REPORT

of the

DEFENSE SCIENCE BOARD

TASK FORCE

ON

Small Intercontinental Ballistic Missile Modernization

MARCH 1986
Office of the Under Secretary of Defense for Research and Engineering

Washington, D.C. 20301

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OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-3140

DEFENSE SCIENCE
BOARD

10 March 1986

MEMORANDUM FOR THE SECRETARY OF DEFENSE

THROUGH: UNDER SECRETARY OF DEFENSE FOR RESEARCH
AND ENGINEERING

SUBJECT: Report of the DSB Task Force on ICBM Modernization -
ACTION MEMORANDUM

This memorandum transmits the report of the ICBM Modernization Task Force. The salient recommendations are included in the executive summary of the report. The report was briefed to and approved by the full Defense Science Board.

I am aware that the findings and recommendations of the group will not receive universal approval within DoD. However, the Task Force is composed of outstanding individuals who have considerable experience and have devoted substantial thought to arriving at their conclusions. These deserve your careful consideration. I believe this report is in an appropriate form to transmit to Congress as requested in the FY86 Defense Authorization Act.

Charles A. Fowler

Charles A. Fowler
Chairman

Attachment

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

DEFENSE SCIENCE
BOARD

6 March 1986

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Report of the The Defense Science Board Task Force on ICBM Modernization

I have enclosed the final report of the Defense Science Board Task Force on ICBM Modernization. Our major findings and recommendations may be found in the Executive Summary. It has been a pleasure to serve with such a distinguished group of individuals on this Task Force. We would all like to express our gratitude for the excellent cooperation we received from those supporting this effort.

John M. Deutch
Chairman
Defense Science Board
Task Force on ICBM Modernization

EXECUTIVE SUMMARY

The Task Force considered a range of ICBM and basing alternatives, with emphasis on the question of survivability and stability. The principal deployments analyzed were: (1) 500 Small ICBMs (SICBMs) deployed in Hard Mobile Launchers (HMLs) on four existing U.S. Government complexes in the Southwest; (2) 50 MX ICBMs deployed in a variable number of superhard silos (patterned array); and (3) 50 MX ICBMs deployed in carry hard configuration, i.e., in hardened cannisters deployed among a large number of low cost vertical shelters.

The Task Force concluded that there is at least one SICBM basing mode -- and possibly one or more MX basing modes -- which, although costly, have a high degree of survivability and accordingly are suitable candidates for deployment by the U.S.

The Task Force further found that:

1. At current Soviet accuracies and current U.S. cost estimates, and at attack prices below the approximate equivalent of half the current total Soviet throwweight (ICBMs plus SLBMs), MX deployed in patterned array or in carry hard appears less expensive to acquire than an SICBM/HML force of equal warhead numbers.

2. However, as Soviet accuracies approach a 300 ft. Circular Error Probable (CEP), the cost advantage of patterned array and carry hard disappears and then reverses to become a cost advantage for the SICBM/HML system. This cost advantage of the SICBM/HML force grows if one wishes to charge a Soviet attack price of greater than about half of the current Soviet throwweight.

3. If Soviet accuracies become better than about 300 ft -- e.g. with inertial missile guidance updated by external navigation aids after launch, or with terminal guidance systems -- the cost of carry hard and particularly patterned array is severely increased while that of SICBM/HML remains stable.

The Task Force recommends that SICBM design weight be increased from 30,000 lbs to 37,000 lbs. The recommended additional weight permits full target coverage, penetration aids, and the capacity for future payload variations -- including a Maneuvering Re-entry Vehicle (MaRV), or two warheads of smaller size than the baseline configuration of a single MK 21. This missile should be developed for deployment in HMLs of at least 30 psi hardness on U.S. base complexes. Full-Scale Engineering Development should begin in FY 87 pointing toward an Initial Operating Capability (IOC) in 1992. The flexibility of such a system to remain highly survivable in the face of future Soviet developments and countermeasures is its outstanding feature.

The Task Force further recommends that a careful analysis and validation effort be undertaken of the carry hard concept for MX basing, as well as an investigation of superhard MX basing integrated with ballistic missile defense designed to defend very hard targets.

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I. Introduction and Background

This is the final report of the Defense Science Board (DSB) Task Force on ICBM Modernization. The Task Force was established by Under Secretary of Defense Hicks in response to the FY86 Department of Defense Authorization Act. The pertinent legislative language and the Terms of Reference establishing the Task Force are included in Appendix A. Task Force membership is included in Appendix B. A classified annex includes some additional supporting detail that cannot be presented in this unclassified format.

The principal purpose of the Task Force was to review the technical status of the SICBM program and to assess the contribution that the SICBM in various basing modes could make to the US strategic posture and to deterrence. Such an assessment of the SICBM necessarily includes comparing both its cost and effectiveness to that of other available ICBM alternatives, in particular MX in various basing modes.

The Task Force notes that this represents the fourth land-based ICBM study undertaken by the DSB since 1978. Each of these studies addressed different questions, but the common thread was the search for basing survivability in the face of a responsive threat. The fact that these issues are still being addressed suggests strongly that there is no simple and clearly dominant technical solution. Rather, the important questions of ICBM modernization must involve the interplay of technology, national security strategy, and both international and national politics.

