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DRAFT

September 30, 1961

APPENDIX II TO THE
MEMORANDUM FOR THE PRESIDENT

SUBJECT: Program for Deployment of NIKE ZEUS

This Appendix summarizes the various factors that were considered in reaching a decision to recommend a program for deployment of NIKE ZEUS. The Appendix includes the following sections:

I. Summary

II. Possible Courses of Action

III. Description, Status, and Technical Evaluation

IV. Reasons for Limited Deployment

V. Growth Capability of NIKE ZEUS

VI. Planning and Funding for a Limited Deployment

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I. Summary

The question whether the NIKE ZEUS anti-missile system should be deployed has been under consideration for several years. I have now decided to recommend that funds be included in the FY '63 budget for NIKE ZEUS production support. This would make possible its limited deployment in the near future. The Joint Chiefs of Staff support this recommendation.

A recent technical analysis has confirmed that NIKE ZEUS will not provide soft targets an effective defense against large scale or sophisticated ICBM attacks. A purely technical appraisal would not lead to a recommendation for deployment of a weapon system with so limited an operational effectiveness. This has been the conclusion of past technical evaluations; the current review has revealed no important new technical factors.

On the other hand, the following considerations appear, in my judgment, to favor a limited deployment of Zeus:

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a. Although the potential capabilities of sophisticated ICBMs are undisputed, they must be balanced against the expectation that the Soviets will make some errors in the design of their ICBM force and have technical, organizational, and resource difficulties which could limit the capabilities of this force. Our own experience with the development and deployment of ICBM forces has provided examples of such limitations.

b. The existence of a deployed defense may substantially increase the degree of uncertainty at the Soviet decision-making level. The offense will find it more difficult to be certain that weaknesses do not exist which may have been discovered by the defense. Recent evidence indicates that existing warheads on our ballistic missiles are subject to destruction at fairly large distances by nuclear detonations. Though this would not in fact make NIKE ZEUS effective against planned U. S. missile systems, it is an example of the unpredictable elements involved.

c. In Soviet planning for a military operation, there would have to be some diversion of ICBM forces to penetrate a deployed defense, even though the economic exchange ratio is unfavorable to the defense. This may take the form of extra missiles assigned to saturate, confuse, or destroy anti-missile systems or the introduction of sophisticated reentry vehicles with penetration systems and other protective devices.

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d. Even limited deployment would inhibit blackmail from secondary powers, provide some protection against accidental attacks and against violations of arms control agreements.

e. Some counter may be desirable against future Soviet claims to a successful anti-missile system. Soviet efforts in the field of ballistic missile defense appear to be more ambitious than our own efforts. Even if U. S. scientists can offer claims of a U. S. capability to counter completely the USSR defense, this will not cancel out the psychological advantage gained by the USSR in announcing or demonstrating an ICBM defense capability.

f. A system in being may be used as the basis for introducing some improved performance capabilities if target identification proves to be more feasible than is now expected or if reentry vehicle vulnerability is greater than now estimated.

These factors are sufficiently compelling to recommend a limited deployment of the NIKE ZEUS system. An operational capability can be obtained starting in 1965 and, although other city-defense systems of somewhat greater capability are feasible by about 1970, none of the current proposals provides assurance of a truly effective defense of cities. It should be recognized that deployment of any active city defense (including NIKE ZEUS) presupposes a system of civilian fall-out shelters.

implies that the anti-missile system itself is hardened. Although this course of action represents a major development task, it appears to be fundamentally easier of accomplishment than city defense, and it is estimated that this hardened point-defense anti-missile system could be available for deployment in about five years.

My decision to recommend a limited deployment of NIKE ZEUS must not preclude a continued and vigorous research and development program on other improved ballistic missile defense systems. In fact, the Director of Defense Research and Engineering is initiating research and development programs which would allow later development of the systems mentioned in d and e, above.

