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MEMORANDUM FOR THE SECRETARY OF DEFENSE

SUBJECT: SecDef Project List for CY 1964, Item III b.

Attached is a study aimed at defining the desirable characteristics and related programs for the successors to the MINUTEMAN II and POLARIS A-3.

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Attachment
R&E Log 64-3804

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Attachment

R&E LOG 64-3804
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SUBJECT: SecDef Project List for CY 1964

III b. "Define the desirable characteristics of and the development program for the successors to the MINUTEMAN II and the POLARIS A-3."

GENERAL

Possible improvement options for POLARIS and MINUTEMAN are under study by the services and OSD. The relative desirability of each is being weighed in terms of the degree, for a given expenditure, to which they would either compensate for an extensive Soviet ABM deployment (assured destruction) or improve point target kill capabilities (damage limiting). These studies have not been completed, and the conclusions drawn in this paper should be treated as preliminary.

INCREASING PAYLOADS

The most interesting options for increasing survivable payload at minimum net cost are: (a) the POLARIS B-3 and, (b) the Improved Capability MINUTEMAN (ICM) - the ICM being coupled with hard point defense to compensate for the increased vulnerability to Soviet MIRV's* which would be associated with fewer and larger missiles. The B-3's would retrofit existing submarine tubes and the ICM the missile silos with the largest diameter missiles fitting into present MINUTEMAN silos compatible with shock mitigation and hardening requirements.

CHARACTERISTICS

The characteristics of these missiles are compared below with the POLARIS A-3 and MINUTEMAN II.

	POLARIS A-3	POLARIS B-3	MINUTEMAN II	ICM
Gross wt	35,775#	65,650#	72,000#	285,000# (approx)
Diameter	54"	74"	65"	118" - 120"
Launch mode	Underwater	Underwater	Silo-hot launch	Silo-cold launch
Payload	1347# at 2250 nmi	2700# at 2250 nmi	1240# at 6000 nmi	6500# at 6500 nmi
Current Re-entry System	3-Mk 2 or 3 Mk 12 + pen aids	6-Mk 12 R/V's + pen aids. Also MIRV	1-Mk 11A or Mk 12 + pen aids or 3-Mk 12. Also Mk 12 MIRV	About 12 Mk 12 MIRV

*MIRV: Multiple Individually Guided Re-entry Vehicle

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R/V's	Yield	Weight (lbs)
Mk 2 (3)	225 KT ea	1100 (cluster)
Mk 11 A	1.2 MT	940
Mk 12 (single, and as element of cluster or MIRV)	170 KT	350
Mk 17[a/]	1.8 MT	1200

[a/] Now under consideration

POLARIS B-3

A PCP for POLARIS B-3 development is expected shortly. The proposed missile would be configured to deliver as large a payload as possible to a useful range within the physical constraints of the tubes on POLARIS submarines. It would be developed within the current technical state-of-the-art of the A-3 missile and would increase the payload capacity of a submarine by a factor of 2 for a fixed range. Six of the Mk 12 R/V's now under development by the Air Force would be combined in the B-3 payload with advanced penetration aids currently under development. A feature of the payload separation design would be flexibility to accommodate alternative payload configurations which could be chosen on the basis of later threat information or improved warhead technology. For example, instead of six Mk 12 R/V's, it may be desirable to equip the B-3 with at least twice that number of a possible new small re-entry vehicle. This type vehicle will begin preliminary development under ABRES this year.

The B-3 development program would be phased to permit replacement of older POLARIS missiles after a 10-year service life with the new B-3 procurement. The tentative plan is to provide an initial operational availability date on the first submarine in December 1971, building up to a force of 22 B-3 and 19 A-3 submarines by the end of 1975. Necessary ship changes for B-3 would be accomplished as a part of the regular overhaul periods, and the new missile could then be incorporated any time thereafter with a 10-week yard period. Navy cost estimates for this program on the above assumptions are:

	$ Millions
RDT&E	904
Investment cost for B-3 on 22 SSBN's	1,564
10-yr service life adjustment*	- 845
Net cost of B-3 (22 subs)	1,623

* Cost of replacing A-2 missiles with A-3 production after 10 years service (A-2 production having been terminated as of February 1964), if B-3 is not produced.

