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150

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MX DEPLOYMENT: INADEQUACIES OF THE AIR AND SEA BASED OPTIONS

INTRODUCTION

For at least the last four years of its "life," the MX program has suffered buffeting from winds that have come seemingly from every point of the political compass. Attacked from the Left for its potential for destabilizing strategic deterrence and for its excessive costs (economic and environmental), it has more recently come under fire from some on the Right for its SALT-dictated basing mode, the physical characteristics of which raise the question of whether it is the most effective means of fielding the new ICBM. Much of this criticism has been directed specifically at the chosen land-basing scheme for the missile, a plan which, as finally approved by President Carter, would have necessitated the construction in the Southwest of some 4,600 concrete shelters in which to both house and hide 200 MX ICBMs.

The Reagan Administration entered office certain of the need for the new missile but aware of the troubling political questions surrounding a land-basing concept whose final details had only been settled on in the closing days of the previous administration.

Its uncertainty about the appropriateness of the basing scheme was made manifest by Secretary of Defense Weinberger's decision in March 1981 to establish the Townes Panel to review the various MX basing options and report to the Pentagon on the preferred choice. It proved to be an ominous sign for MX supporters because the reopening of the basing question promised to at least delay the current timetable for MX deployment. The magazine Aviation Week & Space Technology noted:

> One of the biggest mistakes in government is to reopen a decision. To do so simply raises all the old doubts and adds new ones because the decision maker is, in effect, questioning his own decision.

Note: Nothing written here is to be construed as necessarily reflecting the views of The Heritage Foundation or as an attempt to aid or hinder the passage of any bill before Congress.

> What concerns some supporters of a land-based MX is that the Administration is deliberately uncorking a highly charged bottle whose eruption will permit the MX to kill itself off. MX is a complex and expensive program, one with high visibility and a natural budget target, and opposition is already circling around the wagons.[1]

Even as the Townes committee reviewed the matter and as the Air Force's Ballistic Missile Office at Norton Air Force Base in California continued gamely to go forward with the missile program, which has already absorbed more than $2 billion, new opposition to the land-based MX was building. On May 5, 1981, the Church of Jesus Christ of Latter-Day Saints (the Mormons) issued a two-and-a-half page statement opposing the plan to base the MX missile in Utah and Nevada. While not opposing the missile itself, the Mormon statement released by church president Spencer Kimball noted that placing the weapons in Utah and Nevada would mean "one segment of the population would bear a disproportionate share of the burden, in lives lost and property destroyed, in case of an attack...."[2] In light of this concern, the statement continued, "we plead with our national leaders to marshal the genius of the nation to find viable alternatives which will secure at an earlier date and with fewer hazards the protection from possible enemy aggression which is our common concern."[3] There is reason to believe that the Mormon stand will have a considerable impact on public support in Utah, since Mormons make up some sixty-nine percent of that state's population.

In accordance with its mandate from Secretary Weinberger, the Townes Panel since March has been hard at work, first attempting to bring itself "up to speed" on the intricacies of the various basing options -- most of which the Air Force had studied to death in the mid- to late-1970s -- and then rendering advice on the most suitable choice. Among the basing proposals that have been studied by the Townes committee are two schemes for basing MX at sea -- Hydra and SUM -- that managed to garner their share of press attention during the first months of the review and an air-basing option (designated Big Bird) that appeared in late July to have won over the Secretary of Defense. Because of the importance of the Administration's final decision on MX, this paper proposes to examine these three concepts in some detail to see how feasible they would be as replacements for land-basing the MX missile.

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1 William H. Gregory, "Undoing the MX Decision," Aviation Week & Space Technology, 114 (March 30, 1981), p. 11.

2 Quoted in Bill Prochnau, "Mormon Church Joins Opposition to MX Program," The Washington Post, May 6, 1981, p. A1.

3 Quoted in "Mormon Church Opposes Placing MX Missiles in Utah and Nevada," The New York Times, May 6, 1981, p. A1.

HYDRA

On March 18, 1960, the first firing test of Project _Hydra_ took place successfully at the Naval Test Center, Point Mugu, California, when a 150-pound rocket was launched from the water.[4] During 1960 and the following four years, the Navy's Project _Hydra_ successfully launched more than fifty rockets and missiles that had been placed in the water or had been dropped overboard from a variety of vessels, including the seaplane tender _USS Norton Sound_ and several landing ship docks (LSDs). The Navy, however, cancelled the _Hydra_ program in 1965.

Last year, Captain John E. Draim, USN (Ret.), the former project director for _Hydra_, began to draw public attention with a proposal that rather than deploy its MX missiles in an extremely expensive land-basing system in Utah and Nevada, the Defense Department should put the missiles aboard surface ships, where they could be dropped overboard and launched from the water, as had been demonstrated in Project _Hydra_. Draim quickly won support from several notable people, including retired admirals Thomas Moorer and George Miller and former Secretary of Defense Melvin Laird.

As conceived by Captain Draim, hydralaunch MX missiles -- missiles with engine nozzles sealed for waterproofing and equipped with flotation collars for increased buoyancy -- would be deployed aboard a variety of merchant ships. These merchantmen, whose cargoes and missions would be suitably disguised, would steam the high seas on a continuous basis, always prepared to roll their deadly cargoes overboard on command and to launch the missiles from the water when a safe distance away. As John Draim saw it, the advantages of such a basing system for MX would be considerable. For example, it was argued that this basing scheme would prove significantly less costly than the proposed land-basing plan. Draim estimated the sea-based alternative could save up to $15 billion over the currently planned system (originally estimated by the Carter Administration at some $33 billion).[5] One of the major reasons put forth for this cost savings, aside from the elimination of the need for a massive construction project in the Southwest, was the claim that the merchant vessels to be used for hydralaunch basing would not have to be built since enough were already in the inventory.[6] Another advantage, according to the proponents, was that MX missiles secreted aboard continuously moving merchantmen would prove much harder to target than would the land-based missiles. As one supporter noted: "With hundreds

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4 _United States Naval Aviation 1910-1970_, NAVAIR 00-80P-1 (Washington, D.C.: Naval Air Systems Command, 1970), p. 233.

5 John E. Draim, "Move MX Missiles Out to Sea," _National Review_, December 12, 1980, p. 1527.

6 Clarence A. Robinson, Jr., "Alternative MX Basing Concepts Weighed," _Aviation Week & Space Technology_, 113 (October 27, 1980), p. 21.

of M-X-laden (and M-X-decoy-laden) merchantmen steaming around the high seas, the Russians would face an imponderable -- probably impossible -- targeting task. Even if they managed to establish tracks on most of the ships, the costs to them would be enormously higher than those for targeting known land sites."[7]

A third advantage claimed for hydralaunch MX was that deploying the missile at sea would force Soviet military planners to target the majority of their ICBMs on the oceans, away from the continental United States. Finally, the supporters of the concept argued that unlike the land-basing scheme, deploying the missiles at sea would arouse little or no environmental opposition.

The benefits promised for hydralaunch deployment by Captain Draim and his associates are actually far less formidable than they would appear at first glance. The following are some of the more important liabilities of such a basing plan.

Lack of Available Hulls

It is simply not true that deploying the MX missiles aboard merchant ships would prove considerably less costly than the scheduled land deployment. Most backers of the hydralaunch plan assume that MX could be carried aboard U.S. merchant vessels already in commission, thereby incurring few additional costs for the basing mode. This is not feasible. One must examine the merchant shipping assets available to the United States to understand just how unrealistic this assumption is.

Ships available for use with the Miltary Sealift Command, the component command responsible for the United States' strategic sealift, comprise several categories, the four main ones being: the Military Sealift Command-Controlled Fleet, the National Defense Reserve Fleet (NDRF), the U.S.-Flag Merchant Marine and the Foreign Flag (Effective U.S. Control--EUSC) Fleet.[8] Given the sensitive nature of the hydralaunch MX mission, EUSC ships, which are manned by foreign crews, would have to be ruled out for use. That would leave only MSC-controlled, NDRF, and U.S.-Flag Merchant Marine vessels available for MX deployment.

In the 1979-1980 period, the Military Sealift Command-controlled fleet consisted of 111 ships -- the MSC nucleus fleet of 69 vessels (both government-owned and long-term chartered), manned partially by civil service crews and partially by merchant marine crews, and the MSC-controlled commercial fleet of 42

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7 Jerry O'Rouke, "A Sea-Going M-X ICBM?" Armed Forces Journal, May 1981, p. 24.