III. Description, Status, and Technical Evaluation

NIKE ZEUS, under development by Bell Telephone Laboratories since 1956 for the U.S.Army, is the only active anti-ballistic missile defense system under hardware development in the United States or allied countries. About $1.2 billion has been budgeted on the ZEUS R&D program through FY 1962, and the development cost, through FY 1965, is about $1.7 billion.

The NIKE ZEUS is a terminal defense system in which the incoming targets are detected and tracked by radar, the ZEUS missile is launched, steered to an intercept point, and its nuclear warhead detonated by ground command. A special radar provides some capability of discrimination between warheads and decoys.

Testing of parts of the system is well under way at White Sands Missile Range and Ascension Island. Future tests are also scheduled at Pt. Mugu and Kwajalein Island. The latter location will have a complete ZEUS system, and actual intercepts will be flown against ICBMs fired from Vandenberg. These firings are scheduled to begin about April 1962.

The NIKE ZEUS contractor is very competent and experienced and is as qualified as any to handle this very complex job. However, the system design clearly still suffers from its early disregard of the threat of ICBMs designed for penetration, i.e., use of low radar cross-section nose cones, multiple warheads, decoys, and active jammers.

A NIKE ZEUS battery is flexible in organization; the nominal ZEUS battery would consist of:

1 - Discrimination Radar (DR)
6 - Target Track Radars (TTR)
12 - Missile Track Radars (MTR)
96 - Interceptor Missiles

Such a battery is capable of firing and guiding to target simultaneously up to six salvos every twenty-five seconds until the missile supply is exhausted. Each salvo normally has two interceptors to assure target kill.

In addition to the battery, the ZEUS system requires a ZEUS Defense Center (ZDC) which includes the powerful ZEUS Acquisition Radar (ZAR). A ZAR detects incoming missiles and assigns a battery to perform the interception.

ZEUS was originally designed to be a 75 nautical mile system. A decoyed attack forces ZEUS to withhold defensive missile commitment until targets enter the sensible atmosphere. This restricts the range of ZEUS to about 20 nautical miles which corresponds to about a 10-mile radius defended area for an 8 megaton yield in the incoming ICBM. After initial detection of a target, the time required for this ZEUS operation is:

ZAR track and target assignment	20 seconds
Missile flight to target	25 seconds
Total	45 seconds

This timing requires that the ZAR first detect a threatening ICBM at about 200 nautical miles and the ZEUS interceptor be launched when the target is at 120 nautical miles. The exact ranges depend on the geometry of the battery and the protected area and on the ICBM trajectory (including re-entry angle).

Improvements in ZEUS are being considered which could reduce the total time required from first detection to interception to 35 seconds under favorable conditions and thereby reduce the required detection range to 130-150 nautical miles.

An important characteristic of ZEUS is the target altitude when the missile is launched: for typical ICBM trajectories, this altitude, depending on the decoy characteristics, lies between 180,000 and 380,000 feet if interceptor launch is delayed to the last possible moment.

If objects are not discriminated at that altitude, ZEUS must either launch against all of them or take the chance of launching a smaller number of missiles and hoping to redirect them at those which are later identified as threatening. If the cloud contains more warheads than ZEUS has launched missiles, the attack succeeds. Thus, the offense can employ decoys to saturate ZEUS. The number of decoys which defy identification down to the missile altitude at the moment of interceptor launch determines the degree of saturation. Decoys which remain unidentifiable by ZEUS down to 200,000 feet altitude are expected to be light (less than 2% of warhead weight) and consequently could be present in large numbers. (This decoy weight increases very rapidly with altitude below 200,000 feet.) These decoys, like ZEUS discrimination techniques, are under development and have not been field tested.

The current design ZEUS single or multiple battery effectiveness can be characterized as follows:

effective against missiles not equipped with penetration aids. Examples are operational ATLAS, TITAN I, MINUTEMAN (Wing 1), POLARIS A1 and A2.

marginal against missiles equipped with minimum (retrofit type) penetration aids. Examples are ATLAS and TITAN as programmed, MINUTEMAN Wings 2 through 4. These are programmed in the U. S. inventory in 1963.

ineffective against missiles with appreciable payload allocation to penetration aids.