The Task Force was mindful of the substantial pressure on the overall defense budget and the need to consider costs critically. The framework for the Task Force was provided by the Report of the President's Commission on Strategic Forces (Scowcroft Commission) of 1983, which has largely been accepted by both the Executive Branch and Congress. In brief, the Scowcroft Commission proposed that the ICBM modernization should proceed with three integrated steps:

- Development and deployment of a new small ICBM. A Full Scale Engineering Development (FSED) decision was recommended for FY87 with an IOC in the early 1990's.
- Deployment of 100 MX missiles in Minuteman silos in the near term, and vigorous research and development on alternative MX basing.
- An approach toward arms control that emphasizes stability via agreements moving toward equal numbers of warheads of roughly equivalent yield, not equal numbers of launchers.

This Task Force endorses these views, although there are differing opinions on further MX deployments and basing.

A number of reasons were put forth by the Scowcroft Commission for maintaining a strategic triad (ICBMs plus bombers and submarines) and hence pursuing ICBM modernization. The reasons included:

- The mutually reinforcing nature of each leg of the triad in deterring a Soviet attack. In particular, for a number of years to come the Soviets will not be able to attack both our bombers and ICBMs without providing sufficient warning to permit the possibility of retaliation from one of these two legs of the triad.

- The hedge provided by highly survivable ICBMs to an unexpected breakthrough by the Soviets in anti-submarine warfare (ASW) which could threaten our SLBM force. A highly survivable ICBM force also provides a hedge against the future when Soviet SLBM accuracy and numbers improve to the point where simultaneous attack on both US bombers and ICBM's becomes possible.

- The contribution made by the prompt hard target capability of land-based ICBMs to deterring a broader range of nuclear conflict than all-out nuclear war.

- The contribution made by ICBM modernization to both our arms control and political/military posture in the minds of both the Soviets and our allies.

The Task Force endorses these views of the Scowcroft Commission as well. The Task Force notes, however, that there have been developments since that Commission's Report which bear on the present inquiry:

- The prospects of a major arms control agreement of the sort recommended by the Commission have not materialized.

- The Small ICBM program has progressed expeditiously, with continued successful validation of the missile, the guidance, and the HML. Technical issues have been resolved satisfactorily and practical operational concepts have evolved. Both missile and HML will be ready for initiation of FSED in FY 87, which could produce an IOC in FY 92.

- The U.S. Congress has indicated that no more than 50 MX missiles will be deployed unless a survivable basing mode can be found and implemented.

- The MX flight test program has demonstrated a reliable missile with better-than-expected accuracy within estimated production costs.

- The super-hard silo program has demonstrated that hardness levels of 25 to 50 times previous levels are possible in practical designs for super-hard MX silos or vertical shelters by late 1990.

- Two other basing modes for MX (carry hard and shallow tunnel) have recently been subjected to analysis and some limited experimentation. The costs and design of these basing modes are as yet uncertain, but the lower end of the cost estimates for them present attractive options. Current estimates would permit an IOC in the early 1990's.

- The Soviets have deployed two new ICBMs (the SS-X-24 and SS-25), contrary to the provisions of SALT II. Both will be deployed in a mobile mode.

- It has become recognized that mobility has several important implications for strategic forces.

  - Mobility (as well as effective concealment in which one has high confidence) reduces the importance of whether an attacking missile force of any given throwweight is MIRVed. When ICBMs are in silos or shelters an accurate MIRVed attacking force is particularly troubling because MIRVing multiplies the effectiveness of the attacking force's throw-weight by multiplying its ability to attack a certain number of fixed points. But when there are the sorts of mobile deployments undertaken by the Soviet Union and contemplated by the U.S., the destabilizing nature of an attacking force of any given throwweight being MIRVed is sharply reduced. This is because the military effectiveness of a barrage attack against an area where mobiles may be located is governed by the attackers's equivalent megatonnage -- a measure that varies far more directly with throwweight than with warhead numbers. Within a wide range of warhead numbers, attacking forces of equal throwweight have nearly equal effectiveness. A mobile deployment which must be attacked by the barrage of an area thus

devalues an attacker's ability to MIRV (or to have high accuracy).

- It follows that missiles of greater throwweight have a proportionately greater ability to conduct a barrage attack of a mobile deployment area than smaller missiles -- although the area occupied by the mobile deployment, and the hardness of the mobile system, may still be sufficiently great to make such a barrage attack extremely difficult.

- Mobility permits a nation that stresses secrecy and is willing to violate agreements greater flexibility in deploying larger numbers of launchers than it is willing to acknowledge.

- There is substantially increased reason to be interested in ballistic missile defense (BMD) of ICBMs, especially for deployment of MX in any shell game -- i.e. any basing mode using multiple shelters and concealment, such as carry hard or super-hard vertical shelters. The Strategic Defense Initiative (SDI) program focuses on area-wide defense of population and military targets; the Task Force placed its emphasis on terminal defense of basing modes for MX that use shelters and concealment.

- Fiscal stringency, always a consideration, may be particularly serious in light of the overall federal budget deficit.

A. Alternatives Considered

The Task Force adopted as its objective the identification of the ICBM system or systems that would provide survivability and would be adaptable to changing conditions in the manner that is most effective for the cost. For the sake of analysis we considered primarily a deployment of 500 warheads. It is recognized that larger deployments may be desirable depending upon the results of arms control negotiations, Soviet actions, and deployment of other US strategic forces, and that deployments smaller than 500 may initially be undertaken.

The Task Force did not devote detailed attention to the precise utilization of these forces but we note that the prompt hard target capability of the land-based ICBM force is an important characteristic of that force. Additionally, a high degree of survivability of the ICBM forces, standing alone, is desirable at any time; during the 1990's, as Soviet accuracy improves, a high degree of survivability will become essential in order for the US not to be under pressure to launch its ICBM force -- before there were any nuclear detonations on U.S. soil -- because of a belief that an attack was underway.

