 bases, the expected destruction by a small number of 1-MT bombs with a 5-nautical-mile CEP could be surmised to be quite high. That this expectation is high has been demonstrated by the outcomes of a large number of random bomb-drop experiments using actual base layouts; it is also illustrated by the 250-missile Soviet force requirement quoted above for the destruction of most of SAC in 1960–1961.

†The feasibility analysis is contained in two reports by Paul Weidlinger and Mario Salvadori. The analysis was carried out under a contract with The RAND Corporation and the reports have been submitted to the Corporation. The titles of the reports are as follows: *Report on the Dynamic Strength of Rigid-Plastic Beams under Blast Loads*, by Paul Weidlinger and Mario Salvadori, The RAND Corporation, Research Memorandum RM-1806 (to be published); and *Practical Estimated Limits of Blast-resistant Steel Shelters*, by Paul Weidlinger, The RAND Corporation, Research Memorandum RM-1777 (to be published) C(4) Research Memorandum RM-1777 describes the B-52 shelter shown in Fig. 23.

The *alert* function of the alert shelter is as vital as its shelter function. The shelter must permit the launching of combat-ready aircraft and the evacuation of non-combat-ready aircraft before the arrival of manned bombers. And expected high radiation levels after attack make the allowable exposure of aircraft and ground crews during launch extremely short. An aircraft shelter can also shield, at little extra cost, vital personnel, bombs (with ready access to bombers), and air-launched decoys.

Figure 23 shows one design of an alert shelter for the B-52. This shelter, of conventional structural design, is made of reinforced concrete with a steel roof. The aircraft is raised and lowered on a counterweighted elevator, and the segmented steel roof slides off to the sides on rollers that do not bear a load when the roof is closed. Fast operation of the shelter has been required: the room is designed to open in 1 minute and the elevator to rise in another minute. Figure 24 shows how the cost of this shelter varies with its resistance to blast over the range of 50 to 200 psi. At 50 psi, the cost would be about $900,000, and at 200 psi it would come to about $1.6 million. The useful life of such a shelter can be extended, it appears, by using it to shelter the ICBM, Navaho, or other vehicles, and this later use should be planned for in the initial design. B-47 shelters of the same type would cost about 65 per cent as much as the B-52 shelters.

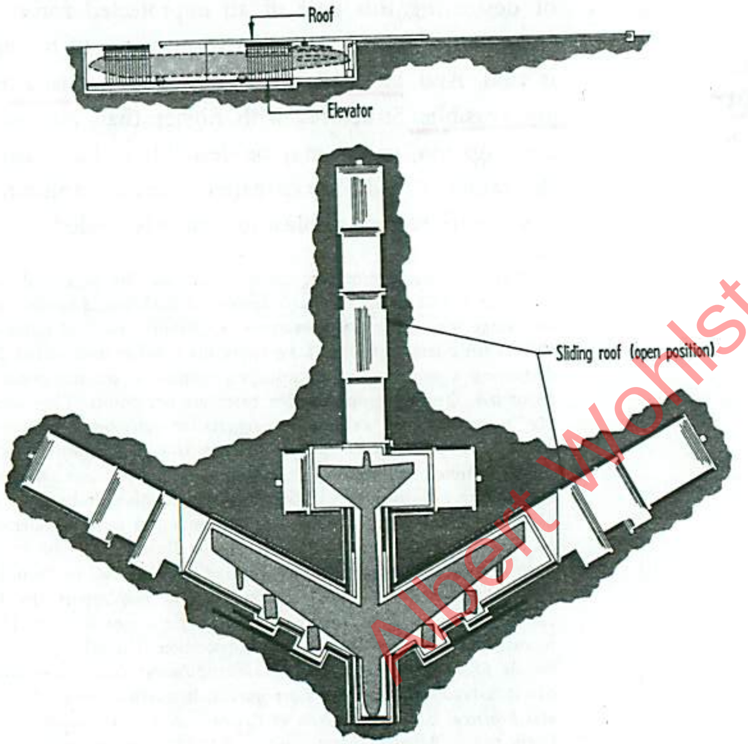

Fig. 23—B-52 shelter—plan and elevation views

Other, more novel, structures are under investigation, and we recommend that the Air Force urgently pursue a program of research and development and testing of such shelters for aircraft and other elements.

If the U.S. ICBM force of 120 missiles based as shown in Fig. 9 (page 28) is modified by the shelter of all vital elements, the Soviet

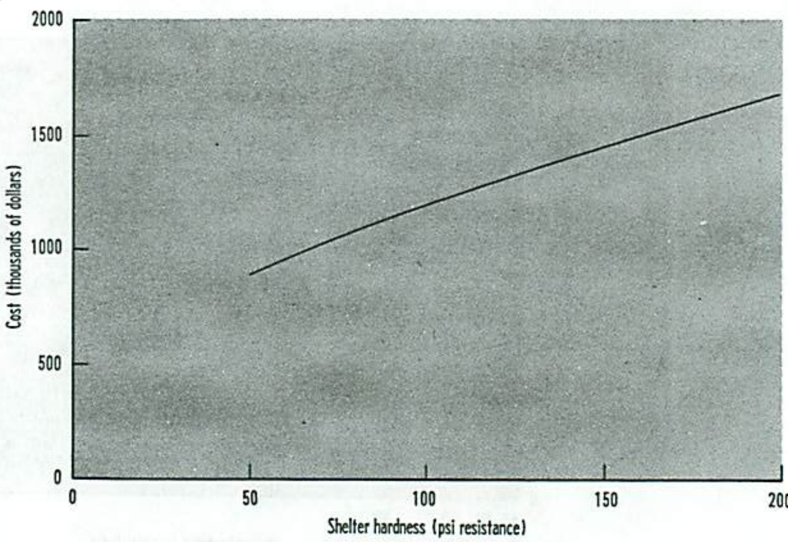

Fig. 24—Trend of B-52 shelter costs with increased blast resistance (reinforced concrete with steel roof)

force needed to destroy it would be increased greatly. It takes, for example, 7600 missiles, before allowing for availability and aborts, to destroy an expected 80 per cent of this system if it is toughened to 200 psi. (This is the force assuming enemy attack on the most highly concentrated vital elements—the guidance sites.) Figure 25 shows the lethal area of a 1-MT and a 20-MT bomb against elements of a missile complex with 200-psi shelters. There are many problems yet to be solved in sheltering missiles and their associated equipment, and we do not maintain that 200-psi protection is optimal. It is clear, however, that for our missiles as for our