In light of the greater payload capability of Soviet missiles and the expected Soviet knowledge of the operational and general characteristics of ZEUS, we assume that Soviet missiles will be at least as effective against ZEUS as U.S. missiles.

Effective ZEUS operation against "bare" missiles is assured. A single ZEUS battery could successfully defeat about 14 such ICBMs arriving per minute, until the missile supply became exhausted. If the last stage tank could not be identified, which is unlikely, the rate which can be handled is reduced by one-half. Operational ATLAS, TITAN I, MINUTEMAN (Wing 1) and POLARIS (A1 and A2) are examples of such threats.

Marginal ZEUS operation can be expected, however, whenever missiles are retrofitted with penetration aid devices. ATLAS E and F (nose cone weight about 3000 lbs.) will, by 1963, be equipped with penetration aid pods weighing about 250 lbs. Against such a threat ZEUS would be forced to fire between 2 and 18 interceptors depending on the extent to which ZEUS interceptors can be diverted with successful discrimination after launch and on the assumptions concerning the number of warheads in the cloud. A reasonable number might be 12. ATLAS E and F fired with full payload at shorter than design ranges (4500 instead of the designed 5500 nautical miles) can come in at a sufficiently steep re-entry angle to make complete identification of tank fragments impossible before the last possible commitment time.

This would increase the number of missiles fired against a single ATLAS by a factor of two or more. This leads to the conclusion that at least two and probably four or more ZEUS batteries working in close cooperation would be required to shoot down a single ATLAS retrofitted with penetration aids. However, radar field measurements and laboratory development work comparing ATLAS tank fragments, as

determined by ground burst, with the ATLAS E and F warheads show high confidence for the elimination of tank fragments by scintillation filtering techniques outside the sensible atmosphere, providing that the discrimination radar is not jammed and is sensitive enough to see the target.

ZEUS operation may also be marginal [redacted] No mere addition of batteries could overcome this problem.

Improvements which might be incorporated into ZEUS could enhance its capability against this class of threat. By reducing system reaction time substantially all the tankage could be identified prior to weapon commitment. This would hold the number of batteries needed to stop an ATLAS to about three. This shorter reaction time would also slightly improve ZEUS against [redacted] reducing the number which penetrate to somewhat less than thirty percent.

[redacted]

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Admittedly, ZEUS effectiveness can be improved against a particular threat but it is important to note that this improvement is not realizable if we consider that ZEUS must be prepared to cope with a wide variety of threat possibilities, of whose details we have little a priori knowledge.

ZEUS or a reasonably modified version of it could be effective against a determined Soviet attack if the Soviets, in spite of U.S. production of ZEUS, use in 1965-70 ICBMs and IRBMs with penetration capabilities similar to those deployed in the U.S. in 1961, or utilize a limited missile force (i.e. several hundred missiles) with penetration aids of limited sophistication. We should note from our own experience that this failure to design the attack for penetration is not impossible, although it is unlikely. No comfort can be gained from the present status of our own or Soviet ICBMs. The Soviets would learn of any production plans we may generate for ZEUS and could react rapidly by developing a wide spectrum of penetration aids. For example, intelligence about Soviet AICBM has provided large impetus to U.S. penetration aids program. In general, it can be stated that the time required for incorporation of new penetration aids into ICBMs is less than the time required to alter a defensive system to cope with a particular ICBM penetration tactic.

The size and weight limitations of POLARIS type missiles make them difficult to equip with effective penetration aids; hence ZEUS is more effective against this threat.

It is clear from a study of ZEUS capabilities against sophisticated attacks of many sorts that an increase in the deployment strength at a particular installation will not meet sophisticated massive attacks. In the case of low radar cross-section ICBMs, an increase in battery strength does not decrease the penetration ability of the ICBM at all.