The Task Force believes that it is important to consider a missile and its basing as an overall system. It is only by considering the overall system and its full range of operations that the cost and effectiveness can be assessed within the context of the overall US strategic force posture.

Only two basic missile types were considered: the MX missile presently in production, and the SICBM presently in the early stages of development as a three-stage 30,000 lb. missile. Larger versions of this latter missile were considered as well. These two missiles were initially considered in six combinations with basing modes. All six combinations have the traditional ICBM features of: (1) the ability promptly to engage hardened targets; (2) a high alert rate; (3) the ability for the launch times and targets of the surviving portion of the force to be controlled after attack; and (4) redundant command, control, and communications. The six combinations are:

SICBM	1.	Hard Mobile Launcher (HML)
"	2.	Carry Hard Vertical Shelters[1/]
MX	3.	Superhard Silos (Patterned Array)[1/]
"	4.	Superhard Vertical Shelters[1/] with Concealment (Patterned Array)
"	5.	Carry Hard Vertical Shelters[1/]
"	6.	Shallow Tunnel

The following brief comments are included about each of these basing alternatives.

1. SICBM/HML - The HML would be a vehicle of approximately 150,000-200,000 lbs. which would travel approximately 30 mph (including some off-road mobility), would be hardened to at least 30 psi, and would have the ability to disperse under attack.

2,5. SICBM and MX/Carry Hard - Under the carry hard basing concept the missile would be loaded into a hardened cannister that could be concealed in one of a number of vertical shelters; the cannister and shelter together would provide a hardness of several thousand psi. There would be an effort to design the vertical shelters to be as inexpensive as possible to lower the cost of proliferating them. The degree of hardness of the

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1/ In this report, "silo" deployments are those in which there are the same number of missiles as vertical shelters for them; "shelter" deployments are those in which there are several times more vertical shelters than missiles (i.e., "shell games").

vertical shelter and cannister together would, in concept, be sufficiently great, and the method of maintaining concealment sufficiently effective, to permit relatively close spacing of shelters and a small border around the complex. This would limit the dedicated land area required.

3-4. MX/Superhard Silos or Vertical Shelters - This basing concept relies on the recently developed superhard silo technology to design individual silos or shelters to withstand over-pressure 25 to 50 times higher than current silos. This basing option could use single silos or could include additional silos (shelters) for concealment. The arrangement of the silos or shelters could be in a closely-spaced patterned array to take advantage of fratricide among attacking missiles. The patterned array concept is similar to the Closely Spaced Basing (CSB) concept put forward by DOD in 1982, but the silos or shelters would be harder and more closely spaced. An option for small missile basing in superhard silos or shelters is possible to imagine, but it was not considered by the Task Force because of the high cost of the necessary number of individual silos or shelters.

6. MX/Shallow Tunnel - This deployment would place MX missiles in mobile launchers concealed in a shallow tunnel. A typical deployment might consist of 50-100 MX missiles in 1,000 miles of hardened tunnel. This basing mode would take advantage of hardness and continuous concealment in the linear tunnel.

B. Survivability

There is general agreement that a high degree of survivability is a desirable attribute of land-based ICBM's. Vulnerable land-based missiles can become an attractive target to an adversary and, faced with some types of threats, could tempt decisionmakers to use them based on attack sensor data alone. Accordingly, there has been an understandable value placed on assuring that the US ICBM force is not vulnerable to a surprise Soviet attack. Initially adequate survivability was achieved through hardening. However, as missile accuracy improves, it becomes progressively more difficult to assure adequate survivability by such methods.

Survivability can be achieved through a combination of measures -- hardness, concealment, mobility, defense, and tactics. However, these characteristics are generally expensive and it must be realized that ICBM survivability can only be obtained at considerable cost. The question is how much should be spent to assure the flexibility necessary to handle possible threat developments in the future. It is equally important to recognize that absolute invulnerability is impossible to achieve. It follows that the critical issue is how to assess the relative survivability of alternative force postures.

At the heart of the analysis upon which this Task Force's recommendations rest is an effort to answer two questions.

1. What is the price to the Soviets to attack a given U.S. ICBM force in a first strike that reduces the surviving U.S. ICBM force to some preassigned value?

   The answer to this question gives a measure of survivability of the US Force posture. If the price (measured in terms of Soviet throwweight) which must be paid by the Soviets to attack the U.S. ICBM force successfully represents a prohibitively high portion of the Soviet ICBM/SLBM inventory, one may conclude that a Soviet planner would not attack this US target set. Alternatively, a high price to attack might mean that if the Soviets did plan to attack the target set, such an attack would so reduce the Soviet strategic forces and the options for their use that the survivability of the rest of the US forces and targets would be significantly enhanced.

2. At the margin, what is the approximate cost for the Soviets to add an increment to their attacking force to reduce the number of US ICBM warheads surviving, and what is the approximate cost for the US to improve its ICBM force's survivability (e.g., by adding shelters) in order to preserve the fraction of its warheads surviving?

   The answer to this second question provides one, but only one, indication of the survivability of the ICBM force. National resolve and irrationality cannot, of course, be quantified. But nevertheless, if it is obviously far more costly for the Soviets to add the capability to attack our ICBM forces than for the U.S. to improve the Survivability of those same forces, then it would be more likely to see their strategic efforts channelled in other directions.

The major finding of this Task Force is that at present there is at least one SICBM basing mode -- and possibly one or more MX basing modes -- which, although costly, have a high degree of survivability and accordingly are suitable candidates for deployment by the US.

