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HISTORY
OF THE
MAULER WEAPON SYSTEM

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PREFACE

This monograph traces the history of the MAULER development program and the elusive search for an effective air defense weapon to protect forward combat forces of the field army against low-level air attack. During the post-World War II period, the Ordnance Corps sought to meet the low-altitude threat through the modernization of existing artillery guns. This trend continued until the mid-1950's, when it became apparent that conventional artillery weapons could not be sufficiently improved to cope with the advancing air threat. During that period, a number of possible solutions to the problem were investigated, but few of them reached the hardware stage and only one—the improved 40-mm. self-propelled gun (DUSTER)—was ever released to the Army supply system. Convinced that the achievement of a fully effective forward area air defense system would require a significant engineering breakthrough in fire control technology, the Chief of Ordnance set out to fulfill the requirement for an optimum weapon system through a series of evolutionary developments.

The Light Antiaircraft Development Program, begun in 1952, consisted of three progressive phases, beginning with the improved RADUSTER system for interim use, followed by the advanced 37-mm. VIGILANTE system, and finally, the futuristic MAULER guided missile concept which emerged as the proposed ultimate solution in 1957-58. One by one these weapons fell by the wayside: the RADUSTER, in 1958; the VIGILANTE, in 1963; and the MAULER, in 1965. Today, they stand on the shelf in mute testimony to the exceedingly complex problems posed by the stringent tactical and logistical requirements of forward area air defense. Although the technical feasibility of the single-vehicle MAULER concept was successfully demonstrated, the time and money required to solve certain problems and complete development of the tactical system caused it to lose out in competition with other air defense weapons that presumably would provide an earlier operational capability at less cost.

Aside from the chapter dealing with program management and organization, the MAULER story is related in basically chronological sequence. It begins with the origin of the project and progresses through the feasibility studies, the various development phases, the feasibility validation program and allied studies, and the final MAULER evaluation and termination. The last chapter presents a retrospective view of the problems and circumstances that led to the termination of the program, a brief account of follow-on developments as the alternative to MAULER, and a thumbnail sketch of present-day air warfare in Vietnam.

Unless otherwise noted, the footnotes are unclassified. File locations are indicated for all source documents except those contained in the Historical Division files.

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CHAPTER I

(~~S~~) ORIGIN OF THE MAULER PROJECT (U)

The Advent of Air Warfare

(U) Throughout the countless centuries of warfare the development of weapons has been characterized by an eternal duel between the offensive and the defensive, the latter historically following the former. With the introduction of each new offensive weapon affecting the strategy of warfare, there invariably follows a parallel defensive weapon to meet the potential threat to a nation's security. An historical yet contemporary example of such changes in military tactics and equipment took shape in 1914, when the airplane emerged as a powerful weapon against the Allied powers in France. On 30 August 1914, only 27 days after the war began, a single German plane bombed Paris. German air raids on London followed as early as October, and there were frequent attacks on Allied troops and supply lines in France.

(U) Although the first military use of the airplane had occurred during the Tripolitan War in 1911, the development of antiaircraft artillery did not begin until after the first bombing attacks of World War I. The United States developed and produced some artillery pieces and small arms, but the equipment used by the American Expeditionary Forces was acquired in large part from France and Great Britain. In October 1917, some 6 months after the United States entered the war, the first U. S. Army antiaircraft units began training at Langres, France, and the first tactical batteries moved to the front in the spring of 1918. The American units, in action less than a year, destroyed a total of 58 enemy warplanes.[1]

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[1](1) ARADCOM Argus, Vol. 1, No. 9 (1 Oct 58), p. 3. (2) ROTCM 145-20, DA, July 1959, pp. 336, 340-41.

World War II Developments

(U) Although some antiaircraft rockets were developed during World War II, the U. S. Army continued to rely almost entirely on conventional artillery guns as its first line of defense against aerial attack. These antiaircraft weapons ranged from the .50-caliber machine gun and 37- and 40-mm. guns for protection against low-flying, strafing-type planes, to 120-mm. guns for the defense of large areas against bombers. For defense against aircraft at considerable altitudes, the Army's mainstay was the towed 90-mm. gun with a maximum vertical range of 12,000 to 13,000 yards.

(U) A new threat, the German 650-mile-per-hour (mph) jet-propelled airplane, appeared before the end of the war, bringing to obsolescence the antiaircraft artillery fire control systems that had been designed to cope with 450-mph propeller-driven aircraft. This development, together with the advent of the guided missile and the atomic bomb in the closing days of the war, marked the beginning of a new era in the Army's air defense mission.[2]

(U) The Army had begun exploratory studies of a surface-to-air guided missile system as early as February 1944. A year later, following the introduction into combat of the German jet-propelled airplane, the Ordnance Corps joined with industry to produce an antiaircraft guided missile that would be capable of countering the new aerial threat. This project—originally known as NIKE I and later renamed NIKE AJAX[3]—was directed toward the development of a guided missile system for defense against manned, 600-mph, maneuverable bombers flying at altitudes of 20,000 to 60,000 feet.[4]

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[2] TIR CD-1, OCO, Jun 1960, subj: Dev of AD Wpns, pp. 3-4. RSIC.

[3] DA Cir No. 700-22, 15 Nov 56.

[4] See Mary T. Cagle, Development, Production, and Deployment of the NIKE AJAX Guided Missile System, 1945-1959 (ARGMA, 30 Jun 59), pp. 1-4.

The Stilwell Board Report

(U) Soon after the war, it became apparent that antiaircraft targets of the near future would include greatly improved missiles of the V1 and V2 types and partially armored airplanes flying at various speeds up to and including the supersonic and at heights from near the ground to extremely high altitudes. With these conditions in mind, and with the nuclear-tipped intercontinental ballistic missiles an added threat, the War Department Equipment Board, in May 1946, recommended the development of improved air defense equipment that would be capable of detecting, destroying, or nullifying the effectiveness of all forms of aerial vehicles.