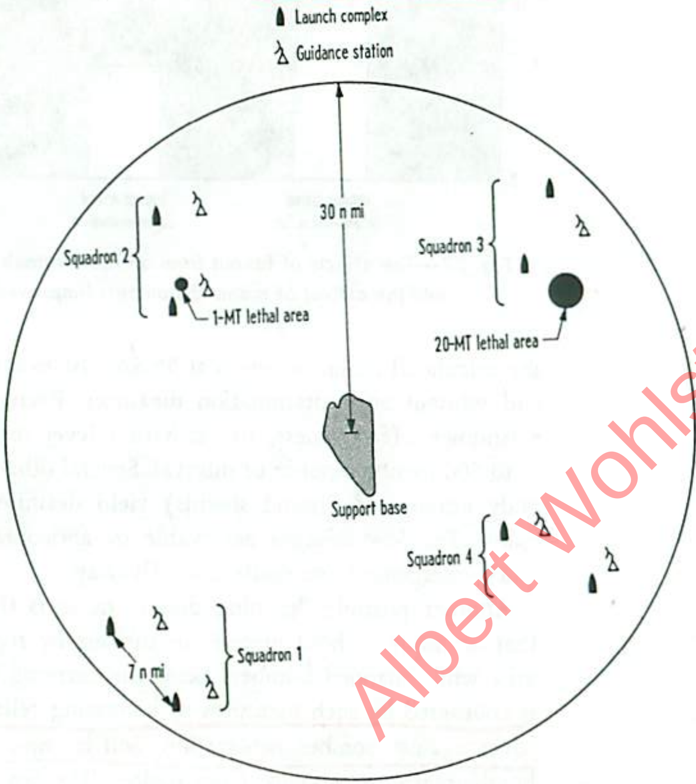

Fig. 25—Layout of an ICBM (SM-65) provisional group and lethal areas of thermonuclear weapons against elements sheltered to 200 psi

bombers, there is no substitute for shelter against the ICBM. Consequently we recommend that the Air Force—

- *Accelerate a program of development of shelter for missiles and other vital ground elements. A wide range of overpressures should be investigated.*

Soviet ballistic missiles are not the only inaccurate weapons likely to threaten SAC during this period. Submarine-launched missiles, air-to-surface missiles, and supersonic manned bombers are likely to have CEP's exploitable by shelters. But even if we were to have much tougher shelters than those shown in Fig. 22—tough enough to resist everything except inclusion in the crater and lip—this would not be enough as a principal defense against more accurate subsonic manned bombers dropping high-yield weapons.

DEFENSE AGAINST JOINT ATTACKS

A defense program capable of handling a pure ICBM attack would be inadequate against a joint ICBM–manned-bomber attack. It is necessary to consider both threats in the 1960's, because their joint use will be more effective than either used separately. It is also necessary to consider at once the best defense for both the 1950's and 1960's, because decisions made now will determine our legacy for the later period.

If the enemy used an ICBM attack to deposit fallout, to delay evacuation until manned bombers arrived, these manned bombers would kill us in our shelters. The orange bars of Fig. 26 show the calculated radiation levels on 55 SAC bases after an ICBM attack. An attack using 500 missiles is shown. If we permit our crews to absorb no more than 100 roentgens, and with the recommended quick-opening shelters, alert crews, simultaneous engine start, and short taxi distances, then a base having a 1-hour dose rate of 3000 roentgens would have a delay before takeoff of about 2 hours. And as Fig. 26 shows, one-half of the bases have more than this radiation rate. Figure 27 shows that over one-third of our bases could be hit by the follow-up manned-bomber raid before they could be evacuated. The follow-up attack is based on the penetration times from the

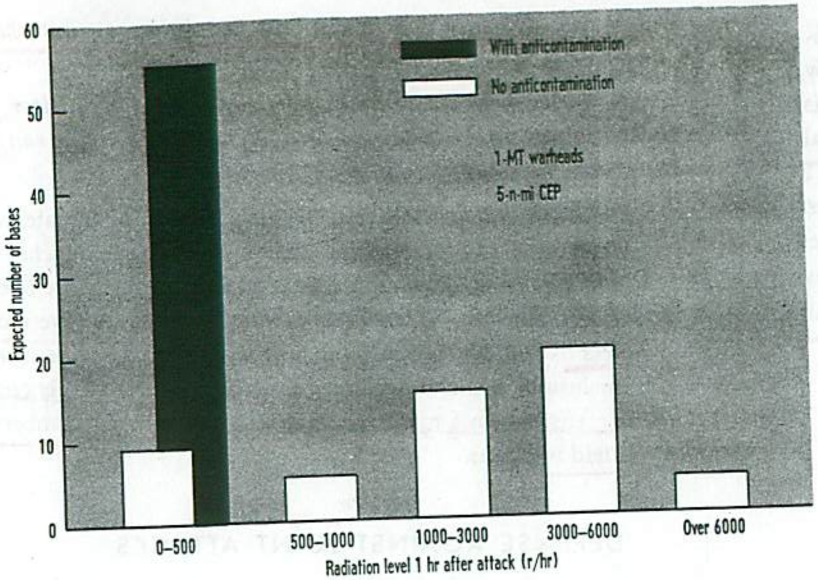

Fig. 26—Radiation level on 55 SAC bases 1 hour after an ICBM attack (500-missile force)

improved warning perimeter recommended. Without improved warning, lower radiation levels would delay us long enough to be killed. Moreover, with larger-yield or enhanced weapons, much higher radiation levels and consequent delays would result—high enough for all of our aircraft to be caught on base.