MINUTEMAN

The Improved Capability MINUTEMAN (ICM) would be the largest missile that could be retrofitted into the MINUTEMAN silo without compromising the 300 psi hardness level. This would increase the payload capacity of each silo by a factor of 5. Because of the large missile diameter relative to the silo diameter, the ICM would be eject-launched in a manner similar to POLARIS. The ICM would be retrofitted into MINUTEMAN silos (Wings I-IV must be deepened 10 ft) and could serve as replacements for MINUTEMAN I and II as they exhaust their useful life or are consumed in training launches.

A wide range of payload configurations are possible on the ICM. For example, it could accommodate on the order of twelve Mk 12 R/V's or a much larger number of the possible new small R/V's.

An important adjunct to the increased capability of the ICM would be the introduction of hard point defense for the launcher areas. A point defense would raise the "cost" to the Soviets, measured in terms of weight of payload, to "destroy" our fixed missile sites.

As the accuracy of Soviet missiles improve, down to the neighborhood of 1/4 nautical mile, it will be attractive for them to divide up the large payload inherent in their boosters so that they can attack several hard targets with the same booster. This option must be taken into careful account with regard to the survivability of our fixed missile force.

A hard point defense would become more profitable if the Soviet offense utilizes the MIRV concept. It is to be noted that as the accuracy of each individual re-entry body of a MIRV configuration increases, and as its size and yield can be decreased correspondingly, hard point defense becomes increasingly attractive. The possible introduction of Soviet MIRV makes our hard point defense much more attractive than was formerly the case when it was considered that it took at least one full Soviet booster to destroy a MINUTEMAN site.

With probable USSR missile accuracies of 1/4 nautical miles or better, the probability of destroying a silo hardened to 300 psi is approximately 94% or better when attacked with two re-entry vehicles of approximately 1.5 MT each. The "price" therefore that the USSR must pay to destroy each undefended silo is probably less than 2 kilopounds of payload. This price increases to 10 kilopounds of payload if the U. S. sites are defended by a NIKE X installation. The average cost of such a defense system is approximately $12 million per silo. For any given total investment, a significantly greater number of undefended missiles can be initially procured than defended missiles. However, as the size of the attacking Soviet force increases, the rate of destruction of undefended missiles is much greater than that for defended missiles. It can thus be seen that for very small attacking forces, it may be more practical to buy a large number of missiles and allow that number to be decreased to an acceptable minimum. However, as the attacking force, in kilopounds, increases beyond a certain trade-off point, it is better to purchase fewer missiles initially and invest some of the fixed investment in a defense system.

Figure 1 illustrates the relationship between the Soviet attacking force and the U. S. surviving MINUTEMAN force for a total U. S. investment of $6 billion dollars. For the parameters indicated in Figure 1, a defense system for a MINUTEMAN force does not appear attractive until a Soviet attack force of 1450 kilopounds (or approximately 362 SS-7s) is expected.

When the value and capability assigned to each silo is increased, such as would be the case if the MINUTEMAN silo were retrofitted with Improved Capability MINUTEMAN (ICM), the requirement to defend these silos increases as seen in Figure 2. For a $6 billion total investment, a defense system for the ICM silos becomes desirable for an attacking force of only 840 kilopounds (or 210 SS-7s). A comparison of the relative defense system requirements for MINUTEMAN and ICM is presented in Figure 3. The above described trade-off points (where defense of missiles become attractive) are given for various overall investments. It can be seen from Figure 3, that for any reasonable investment in ICMs, a defense system should be provided. Considering any reasonable size USSR attack force, a MINUTEMAN II system costing approximately $4 billion dollars or less should be defended. The requirement for defense in systems costing between 4 and 5 billion dollars is marginal. An investment of $6 billion dollars may produce an all MINUTEMAN missile, no defense, system capable of coping with attacks of up to approximately 1450 kilopounds of USSR payload.