8 Marshall E. Daniel, Jr., Defense Transportation Organization: Strategic Mobility in Changing Times, National Security Affairs Monograph Series 79-3 (Washington, D.C.: National Defense University, May 1979), pp. 11-14.

ships, manned entirely by unionized merchant seaman. Of these 111 merchantmen, only 33 were dry-cargo-capable breakbulk vessels.[9] In 1980, the National Defense Reserve Fleet contained only 150 moth-balled ships capable of having value in the military sealift role. Of this number, 130 were World War Two-vintage Victory ships, which despite an ongoing active preservation program (dehumidification preservation and cathodic hull protection) have been "deteriorating beyond salvation" over a considerable period of time.[10] Use of such ships would undoubtedly require an extensive and costly overhaul and refitting program.

At the beginning of 1980, the U.S.-Flag Merchant Marine consisted of 569 vessels, of which 533 were active.[11] Dry-cargo ships useful for military sealift constituted about half of this fleet (275 ships in 1980). Approximately 226 U.S.-Flag merchant ships (170 dry-cargo vessels) would theoretically be available in non-mobilization contingencies (using phased callups) under the Sealift Readiness Program within sixty days of notification. However, in addition to its never having been activated, the call-up procedure under the Sealift Readiness Program is extremely complex. It requires, among other things, the approval of both the Secretary of Commerce and the Secretary of Defense to call up individual ships.[12]

In addition to the time-consuming call-up process, there is the problem that extended use of privately-owned shipping for an MX deployment would prove costly to the United States government and damaging to U.S.-Flag shipping's share of the world market. As the Assistant Secretary of Defense for Installations and Logistics told Congress in 1975: "We have concern for implementing [the SRP] program, however, since these ships would be removed

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9 Ibid., p. 12. The rest of the ships consisted of tankers, tugs and special purpose vessels. Other reports show even lower totals for dry-cargo breakbulk ships.

10 Written statement of Vice Admiral William J. Cowhill, Deputy Chief of Naval Operations (Logistics)in House, Committee on Armed Services, Hearings on Military Posture and H.R. 6495 Department of Defense Authorization for Appropriations for Fiscal Year 1981, Part 3: Seapower and Strategic and Critical Materials Subcommittee, 96th Congress, 2nd session, 1980, p. 173. The quoted phrase comes from W. J. Amoss, "Sealift and the Reality of American Power," Seapower 24 (March 1981), p. 75. There are (1981), however, twenty-five relatively-low-tonnage capacity ships available on short notice (five to ten days) for use in the NDRF's Ready Reserve Fleet (RRF), given crew availability. Current plans call for building up the RRF to 35 ships by 1983.

11 Brent Baker, "Naval and Maritime Events 1980," (Naval Review 1981), United States Naval Institute Proceedings, 107 (May 1981), p. 49.

12 For the call-up procedure, see Clinton H. Whitehurst, Jr., The Defense Transportation System: Competition or Complement to the Private Sector? (Washington, D.C.: American Enterprise Institute for Public Policy Research, 1976), pp. 48-49.

from their normal trade routes and thus if kept for an extended period of time, the U.S. competitive position in the world shipping market could be damaged."[13] Of course, a further factor to be considered would be the impact that having MX missiles aboard ships manned by unionized civilian crews would have on the reliability of deployment patterns. In past years, U.S.-flag shipping has frequently been left hostage to union strikes called over relatively insignificant matters.[14]

The available merchant shipping useable for conversion to the MX hydralaunch mission is therefore extremely limited. Ships of the MSC-controlled fleet are already overcommitted as far as their wartime sealift responsibilties are concerned, while at the same time their peacetime workload has been steadily increased over the past decade to encompass much of the Navy's underway replenishment responsibility, as part of the Naval Fleet Auxiliary Force.[15] As the commander of the Military Sealift Command, Rear Admiral Bruce Keener, commented:

> The U.S. Navy, per se, does not have and will never have organic sealift assets sufficient to meet the demands of more than the very first phases of any emergency. The cost in dollars and manpower for DOD to provide the capability would simply be too great. We rely on the U.S. merchant marine for emergency sealift services and sealift assets, both in peacetime and wartime....[But] the U.S.-flag merchant marine does not have in large quantities the kind of ship that we in defense see the most need for.[16]

From the foregoing, it can be concluded that plans for seaborne deployment of MX using merchantmen would necessitate either an extensive new shipbuilding program or major refitting of mothballed Victory ships now in the National Defense Reserve Fleet. Either course would be time-consuming and would add considerably to the projected costs of such a deployment.[17]

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13 Quoted in Daniel, Defense Transportation Organization, p. 25.

14 Another question to be raised is the extent to which civilian crew members would have to pass security checks for military clearances.

15 This mission was initiated in FY 1972 as a money-saving measure. Initial responsibility was limited to oilers, tugs, store ships and cable-repair ships. Whitehurst, Defense Transportation System, p. 41. In recent years, the Navy has turned the majority of its underway replenishment responsibility over to the MSC.

16 Quoted in Warren P. Baker, "The Strategic Dimensions of Maritime Power," Seapower 23 (November 1980), p. 24.

17 Utilization of U.S Navy ships would prove equally difficult. As of January 1981, the Navy had only 58 amphibious ships in active commission and six more assigned to the Naval Reserve Force. Norman Polmar, The Ships and Aircraft of the U.S. Fleet, 12th Ed. (Annapolis: United States Naval Institute, 1981), p. 132. Of course, at any one time, a significant

Vulnerability to Soviet Targeting

The assertion that MX-laden merchantmen would be almost impossible to target is also highly doubtful. One must first remember that ships capable of topside storage of large MX missiles (192,000 pounds, 71 feet in length, 92 inches in diameter) and fitted for jettisoning them overboard would be difficult to disguise as regular merchantmen. And even if the ships themselves could be suitably disguised, they would have to operate out of ports equipped to provide base maintenance for the missiles -- ports which would quickly become known to the observant Soviets. Then, once the hydralaunch ships left their home ports, they could either be trailed by Soviet surface vessels or submarines, or tracked by long-range aircraft and ocean surveillance satellites.

The Soviets have been deploying ocean surveillance satellites since 1965. Interestingly, two of these satellites were launched a decade and more ago especially to cover NATO naval exercises (1968 -- Exercise Silver Tower; 1972 -- Exercise Strong Express). One of the most recent Soviet ocean surveillance satellites launched was Cosmos 1266, a nuclear-powered satellite sent up in April of this year. These satellites have the capability of providing target data to Soviet missile launch platforms. In this field, the USSR has a clear lead over the United States. For instance, the U.S. Clipper Bow program, designed to develop a tactical support ocean surveillance satellite (furnishing tactical commanders fairly continuous track information on shipping for targeting purposes), was initiated in FY 1979 as an austere R&D demonstration for facilitating a production decision in the 1984-85 timeframe.[18]

Once those MX-laden merchantmen not already being trailed by Soviet surface ships or submarines had been located to within a

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number of these ships is either deployed overseas, in transit or in overhaul or modernization. And as the CNO informed the Senate Armed Services Committee last year, the Navy would soon be experiencing a force level shortfall in amphibious ships. Answer to a question submitted by Senator Gordon Humphrey in Senate, Committee on Armed Services, Department of Defense Authorization for Appropriations for Fiscal Year 1981: Hearings on S.2294, Part 2: Nuclear Forces Report, Army Programs, Navy-Marine Corps Programs, Air Force Programs, Navy Shipbuilding Program, 96th Congress, 2nd session, 1980, p. 916.