The results of this part of the analysis emphasize the importance of anticontamination measures. There are several such measures possible, and the most important one proposed is a moving-water film that keeps selected paved areas clean during the whole period of fallout.* Our calculations show this to be a relatively inexpensive measure capable of reducing radioactive contamination by a factor of 20 to 100. Figure 26 shows

*See J. E. Hill and Marc Peter, Jr., *The Effects of Fallout on Airbase Emergency Operations and Some Possible Countermeasures*, The RAND Corporation, Research Memorandum RM-1629, February 7, 1956 FOUO

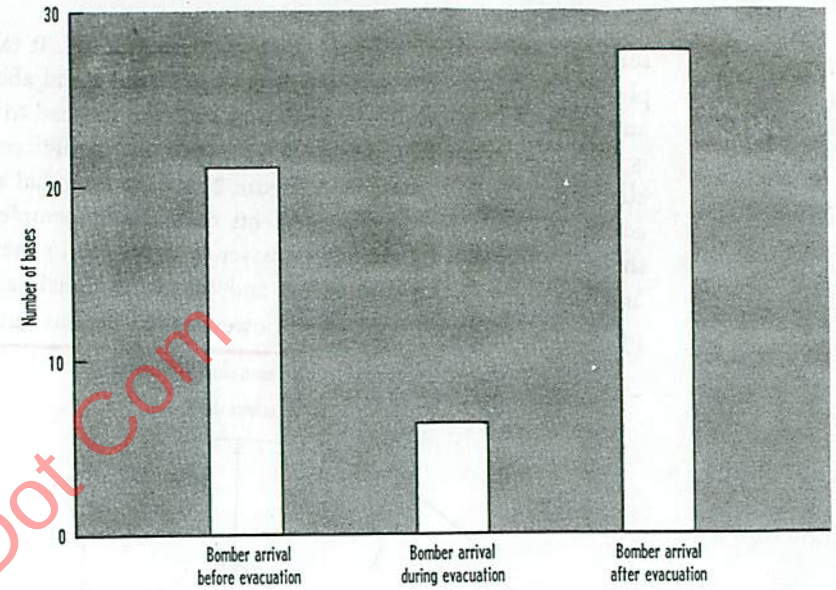

Fig. 27—The effects of fallout from an ICBM attack in delaying evacuation until the arrival of manned bombers (improved warning system)

the calculated radiation levels at 55 SAC bases after an ICBM attack with and without anticontamination measures. Even on the low estimate of washdown effectiveness, the radiation level on all bases is within the 0- to 500-roentgen-per-hour interval. Several other measures (for example, body armor and ground shields) yield definite but smaller additional gains. The low dosages achievable by anticontamination would permit quick emergence from shelters and flyaway.

Another possible "pinning down" tactic is the classic barrage attack that attempts to hold aircraft in shelters by repeated hits in the target area while manned bombers penetrate carrying large bombs. This tactic is countered by such measures as increasing reliable early warning radar cover against bomber penetration, and by shortening exposure times of bombers after emergence from shelter. The Soviet missile force required to do this can be made infeasibly large at a moderate cost—for example, much larger than the 16,800 missile force referred to above.

To protect the strategic force from destruction by a coordinated Soviet ICBM and manned-bomber attack in the sixties, it is absolutely essential that a program to provide shelters for the flyable portion of the strategic force be pursued vigorously; hence the *protective* aspects of the shelter. On the other hand, there is no realistic alternative to evacuation by SAC before enemy manned bombers arrive; hence the alert shelter's *alert* aspect. It should also be observed that fast action of the shelter would be helpful against late-arriving ICBM's. A detailed study of the nature of the threat and of the opportunities for protection leads to the following recommendations:

- *Design several possible shelters* that would provide at least 200-psi protection for aircraft and simultaneously serve as alert hangars.
- *Test the resistance of components of such structures* to large-yield weapons as soon as possible.
- *Program for shelter construction* on a scale that would provide alert shelter for all flyable aircraft scheduled to remain in the strategic force until 1965.
- *Construct alert shelters* on a schedule that would ensure that at least one-half of the strategic force would be in shelters by 1960; the remainder by the end of 1962. These shelters should be designed to be used by later vehicles entering the strategic force.

The measures we recommend for personnel protection may be summarized as follows:

- *On 55 SAC home bases—*

  Design and construct personnel blast and radiation shelters resistant to at least 200-psi overpressure for protection against ICBM attack, and to much higher resistance for the protection of ground personnel assisting in evacuation.

  Design and construct washdown anticontamination systems to speed aircraft flyaway.

  Provide tunnels, shielded vehicles, or some alternative method permitting immediate personnel movement after ICBM attack. In addition, shielded bulldozers will be needed to clear debris from airfield pavements.

- *On approximately 1000 recovery bases—*

  Construct simple antifallout shelters as protection against radiation from countrywide fallout.

CONNECTION BETWEEN THE MAIN GROUPS OF MEASURES

We have emphasized at the outset that each of the main groups of measures proposed is needed, but none by itself is sufficient—

- Without measures that increase the enemy's raid size, a lethal aircraft attack is possible that is too small to give us reliable warning.
- Without improved warning and response, a large lethal attack will find us on base and will kill us; if it does not kill us, it will at least seriously delay us.
- Without improved recovery, we are throwing away a major part of our force and restricting our use of the small remainder.

Not every item in each group is irreplaceable, but certain measures in each group are urgently needed.

COSTS

The total cost of the four main groups of measures estimated over a 6-year period is shown in Table 5.

Most of the cost of the program is in the first two categories. The first group includes chiefly aircraft shelters for the flyable B-52's and KC-135's (85 per cent of total assigned to each unit), and for the 11 wings of B-47's and KC-97's scheduled to be in the force until 1965 or later. The major item in the "improved warning" category is the cost of relocating SAC units from our exposed east and west coasts to the interior.