The Task Force wishes to stress that while the analysis mentioned above is an important part of assessing an ICBM deployment, for a number of reasons it is not a sufficient basis for reaching a decision. First, the analysis is based on a stylized scenario involving a strike out of the blue for which there is either no warning or only tactical warning measured in minutes. Many people quite reasonably argue that this scenario, while important, is not the most likely and certainly not the exclusive scenario that is relevant for planning. Strategic forces may be on alert, e.g.,

because of a large-scale conventional war in Europe or elsewhere, or because of observed preparations for a strategic attack. Second, we must be concerned with how the US ICBM force structure relates to long term arms control efforts. Third, some weight must be given to problems of land acquisition and use and to the peacetime environmental impact of US ICBM deployments. Finally, we note that any analysis which intends to project future military capabilities over a thirty year period is subject to substantial uncertainty, both with regard to unanticipated U.S. or Soviet technical changes and to Soviet intentions. Hence the Task Force has assigned considerable weight to ICBM force structure alternatives that are robust and possess the flexibility to adjust to unanticipated threats.

II. Results of the Analysis

The Task Force has examined an analysis of the cost-effectiveness of five of the combinations of missiles and basing modes described above. Cost here means U.S. acquisition cost to deploy, although operating costs were considered as well. Effectiveness here means the attack price the Soviets would have to pay to attack successfully. Such analysis, by design, emphasizes the survivability of the basing modes and, as will be discussed, the results depend upon the conditions and characteristics of the attack. The Task Force would caution that such an analysis does not illuminate other legitimate points of comparison such as immediacy of deployment, cost to deploy offensive capability, technology strain on the Soviets to develop technical countermeasures, or the relative ease of defending different basing modes. These other points of comparison will be discussed later in the report.

The Task Force has considered the attack price to the Soviets to destroy various numbers of ICBM warheads deployed in various configurations. Three representative cases are:

1. 500 SICBM's deployed on HML's in four existing Government complexes in the Southwest (in a manner such that they do not, in peacetime, interfere with the bases' normal operations).

2. 50 MX deployed in a variable number of superhard vertical shelters, using concealment to enhance survivability (patterned array).

3. 50 MX deployed in a carry hard configuration, i.e., in hardened canisters within a variable number of vertical shelters (significantly less hard and less expensive than those in no. 2 above), also using concealment to enhance survivability.

The quantitative results of this analysis and other excursions carried out by the Task Force for these and other forces are included in the classified annex. The results of the analysis can be characterized in an unclassified manner in the following general terms:

1. At current Soviet accuracies and current US cost estimates, and at attack prices below the approximate equivalent of half the current total Soviet throwweight (ICBMs plus SLBMs), MX deployed in patterned array or in carry hard appears less expensive to acquire than an SICBM/HML force of equal warhead numbers.

2. However, as Soviet accuracies approach a 300 ft CEP, the cost advantage of patterned array and carry hard disappears and then reverses to become a cost advantage for the SICBM/HML system. This cost advantage of the SICBM/HML force grows if one wishes to charge a Soviet attack price of greater than about half of the current Soviet throwweight.

3. If Soviet accuracies become better than about 300 ft. -- e.g. with inertial missile guidance updated by external navigation aids after launch, or with terminal guidance systems -- the cost of carry hard and particularly patterned array is severely increased while that of SICBM/HML remains stable.

These results can be simply represented in graphic form. In this graph, the total acquisition cost (R&D, basing hardware and construction, missiles, and support equipment) that is required is a function of the attack price to accomplish a 90% DE. The relatively large initial investment for SICBM/HML involves everything except the base support; the latter accounts for the gradual upward slope of the SICBM/HML curve as base support is acquired one base at a time. Acquisition costs for MX in carry hard or patterned array are more sensitive to the attack price that is charged because of the cost of additional vertical shelter construction.

The analysis includes the following assumed conditions:

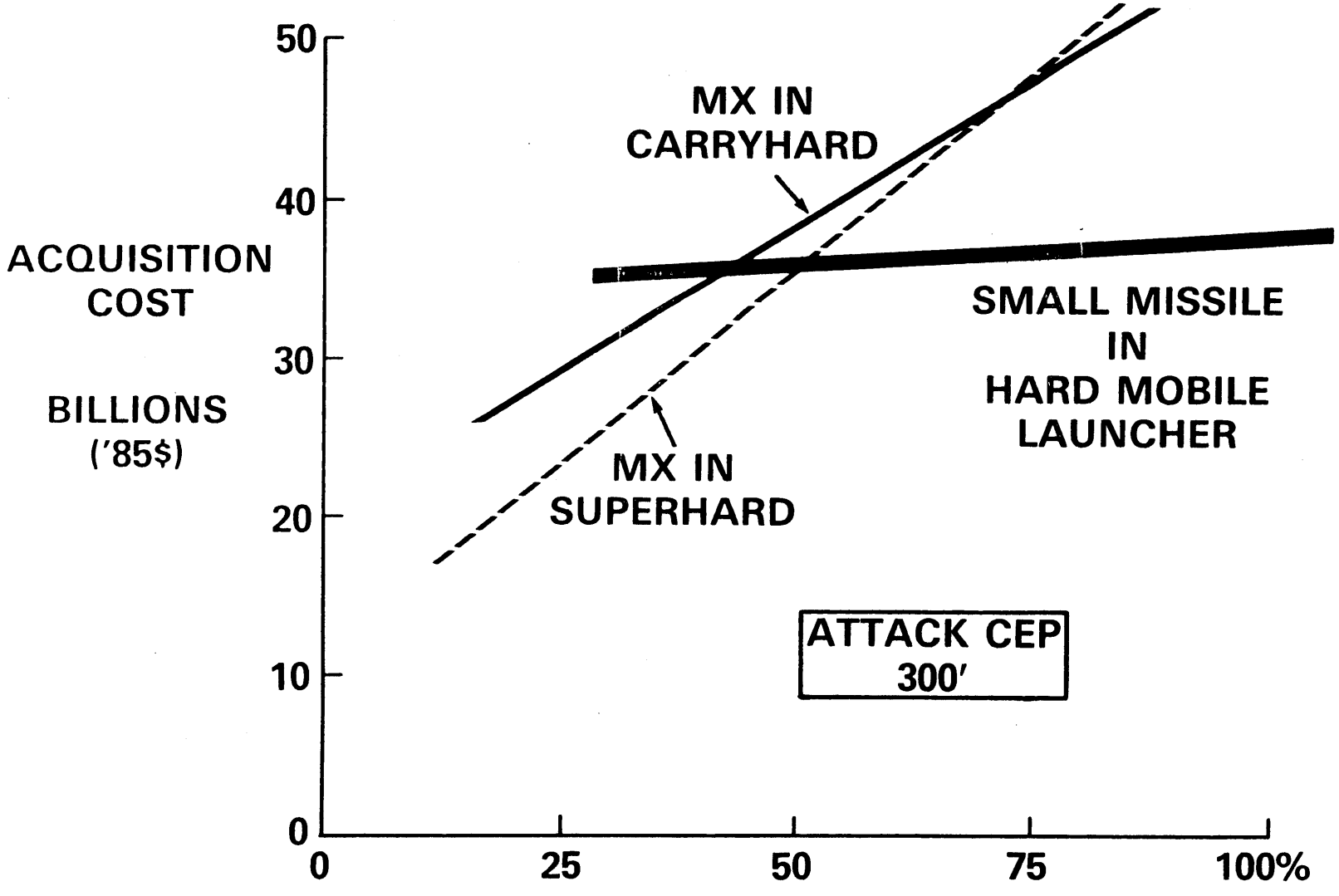
1. The attack price for SICBM/HML corresponds to a dispersal only after attack (tactical warning).

2. The MX missiles are concealed in random locations among fixed sites.

3. The attack on SICBM/HML is a simultaneous barrage after 30 minutes of flight and HML dispersal.

4. No additional attacking missiles are used to pin down MX in super hard silos or shelters.

500 DEPLOYED U.S. WARHEADS
ACQUISITION COST VS ATTACK PRICE



These results are based on certain additional assumptions. The critical ones are the following:

1. Relative costs of US systems, especially the cost of the vertical shelters for MX in carry hard. A reduction in the cost of these vertical shelters will improve the attractiveness of carry hard; the costs used by the Task Force, as in other cases, are those provided by the Air Force. Contractor estimates are lower because of both lower estimates for specific equipment and a different design.

2. Soviet CEP's and warhead types. Substantial Soviet accuracy improvements will not affect the survivability of the SICBM/HML force but will substantially reduce the relative attractiveness of carry hard and particularly of patterned array. Patterned array, as discussed below, is also threatened by earth penetrating weapons, should they be developed by the Soviet Union.

3. SICBM/HML dispersal. In the analysis this dispersal occurs only after attack or tactical warning of attack. The Soviet price to attack is significantly increased by dispersing the SICBM/HML force before attack. Also, as discussed below, an attack by an undetected concentration of Soviet submarines firing depressed trajectory SLBMs would reduce the required Soviet ICBM attack price.

4. The percent of the force that is expected to survive the attack. The results are for attacks causing 90% damage. For attacks causing 50% damage, the attack price, in terms of Soviet ICBM's, is about one-third to one-half the attack price for 90% damage.

5. The absolute number of warheads deployed. Larger force sizes than 500 warheads will favor carry hard and patterned array relative to the SICBM. At 1,000 deployed warheads there are significant cost advantages to the MX deployments if the SICBM is not MIRVed.

6. Acquisition Costs. Depending on the degree to which one discounts future operating costs, including these costs as well as acquisition costs — as discussed below -- will favor the MX deployments.

7. No ballistic missile defense. The analysis has not included deployment of active U.S. missile defenses.

8. One warhead on SICBM/HML. As discussed below, even if most assumptions are shifted in a direction which favors a lower cost for MX deployments, the cumulative cost

advantages for MX caused by these shifts are counterbalanced to a significant extent by deploying two warheads rather than one on the SICBM/HML; this may be practical with future warheads smaller than the MK 21 without undermining the mobility inherent in the SICBM/HML design recommended below.

The Task Force notes the above uncertainties so that it will be clearly understood that the selection of other assumptions could lead to different comparisons. Additionally, the following qualitative remarks about the analysis deserve attention.

1. Excellent Soviet accuracy (perhaps with utilization of an external guidance update) will defeat individual superhard silos because the crater size is larger than the CEP at reasonable warhead yields. Moreover, the fratricide effect among attacking warheads that is caused by the close spacing of patterned array silos or shelters may be countered by the Soviet use of earth penetrating weapons. The survivability of either of these patterned array basing systems against very accurate Soviet missiles depends on this fratricide effect (in which case, if effective, it lasts for a few hours) or on BMD. Soviet accuracy improvements and further fractionation (placing additional MIRVs on the same missile) reduce the attractiveness of carry hard as well, but not by as much as they reduce the attractiveness of patterned array; the degree of this reduction is significantly affected by the cost of the carry hard vertical shelters.

2. Both carry hard and patterned array require the condemnation of private land or the exclusive use of government land. Both require dedicated and secure land of the proper geology (i.e., flat and not rocky or wet). Carry hard land requirements are substantial -- 500 to 1000 sq. miles -- and based on present surveys this amount of DoD land of the right sort is not available. The land acquisition required for, particularly, the carry hard basing mode should be contrasted to the ability of the SICBM/HML force to use areas on existing military bases in peacetime without interfering with those bases' operations.