18 "The Navy's requirements is [sic] for a system that will continue to go around and...to report what it finds and sees in the swath that it covers and report this back as rapidly as possible to the commanders at sea, so to speak." Testimony of Assistant Secretary of the Navy for Research Engineering and Systems, David E. Mann, Senate, Committee on Armed Services, Department of Defense Authorization for Appropriations for Fiscal Year 1979: Hearings on S. 2571, Part 8: Research and Development, 95th Congress, 2nd session, 1978, p. 6269. See also Ibid., pp. 6198-6199.

few square miles of ocean, they could be readily subjected to attack by long-range cruise missiles and ballistic missiles armed with nuclear warheads that had been launched from submarines a considerable distance away. Soviet submarines currently available for such a strategic counter-ship mission comprise a large and varied force of nuclear- and diesel-propelled ballistic missile- and cruise missile-equipped boats. These include some fifty-four SSBNs and SSBs of the Yankee, Hotel II and Golf I and II classes and about seventy SSGNs and SSGs of the Oscar, Papa, Charlie I and II, Echo II, Juliett, Whiskey Long-Bin and Whiskey Twin Cylinder classes.[19] The variety of weapons available aboard these submarines run the gamut from the 1600 nautical mile SS-N-6 Mod 2 and Mod 3 SLBMs of the Yankee class boats to the 30 nautical mile SS-N-7 cruise missiles of the Charlie class subs. Certain naval analysts have believed for some time that Yankee class submarines have had an additional mission as counter-ship platforms (for targeting American carrier forces). Hydralaunch merchantmen would prove to be targets as least as valuable to these boats as the U.S. aircraft carriers are. Because the long-range SS-N-6 SLBMs aboard the Yankees utilize liquid-fueled propulsion, they can have their thrust terminated by valving at any time during powered flight, thus allowing them minimum ranges of between 100 and 200 miles.[20] Use of SS-N-6s on minimum range trajectories against MX-carrying merchant vessels would tend to both increase missile accuracy and reduce the time allowed for evasive action by the ships being targeted.

Because of the lack of protection offered by the flat surface of the ocean, surface ships are vulnerable at sizeable distances to the effects of air-burst explosions of nuclear warheads. A peak overpressure of 5-6 psi will cause fairly severe damage to a ship's superstructure and ancillary equipment. At optimum altitude, the airburst of a one megaton warhead will cause peak overpressures in the 5-6 psi range out to and somewhat beyond three-and-a-half nautical miles.[21] Topside damage aboard ship both from blast

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19 It should be noted that there were reports in 1980 that the Soviets had begun removing missile tubes from the Yankee class SSBNs in order to convert them into attack submarines, a fact that would (if completed) significantly reduce the numbers of SLBMs available for counter-ship mission. Michael MccGwire, "A New Trend in Soviet Naval Development," Naval War College Review 33 (July-August 1980), p. 9. However, the Soviets might well reverse this activity if the United States went ahead with plans for a hydralaunch force.

20 Carl H. Clawson, Jr., "The Wartime Role of Soviet SSBNs--Round Two," United States Naval Institute Proceedings, 106 (March 1980), p. 66.

21 Despite the shorthand use of the term "peak overpressure" in connection with the destructiveness of nuclear explosions, it should be recalled that target damage is caused both by diffraction loading due to blast overpressure and by drag loading which results from dynamic pressure (winds). At 3.5 nautical miles, the peak (blast) overpressure from a 1 MT air burst would be 5.5 psi and the wind velocity would be 177 mph.

overpressure and winds (primarily the latter) would in all probability prove more than sufficient to prevent intended jettisoning of the missiles. And the Electromagnetic Pulse (EMP) effects from such an explosion would play havoc with shipboard communications and other electronic systems out to even greater distances.[22] And it is very probable that Soviet submarines would launch salvoes of two or more SLBMs (the SS-N-6 Mod 3 is already equipped with three MRV warheads) against each ship, thereby decreasing the requirements for high accuracy and increasing the synergistic effects of the bursts.

Sinking the ships would not be required. Soviet targeting against MX hydralaunch merchant vessels would be completely successful if the nuclear explosions prevented the launching of the missiles (providing a mission kill). Therefore, even the relative inaccuracies of older Soviet SLBMs such as the SS-N-4 and SS-N-5 would not present an overriding problem.

Missile Accuracy

Another factor mitigating against the MX hydralaunch deployment concept is the matter of missile accuracy. The MX has been designed to be an extremely accurate ICBM, with a capability significantly better than that present on the Minuteman III. This major improvement in accuracy, necessary if the missile's warheads are to have a high hard target-kill capability, is to be provided by the missile's inertial measurement unit, known as AIRS (Advanced Inertial Reference Sphere). AIRS is a beryllium sphere containing three Northrop Third Generation Gyroscopes (TGGs) utilizing the latest advances in bearing technology (for relaying attitude information) and three Honeywell accelerometers (to measure velocity).[23] AIRS is to be suspended inside a case and surrounded by a thin layer of low-viscosity fluid to cushion it against missile vibration and temperature effects and to allow it to float freely while the missile is in flight. AIRS is also self-aligning and self-calibrating. Together, these features make it all-attitude and all-azimuth capable and enable the inertial guidance system to zero out all of the effects of gravity when it is launched. When combined with its advanced guidance and control flight computer, many times faster than the computer

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22 The relative intensity of the Electromagnetic Pulse effects resulting from a nuclear explosion varies according to the height of the burst, with high-altitude nuclear explosions producing pronounced EMP effects over the largest geographic area. For a general discussion of EMP phenomena see "Nuclear Pulse (I): Awakening to the Chaos Factor," Science 212 (29 May 1981), pp. 1009-1012.

23 Bruce A. Smith, "Test Scheduled for MX Inertial System," Aviation Week & Space Technology, 112 (April 7, 1980), pp. 67-71; Bruce A. Smith, MX Missile Performance, Throw Weight Improved," Aviation Week & Space Technology, 112 (June 16, 1980), p. 131; and "U.S.: New MX Order for Northrop," Defense & Foreign Affairs Daily, April 2, 1980, p. 2.

used in Minuteman III, utilizing hardened logic devices and plated wire memory, AIRS provides the MX missile an unprecedented accuracy.

Unfortunately, the hydralaunch environment cancels most if not all of the promised improvement in accuracy provided by AIRS. Next to the inertial sensing equipment itself, the most important contributors to overall missile accuracy are the initial conditions at launch. For a missile to fly the thousands of miles required of it with the precise ballistic trajectory for its warheads to hit their intended targets with high accuracy, it is necessary that the missile's inertial guidance system be properly calibrated for the missile's exact latitude and longitude coordinates at the time of launch.

Land-based ICBMs are deployed in carefully surveyed, fixed silos to nullify errors resulting from the inaccurate calculation of launch location. On the other hand, submarine-launched ballistic missiles, because their moving launching platforms are subject to greater position errors, require guidance systems with the capability to correct missile trajectories in flight, if they are to achieve greater accuracy. Thus, current SLBMs such as the U.S. Trident I (C-4) and the Soviet SS-N-18 utilize stellar inertial guidance systems, which allow onboard measurement of the missiles' orientation in space relative to one or more stars of known celestial coordinates, for course correction by their inertial guidance units and subsequent steering modifications.[24]

Therefore, without some sort of mid-course data update for course correction, MX missiles (not now configured for such updates) jettisoned from merchant vessels and launched from the ocean would not have sufficient accuracy to have a high probability of success against Soviet hardened targets. With necessary missile guidance modifications, mid-course correction could be provided for hydralaunch MXs through data transmission from military navigational satellites such as GPS and Navstar. However, total reliance on such external means for required accuracy of these strategic missiles would be dangerous, because satellites (and their transmissions) are susceptible to enemy countermeasures and also because the effects produced by high altitude nuclear explosions can black out transmissions for extended periods of time. In a very real sense, reliance on external mid-course guidance would render the seaborne MX force no more secure than the satellites on which it would depend.

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24 Of course some earlier American and Soviet SLBMs also employed stellar-inertial guidance. For a useful discussion of ballistic missile inertial guidance systems, see David G. Hoag, "Strategic Ballistic Missile Guidance--A Story of Every Greater Accuracy," Astronautics & Aeronautics, 16 (May 1978).

Ship Security

One final factor to be discussed here that has not been sufficiently considered with regard to the Draim hydralaunch proposal is the matter of ensuring security for the MX hydralaunch fleet. It should be remembered that the MX missiles would be put aboard unarmed merchant ships, vessels which could depend for their security only upon their presumed ability to camouflage their strategic cargoes and missions. If these vessels could not successfully hide their purpose, they could well become priority targets for terrorists and pirates. Imagine the consternation in Washington if an MX-laden merchantman were to be seized by a group of desperate men who promised to destroy the missiles unless burdensome ransom demands were met, or worse yet, who managed to separate one or more of the warheads from a missile's "bus" and then disappeared with the deadly package.