Table 5

	Millions of Dollars
Increasing enemy raid requirements	1730
Improved warning (including SAC unit relocation)	848
Improved SAC initial response	357
Improved recovery and striking capability	465
TOTAL COST	3400
AVERAGE ANNUAL COST	567

Table 5 does not include the cost of a program to provide new engines for the B-47. Should one be undertaken as the result of the tests we have recommended, the total cost of equipping 11 wings would be about $550 million over the period. It could be largely financed, if necessary, out of savings in tanker operations with a *net increase* in B-47 combat radius. A proposed funding schedule for the major items recommended is given in Table 6.

Table 6

COST OF THE RECOMMENDED PROGRAM BY FISCAL YEARS

(Millions of dollars)

Item	FY 1957	FY 1958	FY 1959	FY 1960	FY 1961	FY 1962
Base relocation	15	287	195	49	...	..
Warning	7	52	120	72	48	42
Shelter	10	280	480	480	480	..
Personnel protection	..	67	62	62	40	..
Communications	20	66	71	63	30	30
Alert and response	..	18	22	5	5	5
Fuel storage	..	20	30	30	...	..
Other	8	35	40	32	20	20
TOTAL	60	825	1020	793	623	97

These costs are subject to all the uncertainties inherent in estimates of expenditures for so distant a future. Some of them—for example, the shelter cost estimates—depend on the outcome of a research and develop-

ment program. Because a considerable part, but not all, of these costs will vary with the number of bombers in the SAC force (for example, the costs of shelters, but not of warning), the largest uncertainty concerns the size of our future strategic force. The costs shown were based on a May, 1955, force projection. However, it should be emphasized that these RAND-estimated costs include not only direct outlays, but the costs of training and support as well—a total Air Force slice. (The more familiar Air Force cost estimates include procurement and construction, but little more of the operating cost than direct-personnel salaries.)

The $560 million annual cost of this program is a respectable sum of money, but it should be looked at in relation to the scale of SAC expenditures. SAC is expected to cost between $6 billion and $8 billion a year between now and 1965. Some fraction of air defense is intended for SAC, and air defense as presently programmed will be costing in total about $6 billion per year by 1961. The proposed measures to provide a secure force add about 5 per cent to the combined cost of SAC and SAC defenses over this period.

We have stressed that we must have protected strategic power at *any* level of force. This does not mean that if additional funds are not available the program should be paid for by reducing force size by 5 per cent, since uncertainties in Soviet capability call for a large SAC. In any case, there are, it appears, more appropriate sources for funds. And, of course, when one considers the basic function of retaliation, expenditures directed toward this goal, not only in the Air Force but in the other services, should be examined.

We regard this program as a minimum. Three years will elapse *after* decisions are taken before there is substantial improvement in our position. This program could be accelerated at some extra cost, but there are necessarily lags in funding, in research and development, in procurement, and in construction. During this period we must accept the risks of attack. However, we should not accept further delays before initiating action, *especially since the decisions to be made now do not involve commitment to the entire program proposed.*

The measures we have proposed range from preliminary investigation of specific problems to final procurement of some end items. Where preliminary action is indicated, cost in dollars is often low (for example, initiating design of aircraft shelters; starting negotiations with Mexico for radar sites; test of low-altitude radar effectiveness; study of ICBM timing; investigation of B-47 engine replacement). But the cost in time is great. These immediate actions (in Fiscal Year 1957) will cost about $60 million. Moreover, in the absence of a decision, future commitments will be made that will later require correction at considerable extra cost. For example, any new SAC base to be located near the coasts clearly will be untenable by the time its construction is completed.

DETERRENCE AND EFFECTIVENESS OF ALTERNATIVE SYSTEMS

Figure 28 shows how a SAC protected by the proposed measures would weather an attack in 1961. Over 80 per cent of the bomber force survives. But the problem of defending an offensive force is not so much to ensure

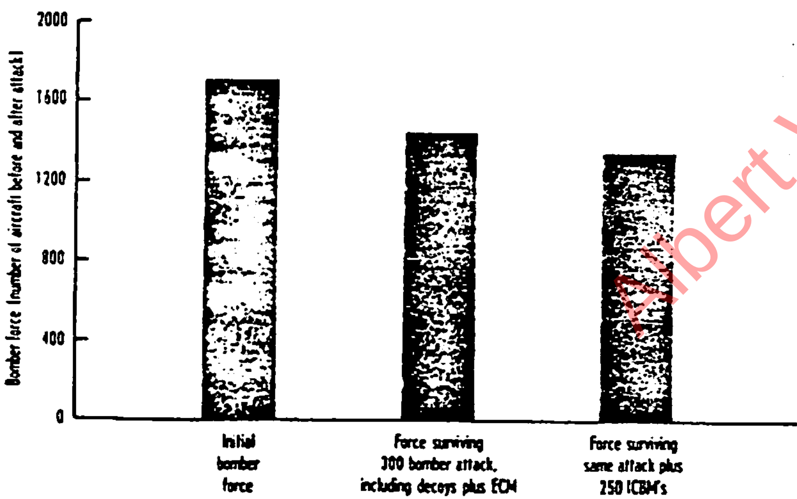

Fig. 28—Survival of SAC protected by the recommended system

merely its survival as to ensure its effective employment. The principal measures of effectiveness in the study, therefore, use the results of analyzing two-sided campaigns in which the surviving parts of the SAC force were routed from our own bases through the enemy defenses to target. The next figure shows the result of a campaign in which the targets attacked are Soviet urban areas. This does not mean other targets are unimportant, but in each of the situations treated here, our strike occurs *after* the greater part of the Soviet strategic force has been launched. Our principal deterrent, then, must be our ability to destroy their cities.

In Fig. 29 we show the target-destruction capability of the SAC force as currently planned, but with some extra aircraft, and of some alternative systems, including the one we are recommending. Each system was given $3.4 billion additional to spend over the 6-year period.