A comparison is made of two methods of assuring the survival of 1000 kilopounds of U. S. payload on alert after USSR attacks of varying levels. For purposes of this comparison, the Improved Capability MINUTEMAN (ICM) in defended silos, as well as the POLARIS B-3 missile systems are considered. Figure 4 illustrates the cost of obtaining this assurance as a function of the expected size of the USSR attack force. Prior to any attack the U. S. alert force of 1000 kilopounds of payload costs $4.3 billion if ICMs are employed and $4.0 billion if present POLARIS submarines are retrofitted

with B-3 missiles. If new submarines as well as B-3 missiles are to be purchased, the cost of this alert force becomes $7.0 billion. As the attack commences and the size of the attack force increases, the cost of maintaining the ICM alert force increases. For example, to maintain this 1000 kilopounds alert force in the presence of a 1500 kilopounds USSR attack would increase the total cost to $7.6 billion. However, in view of the 100% survivability of the POLARIS at sea, the cost of maintaining this 1000 kilopound alert force with B-3's does not increase regardless of the size of the available USSR attack force. There appears, therefore, a clear cut advantage in maintaining this U. S. alert force by employing B-3 missiles in available POLARIS submarines. On the other hand, if new submarines as well as new B-3 missiles must be purchased, the cost advantage lies with the ICM for USSR attack sizes up to 1250 kilopounds of payload. For attack sizes above this cut-over point the cost advantage transfers to the POLARIS B-3 system even though the cost of new submarines are incurred.

In summarizing the hard point defense considerations of the MINUTEMAN and the Improved Capability MINUTEMAN (ICM) as well as the relationship of these missiles to the POLARIS missile system, the following general observations can be made:

(a) If the cost of the MINUTEMAN is sufficiently low it is more economical to purchase undefended missiles only.

(b) If the cost and capability of a missile increases, such as with the ICM, a hard point defense system must be incorporated.

(c) If a hard point defense is used, the cost of the missile being defended should be sufficiently high to warrant the defense cost.

(d) It appears that to maintain a given missile alert force the cost advantage lies with the B-3 type missile retrofitted into existing POLARIS submarines. If new submarines must be purchased, the defended ICM missiles appears to be the most economical approach.

While an ICM program has not yet been defined in detail, we estimate that the costs would be:

	$ Millions
RDT&E	1,000
Investment for 400 ICM's	3,000
10-yr service life adjustment (0.6/launcher)	- 240
Net cost for 400 ICM's	3,760