3. A good deal of attention has been given to the operating cost of the mobile SICBM/HML system compared to that of the other basing options. This concern is justified since both personnel and other operating costs are of importance and are higher than for patterned array or carry hard. The Task Force believes that the manpower portion, i.e., the major portion, of the HML operating

costs can be reduced significantly by practical security arrangements to the point that the manpower costs of a force of 500 SICBM/HML are not significantly higher than that of the older Minuteman II force of 450 warheads on 450 missiles, now based in single silos. A new silo-based ICBM force, however, could be designed to have smaller manpower requirements.

4. Beyond the analysis presented it is important to note that small ICBM's provide a flexibility in future basing which is of great importance. If the Soviets should field a larger than expected arsenal of ballistic missiles the small ICBM permits a versatility of basing in response -- because of its low weight, transportability, and mode of operations. The SICBM/HML deployment is inherently insensitive to the major methods of Soviet ICBM force improvements that have occurred in the past and are still occurring -- accuracy improvements and fractionation. The SICBM/HML deployment requires no important changes in design or concept of operations even if there are major additions to Soviet throwweight. Such throwweight increases could, however, require SICBM/HML deployments to new areas.

5. The Shallow Tunnel as a basing mode for MX and carry hard as a basing mode for the SICBM have also received attention. The cost for SICBM in carry hard is prohibitive and does not take advantage of the SICBM's major virtue, which is its mobility. With respect to MX basing in shallow tunnels, the Task Force does not believe that there is yet sufficient engineering analysis or data to reach conclusions about this system's performance.

6. Arms control agreements that effectively limit Soviet warhead numbers would add significantly to the survivability of carry hard and patterned array -- for the same reason that SALT II, if its limitations on fractionation and new missile types had been effective, would have helped significantly to increase the survivability of MX in the previous horizontal shelter basing mode. The survivability of SICBM/HML is much less dependent on such traditional arms control limitations.

III. Recommendations with Regard to the Small ICBM

A. Force Deployment

This Task Force believes that it is desirable for the US to deploy from a few hundred to a thousand SICBMs on HMLs. The actual number of SICBM's deployed will depend upon:

- the threat;
- the size of the Soviet target base;
- the need for a MM II replacement;
- the status of US SLBM and bomber force survivability;
- the decision on future MX deployments.

The flexibility of the SICBM/HML system would also enable that force which is deployed to be operated at lower levels of activity (and cost) depending on the circumstances. These operating cost differences can be quite substantial.

Arms control could also influence the number of SICBM's deployed in the future, as well as the way they are operated. For example, if substantial reductions in the total number of ballistic missile warheads and cruise missiles are negotiated, it could enhance stability for some share of U.S. warheads to be distributed over as many launchers as possible. In this regard, the Task Force notes that the SICBM would be a second 'new' US ICBM which would conflict with the provisions of SALT II.

The SICBM force should be developed for deployment in HMLs of at least 30 psi hardness on major western government complexes.

- In peacetime, a deployment that does not interfere with base operations, using no dedicated land, can be made on portions of four base complexes in a way that would require the Soviets to barrage approximately 5500 sq. mi. in order to attack the system. Deployment in this area, even with no warning of any kind, would require approximately one-quarter of the total current Soviet ballistic missile throwweight (ICBMs and SLBMs) to obtain a 90% damage expectancy (DE).

- In a crisis, the HMLs would be able to disperse, still on the same military bases, to occupy an area that would require the Soviets to barrage approximately 11,000 sq. mi. To obtain 90% DE, this would require an attack using approximately one-half of total current Soviet throw-weight. With 6 minutes of dispersal time the same 11,000 sq. mi. area could be occupied from the 5500 sq. mi. area by the HMLs dispersing under attack.

- Some HMLs can disperse off-base well within the flight time of Soviet ICBMs when attack warning is given or if warning systems are lost. The area occupied in this amount of time would require the Soviets to barrage over 22,000 sq. miles -- an area roughly half the size of West Virginia. This would require an attack by approximately the entire total current Soviet throwweight to achieve 90% DE.

It has been suggested that the partial deployment of the SICBM/HML force to current Minuteman sites could offer savings in operating and manpower costs. The Task Force believes that such a deployment would present serious difficulties for operating doctrine (e.g., dispersing in response to a crisis) and potential problems of contact with the public. Accordingly, the Task Force recommends that deploying the total SICBM/HML to Minuteman sites not be considered. At the very least the initial deployments should be made on the complexes of southwestern government complexes as described above.

There are two major uncertainties concerning our basing recommendation for SICBM/HML. The first concerns the possibility of an attack from Soviet SLBMs located close to US shores which would reduce significantly the available time for the HMLs to disperse to larger land areas. Analysis indicates that the number of Soviet submarines so located must be relatively large and the SLBM flight times extremely short before this sort of threat would significantly impair the survivability of a substantial part of the unalerted and undispersed SICBM/HML force. We believe that the gathering of such a number of submarines in these locations would be known to US anti-submarine warfare forces and would provide warning. Under such circumstances adjustments could be made to deploy the SICBM to larger areas -- either on existing bases, at different bases, or at other locations. This would of course create additional operating costs. The submarine threat illustrates the importance of preserving some HML hardness while the HML is in motion.