IV. Reasons for Limited Deployment

Although the technical evaluation indicates that any likely anti-missile system can probably be defeated by apparently reasonable enemy tactics, there are other considerations, outside the realm of technical evaluation, that favor a limited and immediate NIKE ZEUS deployment. Certainly these considerations have been applied by Commander-in-Chief, North American Air Defense Command, and the Joint Chiefs of Staff, after carefully weighing technical evaluations of the NIKE ZEUS, which have been available for several years.

A few of these considerations are briefly summarized below:

a. The Possibility of Enemy Weaknesses and Errors

The possibility of enemy errors and limitations existing unknown to us is unprovable by detailed analysis. However, several cases of the possible weaknesses of ICBM systems can be drawn from our own program. For example, the vulnerability range of our present reentry vehicles is [ ] This is about [ ] what was initially assumed. Even worse, the vulnerability radius is much greater under special circumstances and there is no assurance, short of field testing, that this is not true in general. FRD (FRD DOE)

A second example is the composition or "mix" of ICBM forces. The missiles that have adequate weight allowance for reliable penetration (ATLAS and TITAN) are relatively vulnerable to destruction on the ground, while those missiles which we will have in large numbers and which are relatively invulnerable to a first strike (MINUTEMAN and POLARIS) have marginal payloads and design changes must be made in order to gain a reasonable confidence that they can make use of the low cross section warheads as a penetration device.

b. The Confidence Level of Decision Makers

The problems of when and how to launch an ICBM attack are obviously simplified for the Soviet decision makers if there is no opposing defense. They can rely on a simple and virtually certain saturation strategy. Any kind of a defense, however, creates the need for a more complicated and sophisticated attack strategy. This increases greatly the risk of failure and thus lowers the confidence of the Soviet leaders in their ability to make a successful attack.

c. Diversion of Offensive Forces

[ ] FRD (FRD (DOE)

[ ] The analysis should be carried further, however, since a penalty has been paid for this capability. The total yield of nuclear payload has now been reduced [ ] This restraint would permanently earmark the modified missile force as "ballistic missile defense penetrators", and these missiles could not be reassigned by a military planner for use as "fall-out-producing weapons", for example. Generally, a deployed defense will increase the offensive force requirements or shift the attack to undefended targets. FRD (FRD (DOE)

d. Defense Against Secondary Threats

In the foreseeable future secondary powers, such as Cuba and China, may have small or unsophisticated ballistic missile forces that could reach the United States. It is most desirable that we not be vulnerable to such threats or at least not appear to be vulnerable. Accidental attacks and attack by small forces that might evade arms control agreements are other examples of limited attacks that would much better be met by defensive systems than by counterattack.

e. A Counter to Soviet Anti-Missile Development

Intelligence found solid evidence 18 months ago that the Soviets were developing anti-missile systems on a more ambitious scale than the United States. Developmental radars of advanced configuration and many times larger than any planned by the United States were observed. Launching installations indicate a more advanced interceptor (SA-4) than NIKE ZEUS. Also observed were launching installations associated with SA-2, which is deployed at 70 defense centers in the U.S.S.R., and which might be upgraded to kill ICBMs with inadequate penetration systems. It may be that the current series of nuclear tests includes full demonstrations of such anti-missile systems.

Even with assurance from our technicians that our second strike force can penetrate such defenses, Soviet claims and demonstrations will have a major effect on the uninformed here and abroad and may have major political results.

V. Growth Capability of NIKE ZEUS

If a decision to deploy ZEUS is made now, there are some desirable changes which can be incorporated into the present ZEUS system, either meeting first deployment or phased-in later.

The major area that should get attention for growth in the present ZEUS is the Discrimination Radar (DR). Improvement would be directed toward increasing range against small targets and resistance to electronic jammers.