(U) Realizing that a flexible, long-range research program would be necessary to generate new knowledge and successfully achieve the actual design of new equipment, the Board recommended that two parallel courses be pursued: the vigorous research and development of new or anticipated types of equipment, and continued improvement of existing equipment as an interim measure. The proposed solutions to the antiaircraft problem embraced the development of conventional artillery weapons having the greatest obtainable effectiveness, improved fire direction and fire control equipment, and guided missiles capable of intercepting and destroying aircraft and missiles of the V1 and V2 types.[5]

Initial Approach to the Low-Altitude Air Threat

(U) During the immediate postwar period, the Ordnance Corps thus placed primary emphasis on the modernization of existing artillery guns to meet the threat of low-altitude aircraft, while continuing development of the NIKE AJAX guided missile for defense

[5]"Report of the War Department Equipment Board (Stilwell Board)," WD CofS, 29 May 46, pp. 4, 8, 12, 25, 49. RSIC.

of large areas against high-altitude aircraft. This trend continued until the mid-1950's, when it became evident that the performance of the short-range, ground-based, manually operated artillery guns could not be sufficiently improved to cope with the advancing threat of low-altitude aircraft. During that period, the Ordnance Corps investigated a number of possible solutions to the problem, but few of them reached the hardware stage and only one—the improved 40-mm. gun—was ever released to the Army supply system.

The STINGER Project

(U) Initially, the Ordnance Corps focused its attention on the development of an effective low-altitude air defense weapon to replace the .50-caliber machine gun. Studies made soon after the war indicated the need for an improved weapon that would more adequately protect vital army installations, facilities, and troops against attack by low-flying, strafing-type planes. Accordingly, the Ordnance Corps, in June 1948, began work on the STINGER weapon, which consisted essentially of four .60-caliber machine guns and an integrated, on-carriage, radar-directed fire control system. Work on this weapon continued until 1951, when the developer determined that the .60-caliber guns would not meet the new requirement for an effective slant range of up to 14,000 feet. A 37-mm. revolver-type gun was later built and tested for possible use with a modified STINGER system, but it proved to be too complex and unreliable, and the project was finally terminated.[6]

The Improved 40-mm. DUSTER System

(U) When the Korean War erupted in June 1950, the only low-altitude weapons available to the field forces were the .50-caliber

[6] TIR CD-1, OCO, Jun 1960, subj: Dev of AD Wpns, p. 6. RSIC.

machine gun and the standard M19A1 twin 40-mm. gun. Combat experience early in the war indicated the need for a light antiaircraft weapon that would be more effective against low-flying planes than the standard 40-mm. gun. The Ordnance Corps acted to meet the requirement with an improved model known as the DUSTER. Military characteristics for the new T141 (later the M42) twin 40-mm. self-propelled gun were approved in November 1950, but authorization for development of the weapon was not forthcoming until July 1951.

(U) Mounted on a modified M41 light tank, the DUSTER was armed with twin M2A1 automatic 40-mm. guns for primary use against low-flying aircraft, and an M1919A4 .30-caliber Browning machine gun for ground fire support. Its ammunition for the antiaircraft role consisted of high-explosive-tracer, self-destroying cartridges with a muzzle velocity of 2,870 feet per second. The 1.985-pound projectile had a vertical range of 5,100 yards and a horizontal range of 5,200 yards. It was originally intended that the DUSTER have radar fire control equipment carried in a separate self-propelled vehicle; however, this part of the project was cancelled in 1952 because of excessive cost. The M42 DUSTER was finally standardized in October 1953, some 3 months after the Korean War ended.[7] The same was true of various other items of improved ground equipment which either arrived too late or in insufficient quantities to be of any benefit to the ground forces.

Air Warfare in Korea

(U) Some well-known political aspects of the Korean War are still being debated today. But military historians generally agree that it was the overwhelming American air power, in concert with naval fire, that averted sure disaster for the Allied ground forces in the early phase of the conflict. Air Force, Navy, and

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[7] *Ibid.*, pp. 4, 24-25.

Marine Corps planes battled Russian-built MIG jets over the Korean peninsula, disrupted the enemy's supply lines, destroyed major strategic targets north of the 38th Parallel, and provided close tactical support to the Army ground forces. Allied control of the air over the battlefields was particularly crucial during the first few months of the war, when the ground forces fought a valiant holding action to gain time for a buildup of arms and equipment. LTG Walton H. Walker, who directed that action as commander of the U. S. Eighth Army, later said: "I will gladly lay my cards on the table and state that if it had not been for the air support that we received . . . we would not have been able to stay in Korea."[8] North Korean General Nam Il echoed that assessment when he declared at the truce negotiations: "Without the support . . . of your air and naval forces, your ground forces would have long ago been driven out of the Korean peninsula."[9]

(U) With American warplanes controlling the air over the battlefields, the air threat to Allied ground forces was virtually eliminated. Since enemy planes seldom penetrated the Allied front lines, the American ground-to-air defense had little or no chance to test its skill. It was abundantly evident, however, that Russia had pulled far ahead of the United States in the development of air defense weapons. In contrast to the antiquated World War II antiaircraft guns still in use by American forces, the North Koreans had at their disposal an impressive arsenal of modern Soviet weapons which proved amazingly effective, even against high-speed jet aircraft and during night operations.[10] Samuel Taylor Moore,

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[8] Harry J. Middleton, The Compact History of the Korean War (New York: Hawthorn Books, Inc., 1965), p. 96.

[9] Alvin M. Josephy, Jr., Ed., The American Heritage History of Flight (New York: American Heritage Publishing Co., 1962), p. 381.