Securing the fleet against this realistic possibility would require either arming the merchant ships, as was done during the Second World War, or providing each vessel with its own naval escort. Arming merchantmen with deck guns (since small arms alone might not prove sufficient to repel boarding by a determined terrorist force) would take time, even if the guns were readily available. Training the civilian crews to reach even minimal proficiency with these guns would prove even more time-consuming, while the alternative of stationing a permanent detachment of naval personnel aboard each ship to man such guns would only further deplete the already undermanned U.S. Navy.

Yet the second choice is equally troublesome. The Navy lacks the available destroyers and frigates required for such additional escort duties. As of the beginning of this year, the Navy had 37 missile-armed destroyers (DDGs) and 43 all-gun destroyers (DDs) in the active fleet, with another 16 DDs in the Naval Reserve Fleet. Similarly, its complement of frigates (FFGs and FFs) stood at about 70, some 22 below the Service's current force level objective.[25] Thus, a fleet of MX hydralaunch merchantmen would require for their security the expenditure of additional large sums of money and manpower to prevent being seized by armed parties of men while steaming in international waters.

SUM

In the summer of 1978, the Jason Study Group, at the request of the Department of Defense, held a series of meetings at the Stanford Research Institute to explore various concepts for providing ICBM invulnerability. At the end of its three-week

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[25] Polmar, Ships and Aircraft of the U.S. Fleet, pp. 91 and 113; and "Naval Forces Summary, February 1981," (Naval Review 1981), United States Naval Institute Proceedings, 107 (May 1981), p. 237.

session, the group, headed by Stanford physicist Sidney Drell, recommended that DoD develop a plan for the so-called "water-based" MX.[26] In February 1979, Drell and fellow Jason Group member Richard Garwin of Harvard testified before the House Armed Services Committee on their proposal, which they designated SUM (Submerged Underwater Mobile). As orginally envisioned by Drell and Garwin, the MX missiles, instead of being based on land, would be placed on fifty small, coastal submarines. Each conventional submarine of some 450 tons displacement and a crew of twelve would carry two to four MX missiles in capsules outside its pressure hull. Its operating area for its two- to four-week cruises would be a band of ocean 200 nautical miles wide off of the Atlantic and Pacific coasts of the continental United States. It would receive communications from the National Command Authority through a network of on-shore transmitters.[27]

The concept was subsequently modified and refined over a period of months, in part in response to technical criticisms. During 1980, Dr. Drell testified about SUM before a number of congressional forums, including both the Senate Armed Services Committee and the Defense and Military Construction Subcommittee of the Senate Appropriations Committee. In the more refined proposal, the SUM force would consist either of eighty 450-ton submarines, utilizing fuel cell propulsion and carrying two canisterized MX missiles or forty 1,000 ton submarines carrying four missiles. These submarines would not have their own inertial navigation system for determining their positions but would rely instead on the inertial navigation systems contained in the missiles. Twelve to fifteen man crews would operate the boats on their three-week cruises, monitoring the largely automated equipment and performing routine maintenance. Communication with authorities on shore would take place by VLF (very low frequency) radio signals using expendable "awash-buoy" antennas. The submarines, roaming ocean bands out to 200 nautical miles offshore in the Pacific and operating from points between 100 and 300 miles offshore in the Atlantic would prove impossible for the Soviets to effectively target.[28]

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26 Bill Keller, "Attack of the Atomic Tidal Wave: Sighted S.U.M., Sank Same," The Washington Monthly, 12 (May 1980), pp. 54-55; and Eliot Marshall, "MX Missile to Room 200 Racetracks," Science, October 12, 1979, reprinted in Congressional Record, November 8, 1979, p. S15321.

27 Marshall, "MX Missile," p. S16322; Stanford University News Service (Press Release), September 7, 1979; and Stanford University News Service (Press Release), November 20, 1979.

28 The reason for the increased offshore operating distance in the Atlantic is the necessity of the boats avoiding possible destruction from tidal waves caused by multiple Soviet underwater nuclear explosions, the effects of which would be drastically increased in power by the shallow water (400 feet or less in depth) of the continental shelf, which extends to about 100 miles off the East Coast of the United States. This phenomenon, known as the "Van Dorn" or surf-zone effect, was one of the points used

The major advantages suggested by Drell and Garwin for this undersea basing proposal were several. First, they argued that the submarine-deployed MX force as a whole would be invulnerable to Soviet strategic targeting, unlike MX in the projected land-basing scheme, which could be overwhelmed by increased numbers of Soviet warheads. Sidney Drell testified: "As a result of its mobility and concealment under water, it [the SUM force] cannot be effectively barraged or pattern-bombed [even] by the entire Soviet ICBM force."[29] Second, they stated that SUM would prove significantly cheaper than the Carter Administration's land-based deployment plan for MX. Drell estimated it would be $10 billion less expensive (about a third less costly than the $33 billion land-based MX system). Third, they claimed that with sufficient national effort, the SUM system could become operational well before the 1990s, making available to the U.S., at an earlier date than the land-based MX plan, a significant amount of surviv-able megatonnage. Dr. Drell noted:

> ...[A]nything less than the full deployment of the racetrack system against an accurately projected threat is of little real value to the U.S. since we do not even begin to realize an appreciable gain in retaliatory capability as measured by surviving megatonnage until the deployment of most of the shelters has been completed. The SUM system that has been proposed has no such deficiency.... [E]ach additional missile that is deployed contributes significantly to the surviving magatonnage....
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> Past experience shows that, if we are determined to, we should be able to initiate a SUM deployment well before the 1990's.[30]

However, just as is the case with the Hydra concept, on close inspection, the suggested advantages of SUM are seen to be less formidable. These are just a few of the liabilities of this basing scheme.

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to criticize the initial SUM proposal, which envisioned the deployment of a portion of the submarine force in the waters of the continental shelf. See Sidney D. Drell and Richard L. Garwin, "Statement on SUM and Its Invulnerability to the Surf Zone (Van Dorn) Effect," copy of a one-page typescript document, March 29, 1980.

29 "Testimony on SUM as a Basing Scheme for the MX and Its Advantages Relative to the Racetrack by Sidney D. Drell before Defense and Military Construction Subcommittees of the Senate Appropriations Committee, May 7, 1980," copy of a typescript document, p. 8.

30 Ibid., pp. 8 and 12, respectively.

SUM Deployment Schedule

Professor Drell asserted in April 1980 that the SUM system could begin to be deployed in 1986. He testified before the Senate Armed Services Committee's Research and Development Subcommittee:

> I see no basis for extrapolating more than 5 years to develop the very simple submarines we are talking about, which have nothing in guidance beyond what the MX program provides. They are state-of-the-art fuel cells and very simple technology, not even superhard.
>
> The 1986 timeframe is set by the availability of missiles.[31]

This belief in the early availability was founded upon several premises. One of them was the belief, at least initially, that the small, 450-ton submarine required for carrying two MX missiles could be developed quickly as a modified version of the German HDW (Howaldtswerke-Deutsche Werft) Type 206 submarine, which has been in service with the West German Bundesmarine since the early 1970s.[32] In a November 1979 press release, Drell's feelings on this point were explained in this way: "The West German navy already operates modern diesel-electric submarines of precisely the size envisioned to carry the MX, 450 tons."[33] Another premise was that if given national priority, the SUM submarines could be designed and built very quickly. As the basis for this premise SUM supporters pointed to the rapid development in the 1950s of the Polaris nuclear ballistic missile submarines. As Drell testified before the Senate Armed Services Committee:

> ...[A]t the deployment of the Nautilus, the Navy estimated it would take 10 years to go to nuclear missiles at sea....

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31 "Statement of Dr. Sidney Drell, Deputy Director, Stanford Linear Acceleration Center, Stanford, Calif.," Senate, Committee on Armed Services, Department of Defense Authorization for Appropriations for Fiscal Year 1981: Hearings on S. 2294, Part 6: Research and Development, Civil Defense, 96th Congress, 2nd session, 1980, p. 3721.