The second uncertainty concerns the question whether, some day, real-time reconnaissance, tracking, and retargeting by Soviet surveillance and other systems could permit the attack on specific HMLs by Soviet missiles, thus avoiding the need for the Soviets to barrage an entire area. This is a serious issue which cannot be fully explored in an unclassified report. Although we have conducted some investigation of this question, it must be thoroughly reviewed before FSED commences on the SICBM/HML because it may influence some of the system's design requirements and resulting operational flexibility. It is sufficient to note that this sort of capability for surveillance and attack is extraordinarily demanding. (Even more demanding would be real-time target acquisition and attack on these sorts of targets from space.) Furthermore, if the Soviets were at some point believed to have such a capability the mobility of the SICBM would permit the steps -- e.g., camouflage, decoys, more frequent movement, or the redeployment of HMLs to more wooded military bases -- to deal with the threat of such Soviet advanced reconnaissance, targeting, and attack systems. Such countermeasures are more easily implemented with a smaller SICBM and HML. It would be particularly demanding for such a Soviet capability to threaten an SICBM/HML force deployed to various parts of the country. Again, such deployment would be at additional cost.

In sum, the analysis indicates that an SICBM/HML system would survive credible and likely Soviet threats and it would be sufficiently flexible to adapt to much more advanced and unlikely Soviet capabilities. The SICBM/HML system makes use of mobility (as the Soviets are doing with the Minuteman-sized SS-25) to achieve survivability.

B. Full Scale Engineering Development (FSED)

The Task Force recommends that FSED of the SICBM/HML commence in FY87. Since FY83, the Air Force and the Defense Nuclear Agency (DNA) have carried out a program of testing and analysis concerning the vulnerability of an HML to nuclear blast and radiation effects. The results of the experimental, analytical, and field test program indicate that it will be possible to design, construct, and operate a vehicle that will perform to the desired specification. Full scale testing combined with scaled blast hardening tests should assure and validate a system having a hardness of at least 30 psi and the mobility required to achieve adequate dispersal within the time given by tactical warning (or the loss of tactical warning).

Three specific technical questions deserve particular attention during FSED. These are:

1. The need to design and develop a command and control system tailored to the SICBM/HML system concept. We believe that a direct command link to the Strategic Air Command and the National Command Authority -- in addition to such intermediate launch control nodes as are necessary -- would be the desired approach.

2. The need to assure that the HML is designed and constructed to move and survive under stringent nuclear effects. This will assure that full advantage is taken of the HML's dispersal capability. The SICBM/HML system must be designed to have the capability of being launched for a significant time -- weeks -- after a nuclear attack.

3. The desirability of developing a low cost, reliable inertial guidance system. At present a modified version of the AIRS system (the MX guidance system) is the most mature guidance package. Alternative guidance concepts which are lighter, cheaper, and easier to produce and operate should continue to be investigated vigorously.

C. SICBM Weight

At present, the SICBM is being designed to weigh 30,000 lbs because of a Congressional weight limit of 33,000 lbs. This weight limit was originally established by Congress in order to assure that the SICBM met the requirement of mobility and the single warhead restriction recommended by the Scowcroft Commission. This weight restricts the SICBM to carry one Mk21 warhead without penetration aids or, if it carries a package of penetration aids, to sacrifice coverage of some portion of the necessary military targets.

There has been substantial criticism of this particular restriction from many who seek to acquire the maximum ICBM capability at lowest cost.

The Task Force strongly recommends that the weight limit for the SICBM be increased from 30,000 lbs, to 37,000 lbs. This increase will permit the missile to carry a modest penetration aid package to counter possible future Soviet ABM defenses without sacrificing target coverage. The Task Force believes that this extra weight will provide payload flexibility in the future to deal with unforseen threats without significantly sacrificing the flexibility in missile basing options that follow from the SICBM's small size (Minuteman missile weight is 78,000 lbs and MX missile weight 196,000 lbs). This 37,000 lb. design weight can be accommodated by increasing the length of the missile, a step which will not necessitate major redesign or a delay in the current schedule.

This additional payload weight should also provide for alternative warhead configurations, including the possibility of maneuvering re-entry vehicles (MaRVs) and some types of earth penetrator weapons. The overall missile design should provide for these later possibilities even though such re-entry vehicles are in the early stages of research. The additional weight also enhances the possibility of the SICBM carrying two warheads per missile, smaller than the MK-21, should future circumstances warrant. At this approximate weight we do not believe that the inherent flexibility of movement and deployment described above for the SICBM/HML force would be compromised.

Recently there has been considerable discussion about the merits of a new missile with a weight approximately equal (70,000 lbs.) to that of Minuteman and designed to carry three MK 21 warheads. The Task Force notes that the relative attractiveness of a missile should not be evaluated separately from its basing mode. In patterned array or carry hard basing, the MX maintains a cost advantage over such a 70,000 lb. missile because it is more highly MIRVed. In mobile basing, such a new class missile would enjoy a cost advantage over an SICBM with one warhead and a modest cost advantage over an SICBM with two warheads. This assumes, however, that adequate HML mobility could be realized with a missile of this weight. A 70,000 lb. missile would require a gross weight for the missile and HML together of approximately 250,000 lbs. This increase in size could seriously complicate mobility but sufficient data is not yet available for an evaluation of the seriousness of this problem. Moreover, road and bridge construction can be added to the program in order to improve the mobility of larger launchers. It appears going to a larger launcher could result in a schedule delay of up to two years and reduce the flexibility for basing alternatives provided by the recommended small missile.