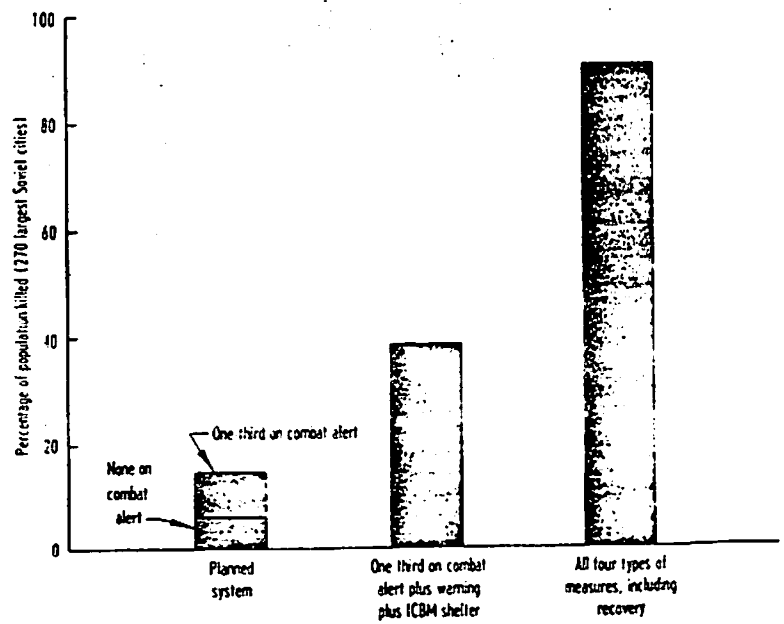

Fig. 29—Estimated destruction capability of four equal-budget ($3.4 billion) strategic systems in the face of a joint ICBM-bomber attack

In the case of the planned system, this extra budget was spent on increasing the bomber and tanker force. It provides 90 more B-52's and 60 KC-135's. This only increases the number of points at which Soviet ICBM's find SAC from 55 to 61. Two levels of performance of this planned system are shown, based on two estimates of the SAC response capability: (1) with none of the force on combat alert and (2) with one-third of the force on combat alert. With no improvement in alert and response over our current position, little of this force would survive an initial joint missile-bomber attack by 250 ICBM's (before degradation for unavailability and aborts) and 300 Bears. Follow-up attacks were assumed to use 500 heavy and medium bombers. Most of our few remaining bombers would have difficulty penetrating Soviet air defenses, even if they could somehow recover and regroup in the face of countrywide fall-out and the enemy reattack. Actual target destruction could well be less than the 8 per cent shown.

This system would perform better with part of the force on combat alert, but it would suffer from lack of warning. In the face of a well-timed ICBM attack, most of the alert force, as well as practically all of the nonalert part of the force, would be destroyed. That part of the alert force escaping destruction by ICBM's would not suffer further attrition from a follow-up manned-bomber attack, and a quick-reacting force should do better than one with a slow reaction (under some circumstances of enemy attack-after-feints, for example, it may do worse)—but hardly well enough to provide a deterrent. If the enemy missile force is as large as 500, and if it is launched with less raggedness, then the target-destruction capability of the system, even with one-third of it on combat alert, goes practically to zero.

If we provide all of the proposed measures except a good recovery capability, and have a combat alert (middle bar of Fig 29), most of the force survives a surprise attack. But we can count on being able to use only those sheltered bombers that are on combat alert. Doing this is a gamble on the enemy's air defense. There are large uncertainties about Soviet air defense kill potentials, and in the campaigns shown here, individual fighter and missile kill potentials were used that are only a fraction of

those often assumed for the U.S. air defense forces. Such an attack by a combat alert force only would be small, would penetrate along known routes, and at a time selected by the enemy through the timing of *his* attack. Our alert force might have to penetrate unaccompanied by ground-launched decoys, because there would be no fail-safe procedure for their recall. (While manned bombers can be launched if it is uncertain whether or not an actual attack is under way, ground-launched decoys must be delayed until there is ironclad evidence of an attack. Under likely circumstances the decoys would penetrate too late to help the manned bombers.) If enemy attrition has been estimated too low, and if many target areas were visited, then much less damage will be done than Fig. 29 shows. If attrition has been estimated too high, then too few targets will be visited. Finally, depending exclusively on a combat alert means putting our offensive force in the awkward position of a defense force. It can be feinted out of position and attacked shortly after being recalled back to base.

This discussion is not intended to imply that a combat alert force is without value. Having the capability of launching a quick first strike against Soviet bases is important. We have stressed throughout this report the importance of shortening SAC's response time, and it is certainly much easier to have bombers combat ready before a surprise enemy attack than to have to ready them afterward. But we wish to emphasize (1) that a combat alert alone will *not* provide a secure SAC force in a period when the Soviet Union has the ICBM; and (2) that we cannot afford to throw away two-thirds or more of our force.

The system protected by the proposed measures has by far the largest target-destruction potential: 85 per cent of the target system. It can choose to operate in a two-wave manner: A combat-alert force can be used in a reflex manner, followed by a strike with the recovered two-thirds of the force. Or, if conditions permit, the entire force can be brought together for a single coordinated mass attack. It can make this choice depend on the circumstances of the actual enemy attack. Therefore, it completely dominates the other systems. This system offers *two* shots at the enemy rather than staking everything on one.

SOME OTHER ALTERNATIVES

Increasing the number of points the enemy must attack is useful, but sole dependence on dispersal does not provide an adequate defense. Figure 30 shows that if we were to spend this additional $3.4 billion budget by going to squadron dispersal (126 bases) for all of SAC, we would

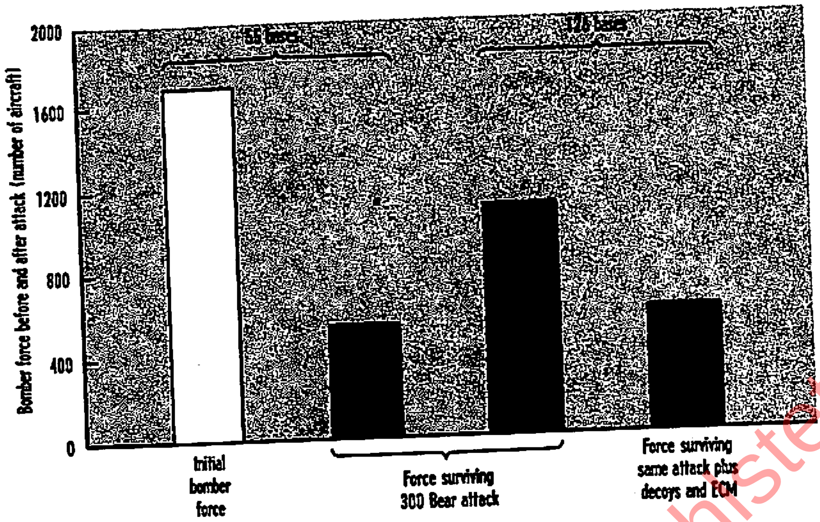

Fig. 30—Added protection of SAC achieved by dispersal alone ($3.4 billion spent on dispersal alone)

have no assurance of protection. Against a 300-Bear attack, the number of our bombers surviving would be doubled, but a somewhat larger or more effective enemy attack would leave us no better off than we are as presently planned.