32 The HDW Type 206 diesel-electric submarine displaces 450 tons surfaced, 600 tons submerged. It has a crew of twenty-two and is equipped with two MTU diesel engines (750 hp each), two 500-kw generators and one 1,500 hp electric motor. Jean Labayle Couhat, ed., Combat Fleets of the World 1980/81: Their Ships, Aircraft, and Armament (Annapolis: United States Naval Institute, 1980), p. 170.

33 Stanford University News Service, November 20, 1979. See also Marshall, "MX Missile," p. 516322. In the 1980 congressional testimony, Dr. Drell apparently avoided mentioning the connection between the SUM boats and the HDW-built submarines.

> There were a number of technical problems raised against it, but beginning in 1957, when Admiral Raborn was given the charge, let us put some ballistic missiles at sea, he managed in 3½ years to test a solid-fuel missile with a thrust unprecedented to go to a 1,200 mile range. That was the Polaris A-1 missile. He developed the technique for underwater, launch popup, solid-fuel missiles, and we, in fact, by the end of 1962 [sic], had operational Polaris submarines going from the Nautilus...at sea in the deployed forces.[34]

Neither of these optimistic assumptions is valid. First, the 450-ton HDW submarines cannot be easily modified to handle the additional weight of two canisterized MX missiles (180 tons additional displacement). They are simply too small. In fact, even the larger HDW-600 of some 550 tons displacement was found by the Defense Department's Office of Research and Engineering (DDR&E) to be too small to handle the missiles. It reported:

> The German submarine (designated HDW-600) has about 10% reserve buoyancy. With the two MX capsules, buoyancy would drop to about 4%, which is insufficient for safe operation. Accordingly, the ballast and buoyancy control systems would have to be redesigned, necessitating other major changes to the submarine layout. Also, the submarine structure and control systems would have to be modified to ensure adequate steering, depth, and trim control.[35]

DDR&E found that a submarine would have to have a pressure hull displacement of at least 1,100 tons (carrying up to four canisterized MX missiles) to be feasible. The independent study of the proposal conducted by the Navy Department, geared toward a longer-range, deeper-operating-depth submarine, came out with a design minimum of 1,600 tons. Diesel-electric submarines of either displacement would have to specially designed for the mission, a

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[34] "Statement of Dr. Sidney Drell," Department of Defense Authorization for Fiscal Year 1981, Part 6, p. 3721.

[35] ICBM Basing Options: A Summary of Major Studies to Define a Survivable Basing Concept for ICBMs (Washington, D.C.: Office of the Deputy Under Secretary of Defense for Research and Engineering (Strategic and Space Systems), December 1980), p. 21. The Under Secretary of Defense for Research and Engineering, William Perry, testified in April 1980: "We have discussed the existing submarines -- the small 500- and 1,000-ton diesel electric submarines -- with the German manufacturer, and have concluded that attaching these large missiles on the exterior of those submarines would introduce substantial structural problems and that the system resulting from that would not be seaworthy." "Statement of Dr. William J. Perry, Deputy Under Secretary of Defense [sic] for Research and Engineering"; Department of Defense Authorization for Fiscal Year 1981, Part 6, p. 3707.

procedure that would take considerable time. DDR&E estimated the IOC for a 1,600-ton SUM boat to be 1992. According to another source, Howaldtwerke-Deutsche Werft told Defense scientists that it would take seven years to modify, test and build a larger 1,800-ton boat for SUM deployment.[36] The need for a new submarine design would also dramatically increase the costs of the system.[37]

The premise that a priority program could make SUM operational in the mid-1980s is also doubtful. The analogy with the Polaris program is not very instructive since in the 1950s and 1960s, the Navy had seven shipyards supplying submarines for the Fleet (five privately-owned commercial yards and two navy shipyards). Today, the Navy is forced to depend upon only two private commercial yards, Electric Boat (General Dynamics) and Newport News (Tenneco).[38] As the Congress' Office of Technology Assessment reported:

> At present there are only two shipyards in the United States capable of building submarines, and both are backlogged. Bringing additional shipyards to the point where they could build submarines, and obtaining the necessary parts and materials, would probably involve substantial delays. OTA estimates that the first such submarine could not be operational before 1988 at the very earliest, with 1990 a more realistic date....Efforts to accelerate this schedule (or, if things went wrong, to maintain this schedule) could delay other, existing submarine construction programs.[39]

System Vulnerability

The proponents of SUM argue that the small, low speed (5 knots) submarines would be impossible for the Soviets to effectively target. This argument is also open to question.

It is true that diesel-electric submarines when on battery are extremely quiet and thus difficult to locate and track using acoustic detection equipment. However, such submarines cannot operate on battery constantly and must run their diesel engines

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36 "Washington Roundup: SUM Rebuttal," Aviation Week & Space Technology, 112 (April 28, 1980), p. 13. Of course, Drell denies that there is a requirement for submarines in the 1,600-1,800 ton range.

37 For example, the Office of Technology assessment cost estimate for SUM system procurement is $32 billion for 51 moderately sized diesel-electric boats.

38 "Written Statement of Adm. H. G. Rickover, Deputy Assistant Secretary for Naval Reactors, Department of Energy," House, Committee on Armed Services, Naval Nuclear Propulsion Program -- 1981: Hearing on H.R. 2969, 97th Congress, 1st session, March 9, 1981, pp. 6168 and 6173.

39 MX Missile Basing: Summary (Washington, D.C.: Office of Technology Assessment, 1981), pp. 35-36.

to recharge the battery a number of times each day. To do this, the submarine must send up a tube to the surface of the water to take in air (snorkle). The combination of the increased noise from the diesel engines and the surface disturbance of the water by the snorkle significantly increases the possibility of detection. For this reason, Professors Drell and Garwin have recommended that the new submarines be powered by large fuel cells, which would have the quiet operating capability of the conventional battery but with the capacity for continuous use. The problem with this concept is that the use of large fuel cells for propulsion is beyond the present state-of-the-art. It is still an unproved technology, one which will take careful management and a fair number of years to develop.

Another vulnerability factor which should be considered is the relatively small operating area envisioned for the SUM fleet. According to Drell, the small submarines would operate in an area of only 500,000 square miles of ocean. This should be contrasted with that of the Trident submarine fleet, which will operate in an ocean area consisting of between fifteen and twenty million square miles (an area 30 to 40 times larger).[40] Deploying the SUM boats into this relatively small portion of the Atlantic and Pacific Oceans would allow the Soviets to concentrate a significant portion of their ASW forces in (and target a good deal of their ICBM megatonnage on) the submarines' operating areas. The slow-moving submarines (which, unlike their nuclear-powered counterparts would lack the submerged speed to shake off their surface pursuers) could be trailed by Soviet surface vessels upon leaving their home ports. Alternatively, the USSR could surreptitiously lay a network of passive hydrophone arrays (like our own SOSUS network) in the waters just off the continental shelf in the Atlantic, for example, to help localize the submarines and chart their deployment patterns.

Much of the vaunted invulnerability of a SUM system is dependent upon the Soviet Union continuing to lag behind the United States in its anti-submarine warfare capability. While Soviet acoustic systems and signal processing equipment are currently much inferior to ours, their ASW research and development effort is extensive and oriented toward finding non-acoustic detection methods which could eventually equal or better our accoustic detection capability. As Rear Admiral Sumner Shapiro testified in 1978:

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40 MX Missile Basing, p. 22. Former Secretary of Defense Harold Brown, in testimony before the Senate Foreign Relations Committee, set the Trident boat's operating area as 18 million square miles. The Department of Defense Statement on Strategic Military Balance: Military Assessment by The Honorable Harold Brown Before the Committee on Foreign Relations of the United States Senate 96th Congress, First Session, 11 July 1977, Figure [7] (p. [28]).

> Our general assessment of the state of Soviet ASW is that it is a big effort, both currently and in the research and development sense.
>
> ***
>
> The limitations that they have in acoustics I think has led the Soviets to investigate other systems that could given them an answer to their acquisition problems....
>
> The Soviets have taken this route probably because they recognized early on the U.S. lead in quieting our submarines and also the lead we enjoy in acoustic technology in general. They may be trying to end run us and come up with some other capability that would give them an advantage over us.
>
> Research and development on this started in the later fifties. They have accumulated very large comparable data base, have a lot of surface ships and research ships collecting information, and they may understand some of the phenomena that were involved, some of it better than we do.[41]

The deployment of a majority of our strategic forces in submarines (SUM and Trident) would only allow the Soviet Union to further concentrate its efforts in the anti-submarine warfare area, thus perhaps leading to an earlier solution to the SLBM threat.