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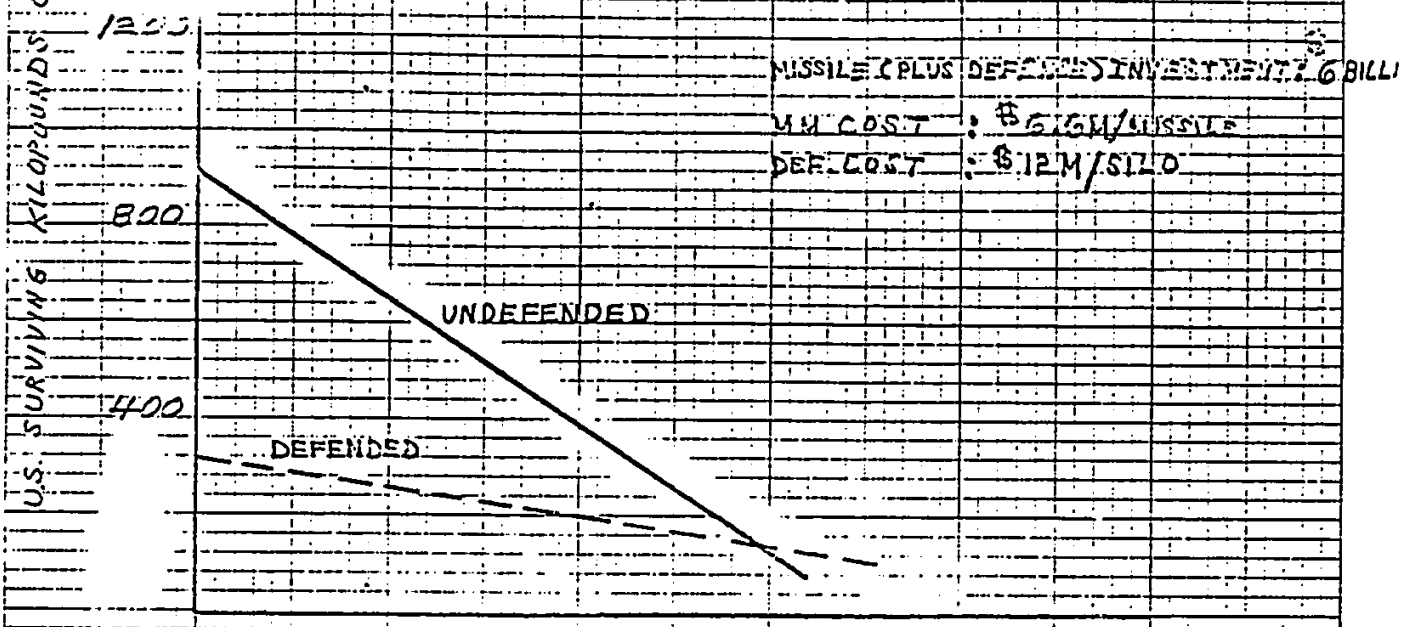
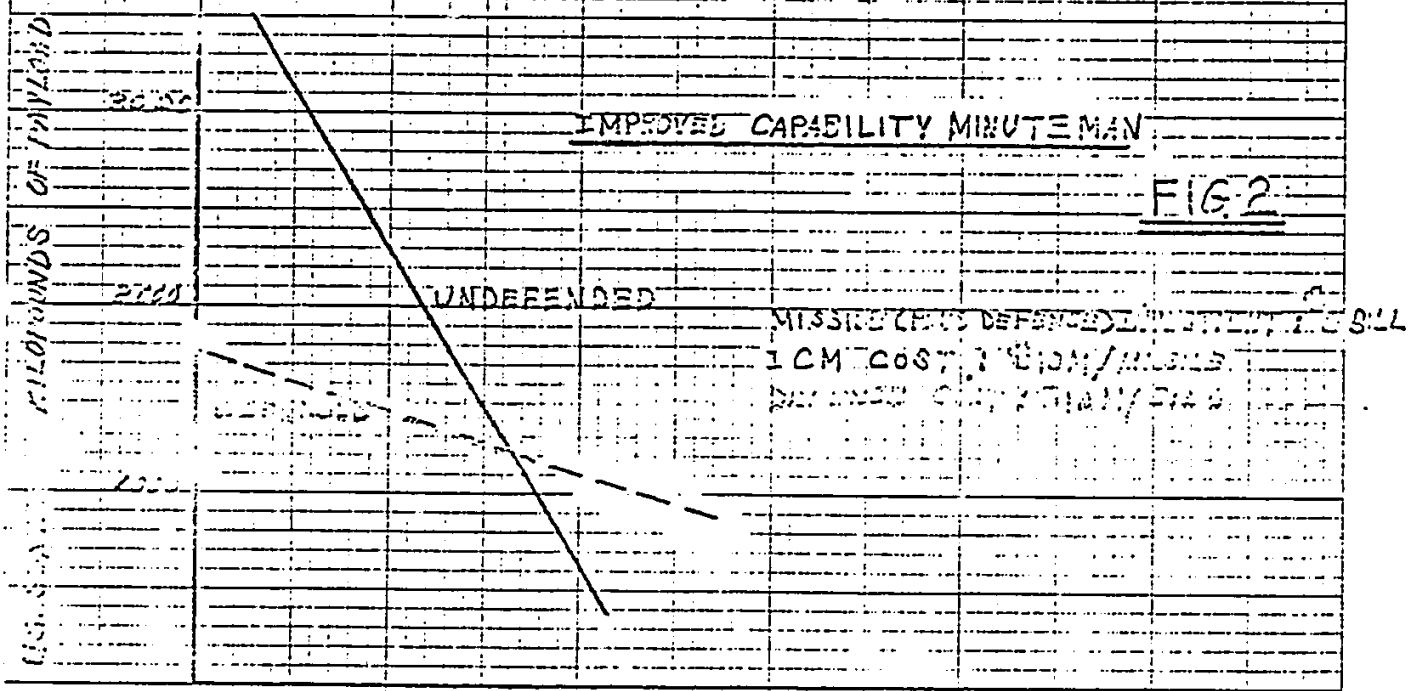
FIG. 1