Figure 31 shows what would happen if this sum were spent on additional active defense—in this case, Talos units. With this extra active defense, practically none of an attacking force of 500 bombers flying at medium altitudes and employing no penetration aids get through to

the bomb-release line. However, this defense cannot be depended on. If the enemy uses air-launched decoys and electronic countermeasures, enough of the force survives to destroy a large part of SAC. Finally, such an augmentation of our active defense does not provide a defense against the ICBM.

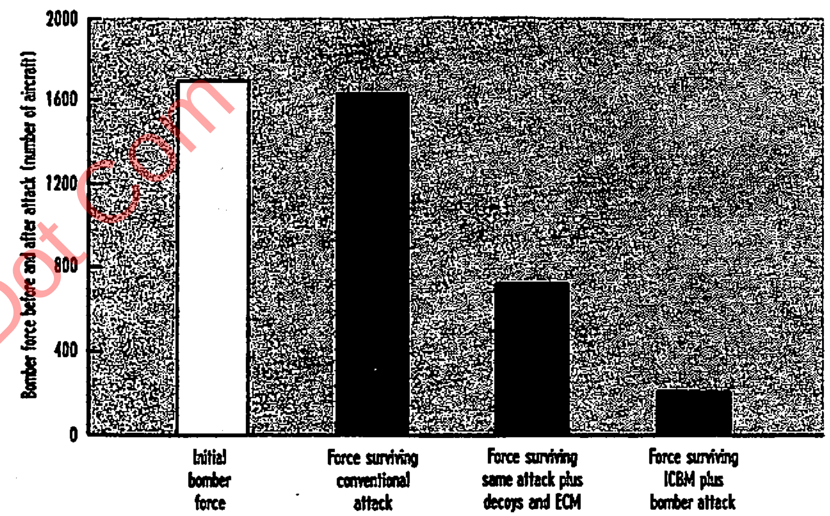

Fig. 31—Added protection of SAC achieved by active defenses alone ($3.4 billion spent on Talos)

The same budget might be spent on keeping more aircraft aloft at all times. The futility of such a policy is evident from Fig. 32 on page 94. With this sum, we could increase the average percentage of SAC aircraft in the air from 4 per cent to only 9 per cent. And at the time of attack the aircraft aloft would be, on the average, less than one-half loaded with fuel.

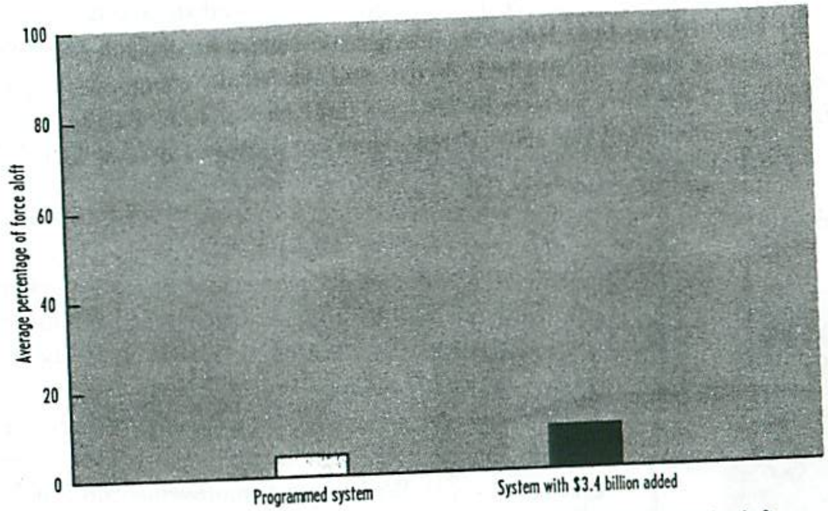

Fig. 32—Added protection of SAC achieved by keeping aircraft aloft ($3.4 billion spent on keeping bombers and tankers aloft)

V. CONCLUSION

To have an objective basis for deterrence we need to adopt measures in each of the four broad areas described above. The most important specific actions in each group are

- *On Warning*:

  Extend the continental early warning perimeter to the south, and

  Locate SAC inside of it.

- *On SAC Response*:

  Increase the readiness of crews and aircraft, and

  Change the decision process to speed SAC's response.

- *On Recovery*:

  Increase SAC's control capacity, to speed and coordinate the use of recovery and staging bases.

- *On Increasing Enemy Raid Size*:

  ~~Shelter vital elements against the ICBM.~~

Three main points should be made concerning the $3.4 billion total 6-year cost of this program: (1) it is small by comparison with the nearly $70 billion now planned for SAC and SAC defense over the same period; (2) it is dwarfed by the costs of alternative methods for securing an adequate ability to strike back while under thermonuclear attack; (3) the *starting* expenditures, that are small, urgently need to be committed now; but this by no means involves an irrevocable decision on the course of the whole 6-year program. The commitment in the next fiscal year amounts to roughly $60 million.

- *The cost of other ways to make SAC secure is very much larger.*

Up to now, in this summary report, we have examined the performance of alternative defenses we can buy with a fixed budget or a fixed increase in budget. We can ask the question another way. How much do the various systems cost to get some fixed strategic capability in the face of enemy attack? Budgets for three other systems having the same target-destruction capability as the recommended system are shown in Figs. 33 and 34, together with our proposed system.