Sidney Drell acknowledged the potential for Soviet detection of the SUM fleet when, in his testimony before the Senate Armed Services Committee in 1980, he commented upon the need to explore actions by the Navy to aid the acoustic masking efforts of the SUM force (through the use of noise generators) and to harass Soviet forces seeking access to the SUM operating areas.[42] On a number of occasions, Professors Drell and Garwin have also stressed the need for U.S. Naval forces to protect the SUM fleet. However, as Dr. Seymour Zieberg, the Deputy Under Secretary of Defense for Research and Engineering, testified in 1980, the use of such naval assets would require the procurement of additional ships and aircraft -- a step which would add some $10 to $15 billion to the cost of the deployed system.[43]

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41 "Statement of Rear Adm. Sumner Shapiro, USN, Deputy Director, Office of Naval Intelligence," Senate, Committee on Armed Services, Department of Defense Authorization for Appropriations for Fiscal Year 1979: Hearings on S. 2571, Part 9: Research and Development, 95th Congress, 2nd session, 1978, pp. 6662, 6665-6666.

42 Testimony of Dr. Sidney Drell, Department of Defense Authorization for Fiscal Year 1981, Part 6, p. 3728.

43 Testimony of Dr. Seymour Zeiberg, Ibid., p. 3736.

Missile Accuracy

The accuracy of the MX missiles carried by the SUM boats is another factor that downgrades the acceptability of the basing scheme. As noted previously, under the Drell/Garwin proposal, the submarines would not have separate inertial navigation systems to provide accurate location information but would instead rely on the inertial navigation systems in the MX missiles they carried. According to SUM proponents, the accuracy of the MX missiles would be heightened by the use of early- or mid-course data updates from ground beacons.[44]

However, ground beacons are subject to the same data transmission problems that satellites have. They may be knocked out early in a nuclear engagement and their transmissions can be jammed or garbled by EMP effects. And even if they are able to provide course correction data, the information they provide may not be sufficient to give the MX missiles the hard target kill capability that MX was designed to achieve. It should be noted that under questioning in 1980, Dr. Drell, a strong advocate of arms control, expressed uneasiness with an MX deployment mode which gave the missiles a countersilo capability.[45]

Manning the SUM Fleet

One other factor which supporters of the small submarine plan apparently did not fully examine is the question of manning. Under the SUM proposal, a crew of twelve to fifteen men would operate each submarine on cruises of from three to four weeks in length. Because of the size of the boats involved, crew habitability would not be particularly good. Sleeping and eating quarters would be cramped and recreational activities would prove extremely limited. Given the schedule of frequent cruises, personnel aboard these SUM boats could expect to spend the majority of their time either in transit to and from port or on station.[46]

Such activity in cramped surroundings would prove burdensome to even the most dedicated sailors and officers. After initial recruitment for such duty, one would expect to see a major dropoff in crew retention. After all, even in the Navy's present nuclear program (and it should be noted that duty aboard nuclear submarines is far more pleasant than would be the case with SUM boats), the Service has been forced to draft a portion of its officers for the program to maintain its minimum manning requirements.[47]

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44 For a discussion of factors affecting missile accuracy, see the previous section of this paper dealing with Hydra's missile accuracy problems.

45 See his exchange with Senator Culver in Department of Defense Authorization for Fiscal Year 1981, Part 6, p. 3725.

46 Dr. Drell talked of an on-station availability of sixty percent and more.

47 See Naval Nuclear Propulsion Program--1981, pp. 31-36.

In general, it appears that SUM offers no major advantages over the Trident program already underway, while adding certain liabilities not now present. As a substitute for land-basing MX it offers even less usefulness. The MX missiles it would furnish would be neither time-urgent nor reliably hard-target-kill capable.

BIG BIRD: THE AIR-BASING OPTION

As conceptually interesting as the two sea-based schemes for MX were, they proved no more intriguing than the air-basing plan that was briefed to the Townes panel in April of this year. During the course of Air Force evaluations in the mid-1970s, all sorts of air-basing schemes, from sea sitters to VTOL (vertical takeoff and landing) aircraft, had been studied and rejected, because even the best concepts seemed to founder for failure to meet several critical criteria -- endurance, survivability and cost. Nonetheless, the fate of the new air-basing proposal initially seemed to be brighter.

In mid-July, information began leaking from the Pentagon that Secretary of Defense Weinberger was favoring an air-basing option for the MX missile. The news undoubtedly came as a surprise to a great many people, including influential members of Congress and even some senior Air Force officers in the Pentagon. As columnist Hugh Sidey expressed it in Time: "...[E]vents in the Dr. Strangelove world of nukes and launchers seem to be moving toward a final shape that has stunned the Pentagon, the industrial complex that builds the military's hardware and the defense experts in Congress."[48]

Despite its sudden impact, the air-basing proposal now known as Big Bird started out unpretentiously. The concept of deploying MX missiles aboard large, fuel-efficient, long-endurance aircraft had been developed by two men, Ira Kuhn, Jr. of B-K Dynamics and Abe Kerem of Leading Systems, Inc.[49] Early this year, with the design for the aircraft in hand, Mr. Kuhn began trying to interest the Defense Department in his proposal. After an initial failure, the developer turned to the Townes panel and succeeded in briefing first a portion of the group and then, in late April, the entire panel. The interest of the Townes panel in the concept led to Air Force and OSD evaluations in May 1981 and to a request in early June that Boeing perform an independent study of the Big Bird proposal.[50]

According to its developer, the Big Bird air-basing scheme was given a positive evaluation by Boeing, which found that the

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48 Hugh Sidey, "The Next Tough One," Time, August 10, 1981, p. 19.

49 Walter Pincus, "'2 Guys' Hatched Air-Mobile MX Concept," The Washington Post, August 13, 1981, p. A1.

50 Ibid.

proposed aircraft was "super good on cost and performance, and good on vulnerability."[51] This favorable report apparently helped bring the idea to the Secretary of Defense's attention. To Mr. Weinberger, the promise of a viable airborne MX fleet seemed to provide a way out of the severe political problems which the land-basing proposal has engendered.[52] Reportedly, the Undersecretary of Defense for Research and Engineering, Richard DeLauer, presented the approved Weinberger air-basing plan to the Townes Committee at the beginning of August.[53]

As tentatively decided upon by the Defense Department, the Big Bird air-basing deployment for MX would consist of two phases. In the first phase, the MX missiles would be placed aboard newly-built models of the C-5A transport, redesigned and equipped with materials for EMP hardening. Some 100 of these huge transport aircraft would be maintained on strip alert at austere landing fields -- two aircraft to each field. Each aircraft would carry one MX missile on a cradle, designed so that the missile could be extracted from the aircraft in mid-air by drogue chutes. Once the missile had reached vertical orientation, it would be ignited and sent on its ballistic trajectory toward the Soviet Union. The additional guidance information required for initial launching accuracy would be supplied to the MX-carrier aircraft by several of the 1,200 ground-based transmitters (GBS) to be located at Vortac navigation sites around the country.

In the second phase, the MX missiles would be removed from the C-5A aircraft (which would then become an augmentation fleet for U.S. military airlift needs) and would be emplaced aboard a fleet of special Big Bird long-endurance aircraft. These planes, built entirely of composite materials and designed with an extremely large wingspan for glider-like aerodynamic lift and flying at a 100-knot cruising speed, would be able to sustain flight unrefueled for 48 hours, and with refueling remain aloft for extended periods of time (3.8 to 5.6 days).[54] For launching their missiles,

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51 Ira Kuhn, quoted in Ibid.

52 Rowland Evans and Robert Novak, "An MX And an Airplane," The Washington Post, July 17, 1981, p. A23.

53 Sidey, "The Next Tough One," p. 19.

54 The substantial wingspan of the proposed Big Bird aircraft is best judged as a ratio of its wingspan to its fuselage length. It wingspan would be approximately 2.19 times longer than its fuselage. A comparison of that ratio to those in other American aircraft is useful. The wingspan of the C-5A is only 97 percent of the length of its fuselage, while that of the B-52 bomber is 1.16 times longer than its fuselage. Even the unique U-2 reconnaissance aircraft has a wingspan only 1.61 times longer than its fuselage (TR-1, U2A/B versions -- that of the U-2R being slightly greater (1.64 times longer)). Of course, an additional factor that is of utmost importance to sustained lift is wing loading, with low wing-loaded aircraft having the advantage.

the aircraft would climb to between 10,000 and 20,000 feet and increase their airspeed to between 130 and 180 knots.