MINUTEMAN



IMPROVED CAPABILITY MINUTEMAN

FIG 2



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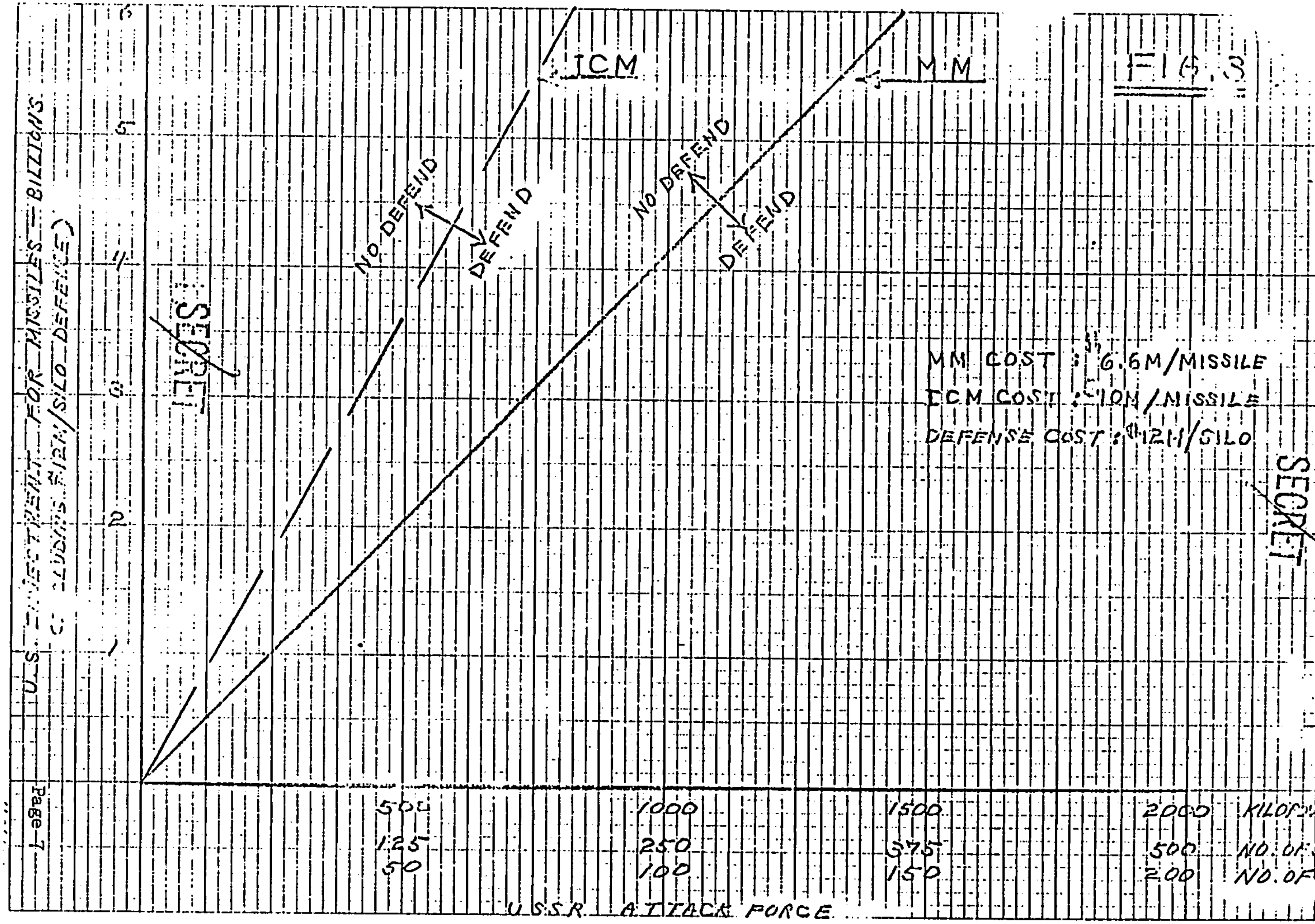
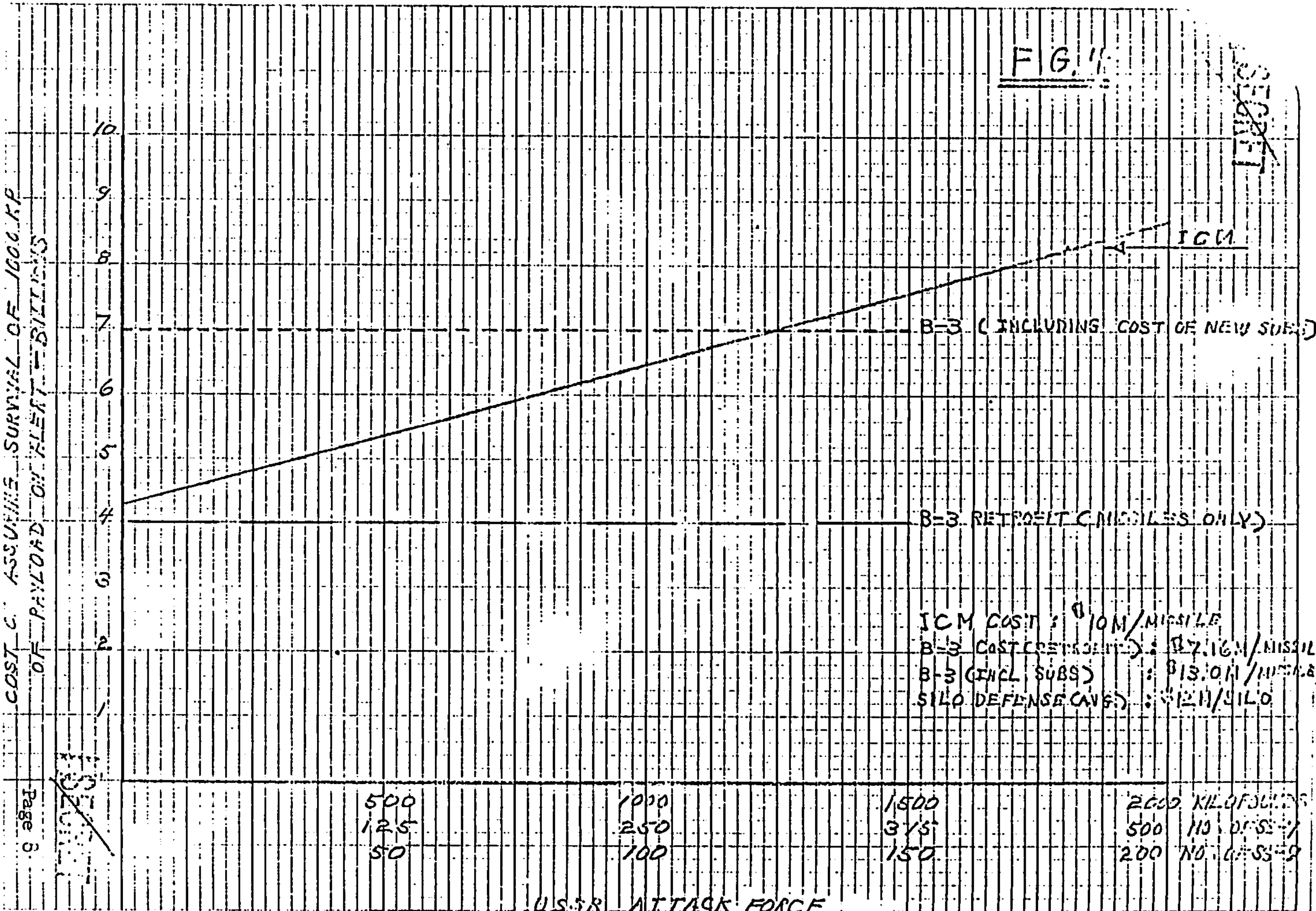