[10] Samuel Taylor Moore, U. S. Air Power (New York: Greenberg Publisher, 1958), p. 156

an eminent authority on air warfare and an observer in Korea, later wrote:

> Although large-caliber Soviet anti-aircraft guns, some of them aimed by radar, protected the most sensitive North Korean targets, the most effective ground-to-air defense proved to be light automatic weapons and well-organized small arms fire. American aircraft brought down by the latter fire exceeded the total lost to Migs. American jets were both destroyed and seriously damaged in low level attacks by automatic weapons and small arms fire.[11]

Revision of the Army Development Guide

(U) An assessment of the air defense problem in 1954 pointed to the need for a family of all-weather, direct and general support guided missiles capable of providing effective defense against all types of aerial vehicles which then existed or which might appear in the immediate future. An analysis of available intelligence data indicated that future air attacks would be characterized by improved aircraft performance with respect to speed (Mach 2 to 10), altitude (0 to over 80,000 feet), and maneuverability; improved navigational aids and low-altitude bombing techniques; increased destructive potential of a single aircraft carrying an atomic bomb; air tactics planned to saturate antiaircraft defense facilities; and the use of guided missiles and electronic countermeasures. To counter this newly defined threat, the Army's antiaircraft forces would need a family of optimum performance weapons and fire control equipment capable of integration into highly automatic antiaircraft defense systems.

(U) The updated Army Equipment Development Guide, published in May 1954 and amended in November of that year, recommended that top development priority be given to providing a highly mobile, short

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[11] Ibid., p. 162. (American airplanes lost to enemy fighters and ground-to-air weapons totaled 1,342—801 Air Force; 541 Navy and Marine Corps.)

range guided missile system which would be especially effective against low-altitude (0 to 10,000 feet) aerodynamic missiles or aircraft. Specific requirements in this priority category included an all-arms, ground- or vehicle-mounted weapon for defense against low-flying targets from 0 to 1,000 feet, and a light, highly mobile weapon capable of engaging 1,000-mph targets in the altitude zone up to 10,000 feet. Second priority would be given to the development of weapons to counter the ballistic missile threat, and third priority to weapons for the defeat of medium- and high-altitude aerodynamic missiles or aircraft. The revised guide did not rule out the continued development of new predicted-fire artillery guns, but specified that such effort should proceed only if it would result in a significant increase in the effectiveness of the antiaircraft weapons family.[12]

The Light Antiaircraft Development Program

(U) The Office, Chief of Ordnance (OCO) had already recognized that the achievement of a fully effective forward area air defense system would require a significant engineering breakthrough in fire control technology. With the cancellation in 1952 of the radar fire control system for the M42 DUSTER,[13] it had established a parallel program oriented toward the attainment of an optimum light antiaircraft weapon system through a series of evolutionary developments. As originally conceived, the program consisted of three progressive phases, beginning with the improvement of an existing artillery gun and proceeding with the development of more sophisticated systems as technological advancements permitted.

(U) In the first phase, a range-only radar was to be added to

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[12]AEDG, 3 May 54, & Ch 1, 3 Nov 54, pp. 45-46, 48-49, 55. RSIC.
[13]See above, p. 5.

the standard M42, 40-mm. self-propelled gun (DUSTER), resulting in the improved RADUSTER system which would be issued for interim use. The Phase II effort was to result in the advanced VIGILANTE weapon, a rapid-fire, Gatling-type, 37-mm. gun with range-only radar and an optical tracking system. Phase III of the program was to culminate in an optimum light antiaircraft weapon system that would be capable of providing the field army full low-level protection against all types of aircraft.[14] (It was in this latter phase of the program that the futuristic MAULER concept emerged in 1957-58.)

Revision of the Phase I (RADUSTER) Plan

(U) From the outset, the Army's light antiaircraft program was beset with severe technical problems that blocked the attainment of the originally stated goals. A review of the progress made during the 1952-55 period led to the conclusion that no modification, however major, could possibly make the M42 DUSTER a completely acceptable system. The plan to produce the RADUSTER system for interim use was therefore changed in June 1956 to provide for development of the improved T50 antiaircraft fire control system to a production standby status; collection and evaluation of technical and operational data on performance of range-only radar and computer fire control systems with light antiaircraft weapons; and continued research in the technical field of fire control equipment for self-propelled weapons.

(U) The primary objectives of the reoriented Phase I effort were to insure the availability of improved fire control equipment for use with the DUSTER in the event of an unforeseen emergency; to provide a basis for more effectively guiding development of the Phase II weapon system; and to retain human and technological

[14] TIR CD-1, OCO, Jun 1960, subj: Dev of AD Wpns, pp. 4, 6, 44-47. RSIC.

resources at a sufficiently high level to permit continued progress in the fire control field. The procurement of T50 hardware for use in the program was limited to one research and development (R&D) prototype for engineering test and three pilot models for user tests.[15]

The Phase II VIGILANTE System

(U) The cancellation of plans for production of the RADUSTER system and the growing obsolescence of the M42 DUSTER dictated that a completely new system be developed and produced at the earliest practicable date. Accordingly, the Continental Army Command (CONARC), in late 1955, prepared a set of proposed military Characteristics (MC's) for the advanced Phase II weapon, based on the technical information and material collected during the earlier STINGER program, the Phase I research studies, and feasibility studies conducted by the General Electric and Sperry Gyroscope Companies under contract with the Ordnance Corps. The 37-mm. Gatling-type gun described in the proposed MC's appeared to be the most effective predicted-fire weapon that could be developed by the early 1960's. The Office, Chief of Research and Development (OCRD) approved the MC's and sent them to OCO for implementation in March 1956. The Phase II weapon system, to be known as the VIGILANTE, was approved for development in October of that year, on the basis of a feasibility study made by the Springfield Armory.