The 100 aircraft of this fleet could be operationally deployed in a number of ways, including ground loiter -- with planes hopping among many austere airfields; short loiter -- with aircraft (in a time of international tension) alerted for fast takeoff and having an airborne endurance of some eight hours while operating from both primary and secondary bases; and long air loiter -- with the aircraft employed in continuous air operations from primary bases for up to five days.[55] However, the deployment proposal for Big Bird apparently put forth by its designer and the one which would promise the highest system survivability is the ocean loiter plan. Under this scheme, the 100 aircraft would be deployed at two air bases, one located on the East Coast and one on the West Coast. Half of the MX-carrying aircraft would be aloft at all times, ranging from their bases out into vast patrolling areas of the Atlantic and Pacific Oceans, where they could safely loiter for extended periods.[56]

Like the sea-basing options, this air-mobile proposal suffers from certain significant drawbacks. Several of them are worth some detailed examination in this paper.

System Cost

There is every reason to believe that the long-term costs of such a basing scheme would be substantially higher than those of the horizontal MPS land-basing system. The cost estimate for procurement of the C-5As varies according to the number of aircraft believed necessary to maintain the strip alert requirements. Proponents of the plan claim that as few as 115 C-5As would be necessary to maintain 100 aircraft on strip alert. Using ballpark procurement figures for the current C-5A design (utilizing the redesigned wing but without re-engining, making structural modifications or adding the EMP hardening which would be required for MX deployment), these 115 aircraft would cost between $10.35 and $12.74 billion in FY 1981 dollars.[57] Other defense experts

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55 Clarence A. Robinson, Jr., "Weinberger Pushes Strategic Airmobile MX Concept," Aviation Week & Space Technology, 115 (August 3, 1981), p. 17.

56 Clarence A. Robinson, Jr., "ICBM, Bomber Decisions Due in Late July," Aviation Week & Space Technology, 115 (July 13, 1981), p. 18; Pincus, "'2 Guys' Hatched Concept," p. A1; and Richard Halloran, "Some On MX Panel Favor Air System," The New York Times, July 17, 1981, p. A14.

57 The ballpark figures used in computing procurement costs for the C-5A (between $90 and $110 million a copy) come from the testimony of Major General Emil Block, "Briefing on CX," in House, Committee on Armed Services, Hearings on Military Posture and H.R. 6945 Department of Defense Authorization for Appropriations for Fiscal Year 1981, Part 4: Research and Development, Book 2, 96th Congress, 2nd session, 1980, p. 1798. Current dollar costs (FY 1982) would be higher both because of inflation and increased production and materials costs.

argue, it seems more accurately, that the number of C-5As required to maintain 100 aircraft on strip alert would be much higher. The Air Force estimates that some 291 would be necessary. This works out to a cost of between $26.19 and $32.01 billion in FY 1981 dollars.[58] Even using a scaled-down deployment of 34 aircraft on strip alert, it would take an overall requirement of 100 to maintain readiness, according to Air Force projections.[59] The cost for this minimum number of C-5As would be between $9 and $11 billion.[60] And incorporating required design changes in the C-5s would add additional millions to the cost of each procured aircraft.[61]

Costs for the austere airfields would also have to be added to any calculations. For a 100-aircraft deployment, 50 airstrips would be required. Even if the Air Force made maximum use of existing fields in the north central part of the United States (which would reduce overall survivability of the airborne portion of the Triad, since only so many aircraft could take off within the requisite period of time and the bomber force and the MX-carrying C-5s would have to jockey for position on the available runways), the air-mobile basing scheme would still require the construction of some 35-40 new airfields. These austere fields would have to have runways a minimum of 10,100 feet in length and 150 feet in width (for turnaround) and surfaced to handle the stress of repeated landings by heavily loaded aircraft. The construction cost of these airfields would also not be cheap.

When the money for four main operating bases, 1,200 ground beacons, the MX missiles themselves and the O&S costs for the system, with the 32,800 personnel (versus 13,500 for MPS basing) is added in, one can see just how expensive the first phase of Big Bird would be. The Air Force estimated that the acquisition costs for the high airmobile option (100 aircraft on strip alert) would be about $54 billion and its operating costs over a 12.5-year life cycle would be $22 billion.[62] To determine a total system

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58 See footnote 57, above. A mid-range figure (about halfway between the number suggested by the proponents and that offered by the Air Force) of 200 C-5A would run from $18 to $22 billion, using the same calculations.

59 Air Force estimates are given in "USAF Analysis Attacks Airmobile MX Concept," Aviation Week & Space Technology, 115 (August 17, 1981), p. 31.

60 See foonote 57, above.

61 For example, the aircraft's standard General Electric TF39 engine is already judged to lack sufficient thrust for the C-5A's requirements at or near maximum takeoff weight (766,000 lbs. at the 2.25G load factor). Given that the deployed weight of the MX missile (192,000 lbs.) and the accompanying cradle would approach the maximum allowable cabin load (242,500 lbs. at the 2.25G load factor) of the C-5A, re-engining the aircraft would undoubtedly be required.

62 "USAF Analysis," Aviation Week & Space Technology, p. 31. The estimates for the low airmobile option (34 aircraft on strip alert) were $33 billion in acquistion costs and $10 billion in operating costs.

cost, the price of the new Big Bird aircraft would also have to be added to these figures. Unfortunately, it is impossible to come up with reliable cost figures for an aircraft still in the concept development stage. However, at the very least, the procurement of these aircraft would add additional billions to the already high procurement and operating costs of the MX air-mobile basing option.

Survivability

The biggest survivability problem that MX will have during the first phase of Big Bird is simply that the C-5As on strip alert require immediate warning of Soviet SLBM launches if they are to get off the ground and out of the immediate impact areas in time. In its evaluation of the latest air-mobile concept, the Air Force estimated that it would take five minutes and twenty-two seconds for the C-5A aircraft to begin taxiing once the Soviet SLBMs broke water. Yet they also estimated Soviet depressed trajectory missile impact times to be between six and ten minutes after launch. Under these circumstances, C-5As located on air-strips within the earlier portion of the SLBM impact window would still be taking off when the warheads started arriving and would be completely destroyed. In fact, under the Air Force study's assumptions (12 of 52 Soviet SLBM boats targeted on the force and 2,300 ICBM warheads used for selected barraging of some 11,500 square nautical miles of fly-out corridors) only fifty percent of a 100 alert-aircraft force would survive (500 warheads) and only 40 percent of a 34 alert-aircraft force would escape destruction (136 warheads).[63]

Moreover, the Air Force's assumptions of survivability appear to be highly optimistic. First, their study assumes that C-5A aircraft can begin taxiing five minutes and twenty-two seconds after SLBM launch. This appears to be somewhat unrealistic. The complex alerting process at SAC, NORAD and NMCC will alone consume the first two to three minutes after the PAVE PAWS radars at Beale and Otis have detected the missiles breaking water.[64] That leaves the alert crews two to two-and-a-half minutes to get to their planes, perform minimal necessary pre-flight checks, start the engines and get them up to full power. As the Air force acknowledged, if warning or reaction times were delayed by even two minutes, survival of the force would drop to "virtually zero."[65]

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63 "USAF Analysis," Ibid. 136 warheads would be only 13.6 percent of the 1,000 warhead original force.

64 See the testimony and information supplied for the record in House, Committee on Armed Services, Strategic Warning System False Alerts: Hearing, 96th Congress, 2nd session, June 24, 1980, pp. 2 and 27.

65 "USAF Analysis," Aviation Week & Space Technology, p. 31; and George C. Wilson, "House Leaders Try to Down Airborne MX," The Washington Post, August 13, 1981, p. A1.