Figure 33 shows the cost of four systems, each capable of destroying

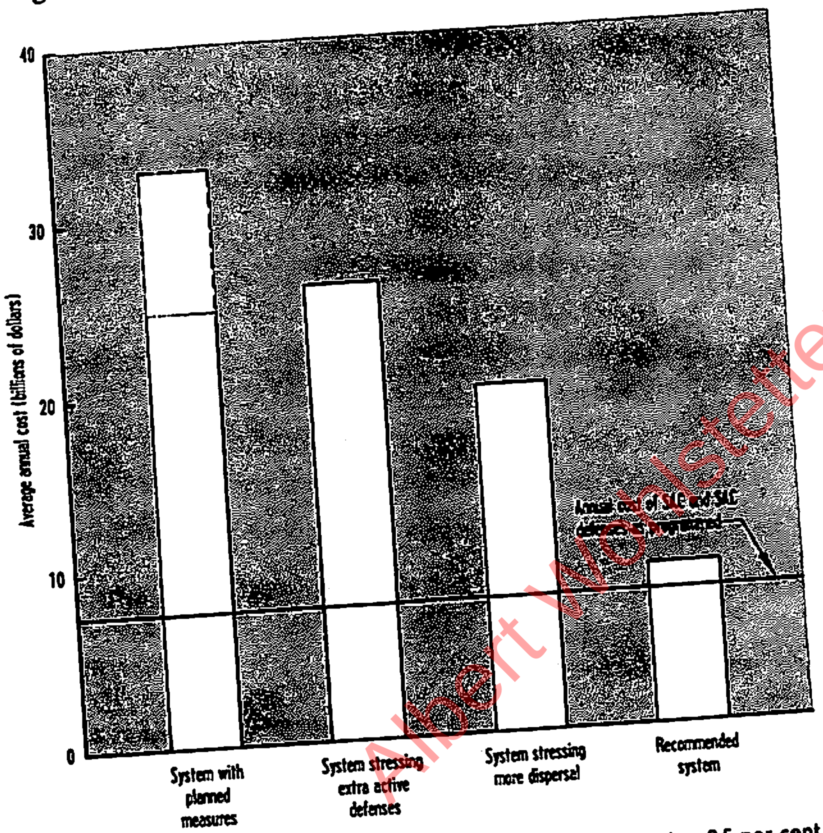

Fig. 33—Total costs of alternative systems capable of destroying 85 per cent of 270 Soviet urban targets (in the face of moderately high Soviet offense and defense capabilities)

85 per cent of 270 Soviet Union urban targets in the face of moderately high though not extreme Soviet offensive and defensive capabilities. Five hundred Soviet ICBM's and 500 Bears and Bisons are launched against each system. The surviving U.S. force must then penetrate a Soviet defense consisting of 130 regiments of all-weather fighters, 165 regiments of day fighters, and 225 local-defense-missile sites. Each system uses the various methods of defense indicated in Fig. 33, and, in addition, has been given enough extra bombers to be able to survive and penetrate the enemy's air defense and to destroy 85 per cent of the target system.

The first system in Fig. 33 depends for defense mostly on speeding SAC's response. Two bracketing estimates of the budget required are shown: (1) With no improvement in response over that currently experienced, a very large extra force (and budget) is required. (With this slow response, manned bombers as well as missiles arrive over base before evacuation.) (2) With a great improvement in SAC's response, and one-third of the force on short alert, a substantial part of the force escapes the manned-bomber component of the attack, but not a coordinated ICBM attack. The force surviving is then limited by the Soviet ICBM salvo capability. Even with the much-improved response, a much larger force than is currently planned would be required. And the outcome is extremely sensitive to the size of the Soviet ICBM force. We are trading our B-52 squadrons against the number of Soviet ICBM's needed to ensure their annihilation, and in this contest, we are at more than a 10-to-1 cost disadvantage.

The second system in Fig. 33 shows the effect of greatly multiplying active defenses against manned-bomber attack. Of the $26 billion annual extra cost incurred by this system, $4.6 billion is spent on additional Talos units and the remainder on additional aircraft. Almost the whole of a manned-bomber force attacking at medium altitude and without using electronic countermeasures and decoys is destroyed. However, this defense does not help against the ICBM. (And it would be quite inadequate against even a manned-bomber attack of more sensible design.) Like the previous system, the surviving bombers are mostly those on bases unhit by the limited Soviet missile force. It should be emphasized that some additions to our active defenses now being advocated, such as the extension of our combat zone to the north, would be even less relevant to the defense of our retaliatory power. Finally, other weapons than the Talos were tested, including the Nike, Nike B, Bomarc, and interceptors, without changing the results in any essential respect.

The third system depends largely on dispersal. Five bombers are located at each of 1000 airfields. The 6-year cost of this dispersal and of increasing the forces comes to $20 billion. The cost of this too is extremely sensitive to the level of Soviet offense.

The last system, that with the recommended mix of measures, is almost identical with the recommended system of Fig. 29. It differs chiefly in suffering less than 2 per cent additional losses to the attack by 500 ICBM's as against the 250 directed against this system in the earlier comparison.

The level of costs shown, and the force requirements on which these costs were based, are affected by the level of capability assumed for enemy offense and defense and by the level of destructive power we take as an objective for ourselves. But of course there are uncertainties here.

What if the Soviet Union has a poorer capability than that used in the preceding comparison, and a smaller level of destruction is enough to deter general war? In the comparisons shown in Fig. 34, a Soviet offensive force only a little more than half that in the preceding comparison is assumed (250 ICBM's and 300 Bears). The effectiveness of Soviet air defenses is also halved. Finally, the destruction of only 40 per cent of the 270-urban-target system is required of each system. (This is equivalent to the destruction of the 23 largest cities.) The annual budgets required by each system are shown in Fig. 34. Again the systems that depend largely on one or two types of defense measures are extremely expensive in comparison with that adopting measures in *each* of the four major groups. (In this case, the recommended system has a smaller budget than that programmed. The $550 million spent annually on extra defense is more than offset by the reduction in force size made possible.)