(U) Designed for the defeat of jet-fighter aircraft flying at altitudes up to 10,000 feet and slant ranges of 14,000 yards, the VIGILANTE consisted of a 6-barrel, 37-mm. gun with an on-carriage range-only radar and optical tracking system. The CONARC stated a

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[15] Rept, OCRD, DA, 20 Jun 56, subj: DA Lt AA Wpn Dev Program, atchd as Incl 1(A) to DOD Rept RD-302/4, Jul 1956, subj: Rept of the Ad Hoc Gp on Low Alt AA Sys. RSIC.

preference for the full-tracked, self-propelled carriage, but indicated that a wheeled or towed carriage would be acceptable if necessary to meet weight requirements for Phase I (parachute and assault landing) airborne operations. Both versions of the system were built and evaluated: the T248 towed model (VIGILANTE A) and the T249 self-propelled model (VIGILANTE B).[16]

Redirection of the Phase III Studies

(U) As noted earlier, the third phase of the development program was to culminate in an optimum weapon system that would be capable of providing the forward combat forces of the field army with full low-level protection against all types of aircraft. In consonance with requirements set forth in the updated Army Equipment Development Guide of 1954, the initial Phase III plan called for studies leading to the development of a small, self-propelled guided missile system capable of engaging both manned aircraft and aerodynamic missiles at altitudes up to 10,000 feet. These studies continued until May 1956 when it became apparent that the state of the art had not progressed to the point where the development of a forward area antiaircraft guided missile could be successfully undertaken. At that time, a number of preliminary proposals and suggestions had been considered, but none of them fully met the tactical and logistical requirements peculiar to operations in the forward combat zone. The technical problems posed by such a weapon stemmed in large measure from requirements for extremely small size and weight, ease of supply and maintenance, and great mobility, ruggedness, and reliability.

[16](1) TIR CD-1, OCO, Jun 1960, subj: Dev of AD Wpns, pp. 44-47. (2) Rept, OCRD, DA, 20 Jun 56, subj: DA Lt AA Wpn Dev Program, and Memo for Secy, Joint Coord Com on Ord, OASD(AE), fr OCRD, DA, 15 Nov 55, subj: Lt AA Wpn, atchd as Incls 1(A) & 1(B), rspv, to DOD Rept RD-302/4, op. cit. Both in RSIC.

(U) Following a presentation on the status of the program in late May 1956, the Chief of Research and Development expanded the scope of the Phase III studies to give the Army technical services more latitude in the search for a feasible solution to the problem. Inasmuch as the Phase II (VIGILANTE) program appeared certain of producing an effective replacement for the obsolete M42 DUSTER at a comparatively early date, he concluded that the Army should set its sights quite high in the Phase III program. To avoid the costly mistakes so easily made under the duress of crash development to meet immediate, critical requirements, the Army, as an all-inclusive objective, was determined to pursue the revised program with thoroughness and attention to detail. Specific objectives were to determine the best weapon system that could be developed to meet requirements of the forward area on a liberal time scale and without restrictive stipulations that the system must be a guided missile, a predicted-fire gun, or any other type weapon; and ultimately to evolve an optimum weapon system and associated logistical and operational doctrine to provide adequate air defense for forward combat areas in the post-1965 period. This weapon would be a timely and effective replacement for the VIGILANTE system, which was expected to be available in the early 1960's.[17]

Report of the Ad Hoc Group on Low Altitude Air Defense

(U) The need for realignment of the Army's light antiaircraft development program had been recognized in July 1955, following a top-level review of the planned FY 1956 R&D obligations. As a result of that review, the Chairman of the Joint Coordinating Committee on Ordnance advised the Assistant Secretary of Defense (R&D) that the program as then constituted was not likely to produce

[17] (1) Ibid. (2) Presn to OCRD on AAGM Sys for Fwd Cbt Areas, 24 May 56, cited in OTCM 37041, 2 Apr 59. RSIC.

very efficient weapons to meet the tactical needs of the field army. Since the lack of progress appeared to stem primarily from a deficiency in the state of the art, and not necessarily from inadequate funding, he suggested that a study be made to explore new approaches to the problem and to provide a firm foundation for future direction of the program. Several months later, in October 1955, the Assistant Secretary of Defense (R&D) commissioned a joint Ad Hoc Group[18] to review, study, and analyze the overall problem of tactical low-altitude air defense as employed by combat forces in the forward area. The objective of the study was to provide technical guidance for the attainment of optimum weapon systems at the earliest practicable date.[19]

(U) The Ad Hoc study report, published in July 1956, contained a comprehensive analysis of the air threat to the forward area and the nature of the technical problems involved in coping with that threat, together with a candid appraisal of the Army's light antiaircraft development program, as revised in June 1956. In general, the findings of the study confirmed that the development of a fully effective forward area air defense system posed an extremely difficult problem that could only be solved by a bold, new R&D approach. In view of the limited improvements expected in conventional predicted-fire artillery guns, guided missiles appeared to be the most effective means of accomplishing the objective. The report concluded, however, that guided missiles for the forward area air defense role "are not now available, and no proposals that have come to the group's attention justify the belief that such a system could be in the hands of the Field Forces before 1965."[20]

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[18]Headed by Dr. Bruce H. Sage of the California Institute of Technology, and consisting of consultants to the Technical Advisory Panels on Ordnance, Electronics, and Aeronautics.

[19]DOD Rept RD 302/4, Jul 1956, subj: Rept of the Ad Hoc Gp on Low Alt AA Sys, pp. iii, v, vi. RSIC.

[20]_Ibid._, p. 36.

(U) At that time, significant progress had been made in the development of highly sophisticated guided missile systems for the defense of large areas against attack by medium- and high-altitude aircraft,[21] but major advancements in guidance technology would be required before undertaking the design of such a weapon for the forward combat zone. With the deployment of effective medium- and high-altitude air defense weapons, such as the HAWK and NIKE AJAX, an increasing proportion of attack aircraft could be expected to enter the battle area at low altitudes. These weapons, located to the rear of the forward areas, would defend the latter from medium- and high-altitude attack by their extended range, but vital installations, facilities, and troops in the immediate combat zone would be vulnerable to low-altitude bombing and strafing attack until an effective light antiaircraft weapon could be developed. In this connection, the study report noted that several guided missile systems—the HAWK, in particular—were originally conceived for the forward area, but had subsequently acquired characteristics that made them suitable for the division and corps areas only.[22]

(U) The problem here stemmed primarily from the severe limitations imposed on equipment and personnel in the forward combat area.[23] Unlike the higher altitude air defense systems, which must be located out of the immediate combat zone because of their

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[21]The NIKE AJAX was already deployed at strategic sites in the United States and Europe; the improved NIKE HERCULES system was in the early stages of production; and the HAWK missile system was being developed for use against aircraft flying at all altitudes up to 30,000 feet.