Second, the Air Force study utilized a 1981 Soviet strategic forces model on which to base their assumptions of MX survivability. The twelve Soviet SSBNs projected could either be augmented through surging the force or increased through additional fleet construction in the mid-1980s. Also, the number of ICBM warheads theoretically allocated to the attack could well prove significantly short of those actually so employed. Given the Soviet advantage in throwweight, a Soviet ICBM program unconstrained by SALT II limits on MIRVing could significantly increase the number of warheads available for barraging aircraft fly-out corridors. Given sufficient warheads of adequate yield (6,200-6,300 warheads of 1 MT yield), Soviet military planners might choose to barrage the entire north central region of the U.S. instead of just selected corridors. Under such a circumstance, they could blanket some half a million square miles of air space.[66] That is the equivalent, for example, of a section of air space 1,000 miles long by 500 miles wide.

As Brigadier General Guy Hecker testified:

> ...The genesis of that figure [500,000 square miles] is when we did the air mobile study last summer [1979], and we looked at the entire United States and airfields that would accept the aircraft, either military or civilian or places in the desert, and we found that, whereas the numerical number of airfields was great[,] as we separated them out we found that one bomb would kill their airfield, and then the submarine with the depressed trajectory could come in on the early coastal areas and would not provide us warning time to take aircraft off and fly out of the barrage area around the airfield, we then, to defeat the utility of the submarine barrage, had to move to the central United States....
>
> Then we found that in that central United States, which was roughly the area described by you...that they [the Soviets] then had enough ICBMs with warheads on them...to barrage fire over the entire area with one megaton weapons spaced approximately in the air at a certain altitude and the nuclear effects from the EMP blast, all the things that go with it, would knock down all of the airplanes in that central area. Not only would it include the MX carrier, but it would include the B-52s and the tankers, and any other aircraft that happened to be airborne at that time....[67]

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66 Testimony of Brigadier General Guy Hecker; House, Committee on Appropriations, Subcommittee on Military Construction Appropriations, Military Construction Appropriations for 1981: Hearings, Part 5: Strategic Programs, 96th Congress, 2nd session, 1980, p. 562.

67 Ibid. It should be noted too, that the effects of thousands of air-burst nuclear explosions over the populous north central United States would prove far more devastating to the country than the ground-bursts from similar numbers of warheads in the deserts of the Southwest.

Even those C-5A aircraft which had taken off early enough to avoid the effects of the incoming SLBM warheads (having gotten airborne between six-and-a-half and eight-and-a-half minutes after Soviet SLBM liftoff, from those fields farthest inland), would be approximately only between 176 and 193 miles out at the time Soviet ICBM warheads began arriving.[68]

Such factors would certainly tend to reduce the theoretical survivability of the airborne MX force, at least until the early 1990s when Big Bird aircraft had reached their full operational capability and were flying patrols around the clock.

Missile Accuracy

The accuracy of air-launched MX missiles is another factor which mitigates against the Big Bird basing scheme. Achieving high accuracy in missiles dropped from aircraft in mid-air is even more difficult than achieving high accuracy from sea-launched missiles. When the Air Force conducted its limited air-drop tests using Minuteman I missiles in 1974, it was not concerned about the complex missile guidance questions involved in such launchings.[69] As one Air Force witness testified that same year:

> There is no real problem getting the missile out of the airplane.

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68 Computed on the basis of 30 minute ICBM flight times and C-5A airspeeds (450 knots cruising speed) allowing three minutes at takeoff for reaching minimum altitude and cruising speed.

69 In the early 1970s the Air Force conducted a series of air drops from C-5A aircraft to demonstrate the feasibility of the air-mobile concept. After making three "Bathtub" drops (using concrete slabs of increasing size and weight), three "mass simulation" drops, and dropping two Minuteman I missiles without igniting them (one inert, the other fully fueled), the Air Force culminated its testing program by dropping a Minuteman I and allowing it to "short burn." The missile was pulled out of the aircraft by drogue chutes and ignited at 8,000 feet. During its 10-second burn it successfully climbed to about 25,000 feet. Senate, Committee on Armed Services, Fiscal Year 1977 Authorization for Military Procurement, Research and Development, and Active Duty, Selected Reserve and Civilian Personnel Strengths: Hearings on S.2965, Part 11: Research and Development, 94th Congress, 2nd session, pp. 6308-6309; and Senate, Committee on Armed Services, Fiscal Year 1976 and July-September 1976 Transition Period Authorization for Military Procurement, Research and Development, and Active Duty, Selected Reserve, and Civilian Personnel Strengths: Hearings on S. 920, Part 1: Authorization, 94th Congress, 1st session, 1975, p. 60. It should be noted, however, that one successful air-launch does not guarantee the reliability of a concept requiring dozens of air-launches of missiles two-and-a-half times heavier in a nuclear environment.

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> One of the problems is telling the missile where it is at the time you fire it off. It is not as if you can survey. It is a lot more difficult than when you have a surveyed in-sight on the ground. The missile has to know where it is to start with so it knows where to go.[70]

The Defense Department proposal for Big Bird envisons the use of some 1,200 GBS transmitters and possibly Global Positioning System satellites for providing guidance data updates for the MX missiles. However, while such systems may be able to furnish position and velocity tracking information to the missiles, they may not be able to compensate for errors introduced by the difficulty of correctly calculating launch azimuths.[71] And small errors introduced at the beginning of the missiles' trajectory become large enough on re-entry to move the warheads' impact points considerably -- thereby effectively reducing hard-target-kill weapons to area-target ones.

Aside from the foregoing points, as has been pointed out in connection with the two earlier parts of this paper, external navigation aids are subject both to jamming and to the blackout effects of nuclear EMP. As in the water-launched basing options of Hydra and SUM, reliance by Big Bird on such mid-course data links might render the entire MX system vulnerable.

CONCLUSION

It can be argued with some justification that none of the three alternate basing schemes discussed in this study can successfully compete with land-basing in all three areas of survivability, reliability and missile accuracy. The United States can only be served by acquiring a new intercontinental ballistic missile that is at the same time survivable and yet accurate enough to provide the National Command Authority with the military option of destroying the enemy's superhardened missile silos and his command bunkers in time of war. A basing system that does not meet both criteria fails to offer sufficient strengthening to a strategic Triad that is in a dangerously weakened position.

Just as the two sea-based MX options lost support when examined closely, the air-mobile deployment scheme that captured

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70 Testimony of General Evans; House, Committee on Appropriations, Subcommittee on Department of Defense, Department of Defense Appropriations for 1974: Hearings, Part 7: Research, Development, Test, and Evaluation, 93rd Congress, 1st session, 1973, p. 1029.

71 See William H. Gregory's editorial, "Magic Elixir for MX," Aviation Week & Space Technology, 115 (July 27, 1981), p. 11.

Secretary Weinberger's favor now appears to be faltering, due largely to the disfavor of important members of Congress and the qualms of senior Air Force officers.[72] It is expected that the Administration will eventually swing back to support for a land-basing plan for MX, for despite its political costs, it provides the necessary attributes for a survivable ICBM system.

While it is difficult to predict the exact dimensions of a land-based deployment plan that has changed so many times over the past four years, the MPS system settled on will probably be scaled down from the originally-proposed 200 missiles and 4,600 shelters of the Carter plan. It is possible that only 100 MX missiles will be deployed initially, and these might even be emplaced in single shelters (horizontal bunkers or existing silos), a step which would almost certainly necessitate the deployment of at least a limited terminal ballistic missile defense system to increase survivability of the new ICBMs -- LoADS or a system derived from it. It is possible that other ICBM survivability fixes might also be employed in conjunction with MX, perhaps the Boeing idea of emplacing small ICBMs in superhardened silos or the Lawrence Livermore Laboratory-backed plan for deploying ICBMs in silos dug several thousand feet into the Earth's surface.

Whatever land-basing choice is decided upon, however, it is imperative that the Reagan Administration move ahead with this strategic program, which has been delayed for far too long. As each month passes without a firm decision on this system, the United States moves farther into that time of strategic vulnerability from which it desperately needs to extract itself.

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72 See, for example, Richard Halloran, "Congress Held Likely to Reject Airborne Missiles," The New York Times, August 2, 1981, p. A24; Martha Barnette, "Tower Says Air-Based MX Could Crash on the Hill," The Washington Post, August 2, 1981, p. A7; Bernard Gwertzman, "Haig to Press Reagan to Abandon Weinberger's Airborne MX Plan," The New York Times, August 15, 1981, p. A1; and Wilson, "House Leaders," p. A1.