What are we to conclude from the uncertainties made explicit by these two sets of campaigns? For one thing, they imply that it is very hard to decide best-force-size questions, to determine how many bombers, etc.,

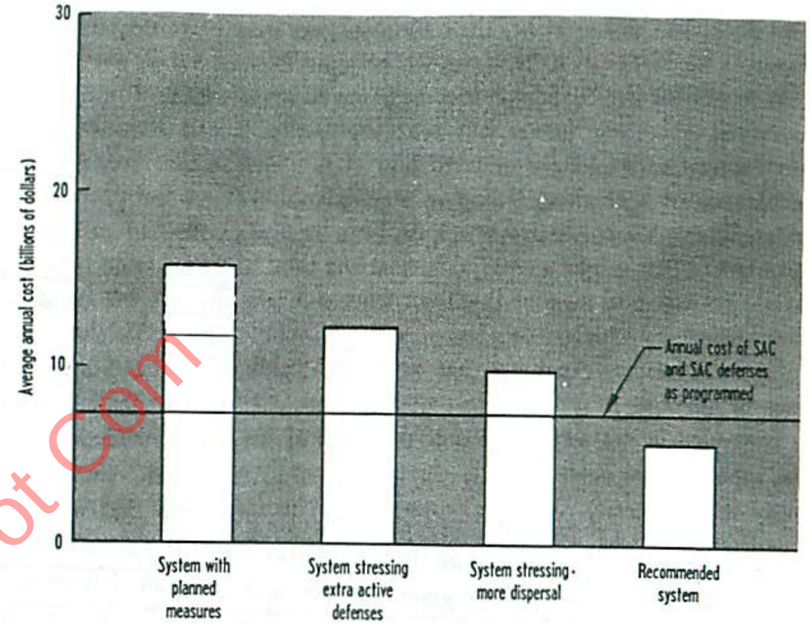

Fig. 34—Total costs of alternative systems capable of destroying 40 per cent of 270 Soviet urban targets (in the face of low Soviet offense and defense capabilities)

we need in order to make it quite apparent to the enemy that we can strike back effectively. This is why we have carefully steered clear of such claims for this RAND study and, in fact, have *phrased the study's results to make it evident that they are comparatively insensitive to these uncertainties: at all levels of enemy capabilities studied, something like 5 per cent of our own SAC and SAC defense budget should be spent in the ways recommended*. On the other hand, the uncertainties described permit no easy confidence as to the adequacy of our force size. Even in our "high" Soviet force level assumption we have not gone beyond the indications of intelligence. They are moderate. Moreover, *some* of the uncertainties are simply a direct consequence of our ignorance of Soviet force planning. Unfortunately *our* ignorance does not create uncertainty in the enemy's mind. Even though we do not, *he* will know whether he has

500 Bears and Bisons rather than 300, and 500 ICBM's rather than 250. It would be foolhardy to be optimistic here just because we do not know.*

A somewhat similar answer may be given to the question of how much protected destructive power will deter the enemy. It will depend on the alternatives he thinks are open to him at the time. These may include acceptance of a crushing defeat in a peripheral war, or the probability of an all-out United States attack on him, or any number of other circumstances that might appear to him at the time to entail huge risks. It would be wrong to suppose that the enemy will take no risks. He is sometimes presented with a choice among risks. It is impossible to fix the exact level of retaliatory capability that we must be able to keep intact in the face of surprise attack. The fact that the line cannot be sharply drawn is suggested in the way responsible members of the government describe the capability we need: "clearly enough," "solidly sufficient," enough to make it "completely plain" or "crystal clear" to the enemy that we will retaliate with devastating force, etc. But our strategic force as it is planned now, even given the low and uncertain estimates of enemy capabilities, cannot ensure a level of destruction as high as that which Russia sustained in World War II—a destruction from which it has more than recovered in a few years. This is hardly the "crystal clear" deterrent we might need in some foreseeable circumstance.

But the concluding point to be made is this: However modest may be our desire for a basic deterrent capability, it would be most wasteful and inefficient to obtain this goal by a method that allows the preponderant majority of our force to be destroyed on the ground at the outset by a surprise attack.

- ***The actions we need to take now will cost about $60 million. Delay on these is costly, but decision on the rest of the program is revocable.***

*In an interview with the press on December 3, 1941, Air Chief Marshal Sir Robert Brooke-Popham, Commander-in-Chief, Far East, for the British forces stated, "There are clear indications that Japan does not know which way to turn. Tojo is scratching his head." As Japan did not have a definite policy to follow, irrevocably, step by step, said Sir Robert, "there is a reassuring state of uncertainty in Japan." (O. Dowd Gallagher, *Action in the East*, p. 94.)

The following measures involve small early commitments on long-lead-time items:

Diplomatic negotiations with Mexico for the southern radar line.

Research and development on shelters, and the testing of components.

Development of an engine replacement for the B-47.

Engineering B-52 and B-47 modifications.

Research and development to give Talos a low-altitude capability.

Survey for the Gulf of Mexico sonar barriers.

Research and development on forward scatter and meteor burst communications systems and on airborne relay stations.

Delay in this program will involve large dollar costs later as well as great risks.

The following items are low in ultimate total cost:

Dispersal and toughening of bomb storage.

Development and procurement of a bomb-alarm system.

Test for low-altitude radar coverage gaps.

Test of an improved GOC line.

Change in the decision process for SAC—provide SAC–CONAD video link.

Priority for SAC use of all U.S. bases.

Test and procurement of GOC acoustic aids.

Improved raid-recognition system.

Study of the ICBM timing problem.

Development and procurement of a fallout monitoring system.

Development of graded SAC response.

While the recommended program is not "a quick fix," some of the measures listed can be made useful at a fairly early date. However, the work to be done to ensure our power to strike back after a thermonuclear attack should not be underestimated. For this reason it is vital to get started on the long-lead-time measures, as well as on those that can take effect quickly.