[22]DOD Rept RD 302/4, op. cit., pp. 1, 12, 36.

[23]The study report defined the "forward area" as that portion of the battlefield involving regimental or battalion combat teams. These would be located in relatively isolated areas, subject primarily to local command and depending in a large measure for their defense against aircraft on mobility and other passive measures. From their location, early warning of the approach of enemy aircraft beyond the line of sight would be unusual. Ibid., p. 3.

vulnerability to enemy detection and counteraction, the antiaircraft weapon for the forward area must have the mobility, ruggedness, and reliability to make it a flexible, integral part of the rapidly moving combat team, rather than a necessary but unwieldy appendage. It must possess simplicity of operation and be capable of rapidly solving the problems of target detection, identification, tracking, and prediction with a lapse of no more than a few seconds between warning and fire. In contrast to the elaborate electronics gear and communications network at the more stationary rear-area air defense installations, the fire control equipment for the forward area weapon must be small enough for mounting on a tracked vehicle and simple enough for operation by a very limited crew without requiring frequent attention from third or higher echelon maintenance. Moreover, the great premium upon logistics in the forward area dictated that consideration be given to the development of a defensive weapon having more than a single use; i.e., a dual capability for both ground-to-air and ground-to-ground action, such as that incorporated in the standard M42 DUSTER.[24]

(U) In the light of the logistic, tactical, and economic constraints of the forward area, the selection of an optimum weapon meeting all the requisite MC's presented a particularly difficult problem. In an analysis of the relative merits of guided missiles and predicted-fire weapons, the Ad Hoc Group defined the magnitude and nature of the problem as follows (emphasis added).

> At the present state of knowledge, the guided missile system at a single weapon installation will be significantly more complicated and will require much more maintenance than will a single predicted-fire weapon. The selection of guided missiles as the antiaircraft weapon for the forward area must await their improvement in reliability, mobility and state of readiness, as well as the acceptance of somewhat more complicated devices than are currently believed feasible to use in this area.

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[24](1) _Ibid._, pp. 5-6. (2) _Also see_ above, p. 5.

Projected improvements in predicted-fire weapons will not result in marked changes in the probability of kill per round unless a new approach to fire control is found. For the period of primary interest, between 1960 and 1970, it will probably be necessary to rely on predicted-fire weapons and to accept lower probabilities of kill than are presently desired. However, if gun training and fire-control equipment can be improved markedly in accuracy, it may be possible to obtain reasonable probabilities of kill per round. Such an advancement would reduce the logistic requirements as a result of decreasing the need for firing a large number of rounds per engagement.

The total equipment and ammunition required to obtain the same probability of kill is probably much greater for the predicted-fire weapon than for a guided missile. However, the amount of equipment that must function properly in order for a single guided missile to be effective is much greater than for a single predicted-fire mount. The complexity and cumbersomeness of component design make it inadvisable to initiate development of guided missiles for the forward area at the present time. However, if high probabilities of kill are essential, guided missiles appear to be the most effective means of accomplishing the objective.[25]

(U) Based on the foregoing observations and a survey of the state of the art, the Group concluded that a full solution to the forward area air defense problem could not be expected for at least another decade, and that some aspects of the problem—particularly in the electronics field—might require a much longer period. A study of the identification problem, for example, revealed that the development of simple IFF (Identification, Friend or Foe) equipment meeting requirements of the forward area approached the impossible. Since an answer to the problem was not in sight, the Group concluded that a less than perfect method, such as visual identification, should be considered for tactical use pending further study. Other problems revolved around the design of equipment, such as computers and radars, that would meet all the requisite MC's. Some items were satisfactory from a logistical viewpoint but fell far short of meeting other requirements.[26]

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[25] DOD Rept RD 302/4, op. cit., p. 6.

[26] Ibid., pp. ix, 4, 25, 27, 35.

(U) The Ad Hoc Group found the Army's light antiaircraft development program to be basically sound and worthy of continued support, but recommended certain changes in direction of the Phase II and III effort. Though somewhat skeptical of the value which an on-the-shelf improvement for the DUSTER could have if an emergency were to arise, it concluded that the justification of the Phase I (RADUSTER) as a technical forerunner for Phase II was sufficient to make it desirable.

(U) Since guided missile systems for the forward area could not be expected for many years, the Group approved the Army's plan to select a predicted-fire weapon for Phase II, with the provision that a portion of the effort be devoted to a continuing analysis of the system characteristics to assure compatibility with military requirements. It also endorsed the policies and objectives set forth in the revised Phase III plan, but emphasized that the final choice between a predicted-fire weapon and a guided missile should be delayed until the characteristics of both systems, or some compromise between them, were established. To that end, it recommended that the Phase III effort be divided in two independent parts: one directed toward obtaining the best predicted-fire weapon to replace the Phase II VIGILANTE system, and the other toward the attainment of an optimum antiaircraft guided missile system.[27] With specific reference to the latter, the Ad Hoc Group warned:

> In their present state of development, guided missiles do not appear to be well-suited to general-purpose use in a forward area. Some caution should be exercised to avoid the adoption of a guided-missile system that may not satisfy field requirements.
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> . . . The technology associated with the guidance of missiles has not reached the point where the development of a forward-area antiaircraft guided missile can be successfully undertaken. The requirements for a missile of this type are such that, if it is to be successful, further component development is necessary in the fields

[27] Ibid., pp. ix, 9-10, 35-36.

electronics, infrared and even optical methods. It will only be as a result of such developmental efforts that a guided missile with the requisite ruggedness, ease of maintenance and handling required for the forward area will be available.[28]

Requirement Established for the MAULER Missile System

([redacted]) The events leading to revision of the dual Phase III effort and the creation of a formal requirement for the MAULER missile system began earlier in 1956, when the Redstone Arsenal R&D laboratories undertook a study to determine the feasibility of using a passive homing infrared seeker to solve the low-flying aircraft problem. Prompted by a recent technological breakthrough in the field of highly sensitive, long-wavelength infrared detectors, this exploratory study included literature surveys and experiments in atmospheric transmission, background clutter, detector design characteristics, optical materials, and aircraft radiation intensities. Based on this work, the Arsenal recommended that consideration be given to the development of a lightweight missile with radar guidance and acquisition for use in the forward area air defense role, and that further studies be made in the obvious growth areas such as the design of a hybrid seeker.[29]

([redacted]) Although several interface problems in the infrared seeker design were yet to be resolved, the Commanding General of CONARC felt that such a missile could be developed and that it offered a greater possibility of success against high-speed maneuvering aircraft than any gun-type weapon. He therefore suggested, in March 1957, that the dual Phase III effort advocated by the Ad Hoc Group be revised to delete any

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[28] Ibid., pp. 11-12.