FIG. 11



PAYLOAD IMPROVEMENTS

The time-urgent Soviet target structure consists of about 550 soft (20 psi or less) targets and, at this time, less than 100 hardened missile aiming points. Our presently programmed force is adequate to assign one reliable missile to each target. It is expected that the number of hardened targets will increase in the future. Accordingly, an important improvement goal for MINUTEMAN is to increase its hard target kill capability. There are two attractive means of doing this: (1) by increasing accuracy; and (2) by making such modifications to the present missile as would allow each to destroy more than one soft target. The latter is particularly interesting in that using fewer missiles to attack the soft targets would permit release of an additional fraction of missiles for assignment to the hard targets. It is projected that improvements in MINUTEMAN guidance will provide CEP's of about 1/4 n.mi. With this accuracy the yield of 170 KT in a Mk 12 R/V will provide a near unity kill probability for point targets up to 25 psi hardness level. If a portion of the MINUTEMAN force were equipped with 3 Mk 12 R/V's capable of being individually aimed (MIRV), only 1/3 the number of boosters would then be required to destroy point soft targets.

A preliminary study made on the application of the MIRV techniques to POLARIS missiles indicates that it is feasible to configure a B-3 missile to cover several separate targets located anywhere within an area up to 88 miles square. The B-3 payload could be four Mk 12 re-entry vehicles or 10 to 12 new small re-entry vehicles (PEBBLES) now under consideration. This study shows a decided advantage of being able to distribute the available missile payload in a more nearly optimum manner by assigning fractional payloads on the smaller targets. For example, with a force of 218 reliable B-3's, one payload (without MIRV) can be assigned to each of 218 (25 defended and 193 undefended) targets. If a MIRV capability is employed, the number of B-3's that can be directed to each of the 25 defended targets can be increased by a factor of four to assure destruction, and still have sufficient (472) re-entry vehicles to destroy more than the remaining 193 undefended targets.

The development of a Mk 12 MIRV for MINUTEMAN appears to be a straightforward engineering problem. The mechanism of such a dispensing system differs from the simple cluster (such as used on POLARIS A-3) in that guidance and a vernier propulsion would be carried along after completion of 3rd stage burning. After 3rd stage thrust termination, the guidance system would command the incremental velocities needed to direct the R/V to each successive target, releasing the R/V's in sequence. Targets attacked by a single missile would be located within tens of miles of each other. Actual Soviet target distribution makes such a concept feasible.

The increased accuracy of the SABRE guidance system now in advanced development might provide CEP's of 900 feet or less with MINUTEMAN II. With this degree of accuracy Mk 12 could be effectively applied against hard as well as soft targets.

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Current programs are expected to provide significant improvements in the MINUTEMAN II guidance and reductions in the geodesy contributions to system CEP. By 1968, this is expected to reduce MINUTEMAN II CEP to about 0.46 n.mi. using the Mk 11A R/V. With a High β * R/V, the system CEP would be reduced to 1/4 n.mi. - this is with the current guidance system. The development of a High β, high yield R/V for MINUTEMAN II would provide a significant increase in hard target kill capability. See following table:

MINUTEMAN II Attack Against Hard Targets

	Mk 11 A		Mk 17	
	1968	Post 1970	1968	Post 1970
Yield (MT)	1.2	1.2	1.8	1.8
CEP (n.mi.)	.46	.36	.28	.22
P_k (300 psi)	.52	.61	.88	.94

SUMMARY

To recapitulate, it appears that a very attractive MINUTEMAN improvement option would be to develop a MIRV capability for MINUTEMAN II, initially using 3 Mk 12 R/V's, with the dispensing mechanism compatible with 6 or 7 smaller R/V's should they later become available. The improved MINUTEMAN II guidance system would be the basis for an initial capability. Improved accuracy SABRE components would be incorporated when they become available. Additionally, development of a High β (Mk 17) Re-entry Vehicle appears to be an attractive option to improve our hard target kill capability.

We have asked the Air Force for their estimates of cost and schedules for developing a MIRV capability for MINUTEMAN II. Our own estimates of cost to convert MINUTEMAN II payloads to MIRV's are about $300 million RDT&E and $2.0 million investment per missile.

The most attractive programs for early Operational System Development thus appear to be: the POLARIS B-3 missile to increase payload within present submarine limits, incorporation of the MIRV techniques in the B-3, and Mk 12 MIRV and Mk 17 High Beta Re-entry Vehicle System for the MINUTEMAN to increase effectiveness of the present payload capacity. Advanced Development projects for SABRE guidance for MINUTEMAN and for a new small R/V for both MINUTEMAN and POLARIS are attractive and are under way. Engineering studies of the ICM, covering the potential increase in capability, the engineering and development activities necessary to achieve this capability, and the associated costs and schedules, are being conducted.

*β = ballistic coefficient of an R/V.

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