IV. Recommendations with Regard to MX

The Task Force believes that (in the absence of BMD) the carry hard concept may offer a credible long-run survivable basing mode for MX. Accordingly, the Task Force recommends that a careful analysis and validation effort be undertaken of the carry hard concept. The important new characteristic of carry hard, compared to earlier multiple aim point systems for concealment of MX, is that carry hard may hold the promise of adding aim points (in the form of vertical shelters) at a cost which is substantially below what it would cost the Soviets to add attacking warheads. If these

deceptive shelter costs (on a marginal system cost basis) can be reduced to around $1.5M per shelter, then carry hard becomes a credible survivable basing mode for MX. These costs, technical uncertainties about maintaining secrecy about the location of each missile in the shelter system, and the availability of dedicated land are all serious questions, however. These technical and cost uncertainties with respect to MX in carry hard are substantial. Accordingly the Task Force recommends that the R&D program be structured to ensure that it will resolve them as rapidly as is practical. Such an R&D program for carry hard should be aggressively pursued during FY 87 so that concept and validation questions could be resolved promptly. A critical goal is to achieve a system-wide marginal silo cost of about $1.5M, or about one-half of the current Air Force estimate.

The carry hard concept could be an attractive option for deployment of the second 50 MX originally recommended by the Scowcroft Commission or, if required, some number of MX beyond 100. Carry hard might also at some point be used to provide more survivable basing for the initial 50 MX than these missiles have in Minuteman silos.

It is important to recognize that other deployment possibilities do exist for MX and are currently available. These are of significantly lower cost than those deployment modes that entail serious efforts to provide long-term survivability. These include, for example, 50 MX in superhard silos (without concealment). Such a deployment would cost approximately $8 billion and would provide an additional 500 warheads with the ability to attack hard targets promptly.

The difficulty with superhard deployment in silos or in shelters with concealment, has to do with its long term susceptibility to technical improvements by the Soviets. In particular, significant improvements in accuracy (which we have underestimated in the past) and specially developed warheads such as earth penetrators would sharply reduce the price to attack such superhard deployments. We note that the survivability of superhard deployments could be substantially improved by terminal ballistic missile defense. As discussed in the next section the Task Force recommends that such a superhard MX basing be investigated together with integrated ballistic missile defense.

V. Ballistic Missile Defense

As noted earlier in this report BMD is one method of increasing the survivability of MX and thus contributing to deterrence. The Task Force notes that shelter basing with concealment (in patterned array or carry hard) increases the leverage of BMD because of the possibility of preferential defense of those shelters containing the MX missile. Moreover, in assessing the effectiveness of a terminal, hard-point BMD system, it is essential that there be an integrated design of BMD and ICBM basing in order to optimize survivability. The Task Force notes with serious concern that such integrated design and analysis are not currently underway. Moreover, as noted above, ballistic missile defense appropriate to very hard targets has received insufficient attention and study. Indeed the menu of choices now available to

preserve ICBM survivability over the long run could have been much broader but for the previous lack of coordination and the absence of a serious effort in this area. The availability of BMD would be critical for long-term consideration of patterned array basing, important for carry hard, but considerably less critical for SICBM/HML survivability. The Task Force believes that it is essential to evaluate in an integrated manner the use of active BMD and passive defense measures (hardness plus concealment or mobility) as a possible technique for enhancing ICBM survivability effectively at reasonable cost. We urge that a serious joint effort by an Army-Air Force design team be undertaken to address, together, the issues of MX basing and BMD protection.

VI. A Final Note

The Task Force is most grateful for the steady, professional, and objective assistance of the Ballistic Missile Office of the Air Force Systems Command in assessing these sensitive and difficult issues.

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1986

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"The conferees further direct that an independent review of small missile and basing options be conducted by the Defense Science Board. The results of this review should be provided to the Committees on Armed Services of the the Senate and House of Representatives prior to submission of the fiscal year 1987 defense budget."

THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301-3010

RESEARCH AND ENGINEERING

20 AUG 1985

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Defense Science Board (DSB) Task Force on Small Intercontinental Ballistic Missile (Small ICBM) Modernization

You are requested to form a Task Force to review the Intercontinental Ballistic Missile modernization programs in the context of the other elements of the U.S. strategic initiatives. The results concerning the Small ICBM and its basing options should be provided to me for submission to the Committees on Armed Services of the House and Senate prior to the submission of the Fiscal Year 1987 defense budget.

The primary goal of this review should be to evaluate the Small ICBM Program for its contribution to U.S. strategic posture including, but not limited to, evaluations for military effectiveness, affordability and schedule. The hard mobile basing concept should be used as the point of departure with excursions for other mobile concepts and super hard silo basing also considered.

In the context of the total strategic force modernization program (both as articulated by the President's Commission on strategic force modernization and as currently approved by law) and arms control objectives, the Task Force should review both projected threats and mission requirements and evaluate the flexibility of the system to respond to changes in them.

Additionally the Task Force should:

- Assess the technical risk, cost, schedule, and manpower for both the missile and major basing options.
- Review the effect of the Congressionally directed weight limit and what changes should be made to enhance military effectiveness.
- Review safety, physical security and environmental issues.

- Recommend the best basing concept for full-scale development and initial deployment, and concepts which might be pursued in parallel for future options including both active and passive defensive measures.

Since the results of the Task Force must be prepared quickly for submission to the Congress early in 1986 as stated above, you are also requested to evaluate if a follow-on effort or continuation effort is required.

I will sponsor this Task Force. Dr. John M. Deutch, Provost, Massachusetts Institute of Technology, has agreed to serve as Chairman of the Task Force and Colonel Thomas J. Thomason, USAF will be the Executive Secretary. It is not anticipated that your inquiry will need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. Code.

D. A. Hicks

Donald A. Hicks

DSB TASK FORCE

ON

ICBM MODERNIZATION

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