[29] AOMC Rept, 9 Aug 61, subj: The Role of ARGMA In-House Labs in Army Programs (DOD Study Proj No. 97), pp. II-15, II-16.

requirement for a predicted-fire system.[30]

([redacted]) A review of the light antiaircraft development program in mid-1957 confirmed that conventional gun-type weapons could not be sufficiently improved to cope with the total air threat envisioned in the 1965-70 period. The results of Phase II studies revealed that the 37-mm. VIGILANTE weapon would provide a major improvement over the standard M42 DUSTER and the proposed (Phase I) RADUSTER systems, in that it would increase the volume of fire in a given air space and it would have a surveillance capability. This weapon, however, would fall short of other critical requirements of the forward area. It would not provide an all-weather capability; it would have a low hit-and-kill probability against the type targets expected; and the pressures generated by its high rate of fire would require an excessively heavy carriage and create severe logistic problems in maintenance and in ammunition resupply and handling.

([redacted]) Firmly convinced that these and other limitations in gun-type weapons could never be completely eliminated, the Commanding General of CONARC concluded that a guided missile system offered the best opportunity of providing forward combat elements with a high level of air defense at a minimum cost in ammunition expenditures. Referring to the recent advancements in guidance technology, he expressed the belief that the "current state-of-the-art will support the development of an interim guided missile system at least as effective, if not more so,

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[30] Ltr, CG, CONARC, to CRD, DA, 7 Dec 56, subj: Rept of DOD Ad Hoc Gp on Low Alt AA Sys; and Ltr, same to same, 28 Mar 57, subj: Recmn for Chs to the Army Fwd Area Lt AA Dev Program. Both cited in Ltr, ATSWD-S 471.94/269(S), CG, CONARC, to CRD, DA, 23 Jul 57, subj: Revised Mat Rqrmt for an Antiair GM Sys, Low-Alt, Fwd-Area, SP, "MAULER." MAULER Project Case Files (MPCF), Bx 13-649, Records Holding Area (RHA).

than any existing or developmental predicted fire weapon."[31] Accordingly, the Army General Staff, on 10 July 1957, issued a revision to the Combat Development Objectives Guide (formerly Army Equipment Development Guide), which called for the initiation of research leading to the development of a "practical and economical short range missile system with sufficient reliability, accuracy, simplicity, ruggedness, and mobility to operate in forward areas under the most adverse combat conditions . . . ."[32]

([redacted]) Two weeks later, the Commanding General of CONARC established a formal materiel requirement for an advanced, all-weather forward area guided missile system to be known as the MAULER. Emphasizing the urgent need for this Phase III weapon system, he requested that its development be accelerated to provide for a concurrent program with the Phase II VIGILANTE, and that it be made available for field use by FY 1963.[33] The revised qualitative materiel requirement for the MAULER stated:

> . . . A materiel requirement exists for a low altitude, all-weather, air defense guided missile system effective against all aerodynamically supported and ballistic rocket (HONEST JOHN/LITTLEJOHN type) targets to slant ranges of at least 5,000 meters (10,000 meters desired), a self-propelled system capable of: detecting, acquiring, identifying, and tracking aerial targets; computing and transmitting positioning data to launchers; being delivered in Phase I of airborne operations and employment in a secondary role of ground fire support. This weapon will replace the RADUSTER (M-42 Improved) or the VIGILANTE (37-mm Gatling Gun under development) whichever is classified as standard at the

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[31] "Background Information for Materiel Requirements," atchd as Incl 2 to Ltr, ATSWD-S 471.94/269([redacted]), CG, CONARC, to CRD, DA, 23 Jul 57, subj: Revised Mat Rqrmt for an Antiair GM Sys, Low-Alt, Fwd-Area, SP, "MAULER." MPCF, Bx 13-649, RHA.

[32] CDOG, 10 Jul 57, subpara 712j, quoted in OTCM 37041, 2 Apr 59. RSIC.

[33] Ltr, ATSWD-S 471.94/269([redacted]), CG, CONARC, to CRD, DA, 23 Jul 57, subj: Revised Mat Rqrmt for an Antiair GM Sys, Low-Alt, Fwd-Area, SP, "MAULER." MPCF, Bx 13-649, RHA.

time a guided missile system is produced.[34]

([redacted]) Meanwhile, in 1955, the Convair Division of the General Dynamics Corporation had begun a privately financed study of a very small, all-arms antiaircraft missile, using infrared homing for guidance. The proposed lightweight, manportable weapon—known as the REDEYE and later adopted as a companion to the MAULER—was designed for use against low-flying, support-type aircraft in combat areas not adequately protected by organic air defense elements. Following an evaluation of the proposed REDEYE guided missile system, in early 1957, CONARC recommended that it be developed as a replacement for the outmoded .50-caliber machine gun.[35] The self-propelled MAULER and the shoulder-fired REDEYE missile systems thus represented the proposed solution to the forward area, low-altitude air defense problem, the former to engage 1,000-knot targets at altitudes up to 10,000 feet and the latter 0-to-600 knot targets at altitudes of less than 9,000 feet.[36]

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[34] CDOG, 10 Jul 57, subpara 737b(3), as revised by CONARC ltr (Ibid.), quoted in OTCM 37041, 2 Apr 59. RSIC.