Reduction of flight time for a 20 mile interception from 25 seconds to about 15 by design of a new short-range, high performance "sprint" missile, would gain invaluable time for discrimination at lower altitudes. Dead zones would also be reduced. Such an interceptor missile could be retrofitted to a deployed ZEUS system with relative ease.

More [redacted] of the cost of a ZEUS interceptor is in the nuclear warhead. If a cheap, effective non-nuclear warhead can be developed the problem of exhaustion of missiles can be overcome t

a great extent. Since the missiles are now only a small part of the ZEUS cost, the cost per intercept of the radars would also have to be reduced in order for an important overall reduction in cost per intercept to take place.

Development of a phased array radar, known as ZMAR, has recently been initiated. If successful it will:

1. Perform all of the radar functions with one equipment.
2. Remove most of the radar restrictions on multiple, high-rate-of-fire intercept.
3. Greatly increase resistance to jamming and overcome the ZEUS discrimination radar vulnerability to low cross-section targets accompanied by tank fragments.
4. Eliminate acquisition delays inherent in the mechanically scanned ZEUS acquisition radar.
5. Provide tracking performance adequate for the short ranges envisioned. Many of the components of the present ZEUS system would have to be changed if ZMAR is incorporated in ZEUS, so it would in effect be a new system.

Effective defense of hard targets can be achieved with a low-power, hardened radar system similar to ZEUS-ZMAR described above. Such a system would have very small intercept ranges (under 5 miles) and could therefore hold its fire until the attacking missiles reach very low altitude. The difficulties of discrimination are greatly eased or eliminated and firepower problems alleviated. Such a system must be hardened but otherwise can have less complex and expensive components than ZEUS-ZMAR.

The two types of defended targets of interest are command centers and retaliatory forces. For command centers, the per-installation value defended is probably high enough to justify a version of ZEUS-ZMAR with its expensive radar.

VI. Funding and Planning for a Limited Deployment

The recommended program would defend six cities and about 39 million people using six ZDCs, 12 batteries, and 1200 missiles.

Each of the 12 batteries would consist of one discrimination radar, six target track radars, 12 missile track radars, the associated guidance monitoring ground support equipment, and 96 missiles. After the 48 month lead time the first unit would be operational. Total equipment would be delivered and installed in a two year period.

The Army program submission postulated production of a "29 Defense Center -- 70 Battery" a/ system, defending 27 major areas in the U. S. and Canada, with 7 defense centers and 12 batteries to be deployed by the end of FY 1967.

Table I, following, provides a comparison of the obligational authority required for the "NIKE ZEUS AICBM system" as included in the Army Program Submission with the recommended program. It presents all obligational authority to be required in the period FY 1963-1967 except for the production of the warheads. It should be noted, however, as shown in Table II, that even for the recommended program substantial funding beyond FY 1967 will be required. Furthermore, if a decision were to be made later to explain the scope of the ZEUS deployment program, considerable additional funding would be required beginning in FY 1964.

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a/ In this program the batteries are approximately one-half the size of the batteries proposed for the limited deployment.

TABLE I

Obligational Authority for Zeus Programs, FY 1963-67
(Millions of Dollars)

	DEPARTMENTAL PROGRAM SUBMISSION		RECOMMENDED PROGRAM	
	FY 1963	FY 1963-67	FY 1963	FY 1963-67
R&D	270	690	270	690
Initial Investment[a]	180	7140	110	2740
Annual Operation	-	10	-	(50) ?
Total	450	7840	380	3480

To battery — In late

TABLE II

Obligational Authority Required for Recommended Zeus Program
FY 1963-68
(Millions of Dollars)

	FY 1963-68
R&D	740
Initial Investment	2820
Annual Operation	100[b]
Total	3660

a/ Two years of replacement spares have been included in initial investment in addition to the initial stocks.

b/ The annual operating cost of the recommended force is estimated to be $250 million in FY 1969 and following years.