[35] (1) AOMC Rept, 9 Aug 61, subj: Role of ARGMA In-House Labs in Army Programs (DOD Study Proj No. 97), p. II-14. (2) REDEYE Msl Sys Plan, ARGMA MSP-8, 15 Feb 60, pp. A-1, B-1, B-6.

[36] (1) Ibid., p. B-3. (2) OTCM 37041, 2 Apr 59. RSIC.

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CHAPTER II

([redacted] THE FEASIBILITY STUDY PROGRAM (U)

(U) The supposedly high priority MAULER study program got off to a belated, low priority start in the latter half of FY 1958. The Chief of Ordnance had sent OCRD a proposed plan and schedule for the initiation of the study phase as early as March 1957. Yet authority and funds to implement the program were not forthcoming until 18 October 1957, and it was late November before the directive reached the action agency.[1] By that time, the first date specified in the schedule had already been exceeded by several months and it was apparent that all of the dates listed would have to be changed. The Chief of Ordnance emphasized, however, that such changes "must be kept to a minimum in view of the urgent need for the subject weapon system."[2]

Austere Approach to an Ambitious Objective

(U) The critical need for a fully effective low-altitude air defense system had long since been recognized. Moreover, the Office, Secretary of Defense (OSD) and the Army General Staff had been fully apprised of the complex problems involved in the design of such a weapon. Yet the MAULER guidelines handed down from the Pentagon were clearly based upon budgetary considerations rather than military necessity. The problem here did not stem from a lack of appreciation of the military need as such, but rather from

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[1] (1) DF, CRD/C 11048, CRD, DA, to CofOrd, 18 Oct 57, subj: MAULER Program. (2) Ltr, OO/7S-12816, CofOrd to CG, RSA, 22 Nov 57, subj: same. Both in MPCF, Bx 13-649, RHA.

[2] Ibid.

the Administration's parsimonious defense spending philosophy. The result was a severe shortage of Army R&D funds and hence the absolute necessity of getting the most out of every dollar. In the long run, however, this dollar-stretching ("More Bang for a Buck") approach proved to be more wasteful than frugal, mainly because the Army tried to support too many programs with too few dollars.[3]

[redacted] In July 1957, it will be recalled, the Commanding General of CONARC had established a formal materiel requirement for the MAULER weapon system and urged that its development be accelerated to provide for troop delivery by FY 1963. However, the Chief of Research and Development decided that adequate funds would not be available to support a full-fledged program, and asked CONARC to recommend a course of action based on limited funding.[4] The CONARC Commander, in September 1957, submitted a set of guidelines for an austere program as a practical, low-budget solution to an early MAULER capability. While emphasizing the urgent need for a fully effective air defense system, he agreed that a reduced capability would be acceptable as an interim system if the optimum requirements operated to delay the availability of the MAULER weapon. A separate but austere MAULER guided missile program, he said, would not be competitive with the (Phase II) VIGILANTE system, but rather a timely effort to develop a substantially more effective system with growth potential for future application.

[redacted] The austere approach suggested for the MAULER study phase

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[3] MG J. H. Hinrichs, who became the Chief of Ordnance in early 1958, focused attention on the fallacy of such a practice in a memorandum to the Deputy Chief of Staff for Logistics in May 1959. See quotation from the memorandum, p. 153.

[4] 1st Ind, CRD/C 3980, CRD, DA, to CG, CONARC, 5 Jul 57, on Ltr, CG, CONARC, to CRD, DA, 28 Mar 57, subj: Recmn for Chs to the Army Fwd Area Lt AA Dev Program. Cited in Ltr, ATDEV-4 471.94/393, CG, CONARC, to CRD, DA, 27 Sep 57, subj: MAULER Program. MPCF, Bx 13-649, RHA.

leaned heavily on the use of components developed in other programs or other services. In the armament area, for example, the shortage of funds dictated that the Army use a ready-developed air-to-air missile seeker which appeared to have nearly direct application to the MAULER requirement.[5] The vehicle for the weapon was not expected to present a funding problem, since new development would not be necessary. Specifically, the "basic mount should be a self-propelled lightly armored vehicle selected from those of the standard or approaching the standard classification." By far the most difficult problem to be resolved was that of target acquisition. The CONARC Commander pointed out that this problem "has existed without solution through all low-altitude weapons systems to date," and further, that a "target acquisition method must be developed as a part of VIGILANTE, or it cannot be a satisfactory weapon." He indicated that a solution to the target acquisition function in the VIGILANTE would be equally applicable to MAULER. Beyond that, the only guidance proffered was that the solution probably would not be found in on-mount devices, but would more likely be found in the organization of all data sources within a battalion to allow instantaneous sharing of target information.[6]

Technical Requirements

(~~S~~) Pursuant to program guidance received from OCO in late November 1957, and in-house studies completed earlier in the year, the Redstone Arsenal R&D Division developed a set of tentative

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[5](~~S~~) According to the CONARC report, a number of air-to-air missiles had been successfully launched from the ground and shipboard against low-flying aircraft. It cited a series of shipboard firings conducted some 4 years earlier, in which 10 out of 12 SPARROW III missiles successfully intercepted a target drone at 500 feet.

[6]Ltr, ATDEV-4 471.94/393, to CRD, DA, 27 Sep 57, subj: MAULER Program. MPCF, Bx 13-649, RHA.

technical requirements for use in the MAULER design competition and preliminary design studies. Consisting essentially of a detailed technical description of the qualitative materiel requirement established in July 1957, this interim statement of weapon system characteristics was intended to provide the study contractors broad guidance for the preparation of system concept proposals. At this early stage in a development program, the technical requirements must necessarily be based on unofficial military characteristics (MC's) and are generally subject to major changes after review of initial design studies. In the case of the MAULER, however, the tentative technical requirements (TR) published in February 1958 were practically identical to the formal MC's later approved by CONARC and OCRD. The major changes incorporated in the formal MC's were these: the minimum target radar cross section decreased from 1.0^2 meter to 0.1^2 meter; the target maneuver specification increased from 3G to 6G; and requirements added for an alert/alarm system and a maximum missile reload time of 1 minute.[7]

[redacted] The MAULER MC's specified a requirement for an advanced, all-weather, self-propelled guided missile system capable of countering the total air threat to forward combat elements and critical installations of the field army. Specifically, the weapon system was to be designed for effective operation against tactical aircraft (both piloted and pilotless), light aviation of both fixed- and rotary-wing type, drones, missiles, and rockets (of the HONEST JOHN/LITTLEJOHN type) with a minimum radar cross section of 0.1^2 meter (tentative TR, 1.0^2 meter) and operational

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[7](1) "Technical Requirements for a Preliminary Design Study of MAULER System," R&D Div, RSA, 3 Feb 58. (2) Ltr, ATDEV-4 400. 114/40, CG, CONARC, to CRD, DA, 11 Jul 58, subj: USCONARC Apprd MC's for MAULER. Both in MPCF, Bx 13-649, RHA. (3) OTCM 37041, 2 Apr 59, subj: Proj 516-04-010 (TU1-3072) MAULER - Estb of Proj & MC's for. RSIC.

capabilities as follows:

Speeds. All speeds up to 1,000 knots, required.

Altitude. All altitudes up to 10,000 feet when flying singly or in close formation.

Horizontal Ranges. All slant ranges up to 5,000 meters required; 10,000 meters desired.

Target Maneuver. While executing maximum maneuver at the specified altitudes and ranges, with no less than 6G maneuver (tentative TR, 3G) at all altitudes indicated.

The effectiveness or accuracy of the system against the specified targets was to be such as to achieve a single engagement "K" kill probability of 0.5 (required) and a single shot "K" kill probability of 0.6 (desired). Guided missiles of the passive homing type were preferred, but consideration would be given to any new techniques or revolutionary discoveries in the field of air defense.

([redacted]) The size and weight of all major components were to be the minimum consistent with required system effectiveness and intended employment. The carriage was to be a mobile, lightweight, lightly armored, standard or quasi-standard vehicle capable of transporting the crew and towing a lightweight ammunition trailer. Its weight, including armament, was not to exceed that imposed by Phase I airborne operations. A missile weight of no more than 50 pounds was desired, but in no case was it to exceed the handling capabilities of one man.

([redacted]) In addition to its primary air defense role, the MAULER weapon system would be used in a secondary role to provide ground fire support, including an antitank capability. The latter role, however, was not to degrade the system's air defense capabilities. Among other required operational capabilities were these:

Cross-country mobility equal to that of divisional combat vehicles.

Maintenance in a state of continuous battle readiness for a minimum of 20 hours per day.

Target detection, identification, and acquisition while on the move and launching missiles within 5 seconds after stopping. (Missile launching while on the move highly desirable.)

Warm-up time from a cold start not to exceed 2 minutes; missile reload time between engagements not to exceed 1 minute.

Equal effectiveness throughout a 360-degree field of fire.

A radial dead area of 500 meters slant range required; 250 meters slant range desired.

A method of target acquisition (alarm/alert system) to permit instantaneous sharing of target information by all MAULER fire units at battalion, battery, or platoon level.

An operating crew of not more than one man to conduct a single engagement.

A simple alternate means of launching missiles in the event of failure of the primary fire control system.

An on-carriage power source separate from the vehicle engine, with provision for emergency use of the latter.

Effective operation between the temperatures of -40° and +125°F. over sustained periods.

Sufficient ruggedness to permit transport of complete system without damage over unimproved roads and field terrain; in Phase I of an airborne operation; by rail and ship; and by landing craft in amphibious operations. The system was also to have a shallow fording capability equal to that required for tanks.

([redacted]) In the case of competing characteristics, the developer was to give priority in this order: system effectiveness (accuracy, lethality, reliability, and immunity to electronic countermeasures), range and altitude, mobility, safety, and maintainability.[8]

MAULER Design Competition

(U) During a joint Ordnance-CONARC conference held at Redstone Arsenal on 3 February 1958, representatives of 98 industrial firms and non-profit research organizations were briefed on the MAULER

[8] OTCM 37041, 2 Apr 59. RSIC.

technical requirements and invited to submit system concept proposals for a 6-month preliminary design study.[9] The statement of technical requirements handed out to the prospective contractors stated that the specific purpose of the task was to determine a system which would provide the requisite protection from the anticipated threat. It emphasized, however, that it was "more important to have a system available with growth potential, by the required 1963 date, rather than to delay development and production of a system past this date in order to fully meet all of the operational requirements."[10]

(U) The Redstone Arsenal R&D Division received a total of 32 proposals by the specified deadline, 24 March 1958.[11] Shortly thereafter, on 1 April 1958, the Arsenal's technical missions and operating divisions were transferred to the newly formed Army Rocket & Guided Missile Agency (ARGMA), a subordinate element of the Army Ordnance Missile Command (AOMC) which had been established at the installation on 31 March 1958.[12] This reorganization had little or no impact on the execution of assigned R&D projects, since the mission divisions were transferred intact with no change in personnel, internal structure, or physical location.[13] As far as the MAULER program was concerned, it simply meant that actions requiring approval by higher authority, such as the selection of study contractors, would have to pass through another link in the

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[9](1) ARGMA Diary, 1 Apr - 30 Jun 58, p. 96. (2) MAULER CWSP-2, ARGMA, 30 Jan 59, p. 1.

[10]"Technical Requirements for a Preliminary Design Study of MAULER System," R&D Div, RSA, 3 Feb 58. MPCF, Bx 13-649, RHA.

[11]ARGMA Diary, 1 Apr - 30 Jun 58, p. 96.

[12](1) DA GO 12, 28 Mar 58. (2) OrdCorps Order 6-58, 31 Mar 58. (3) AOMC GO 6, 1 Apr 58.

[13]The mission elements assigned to ARGMA were the R&D, Industrial, and Field Service Divisions and the Ordnance Missile Laboratories. For a background summary of the reorganization, see ARGMA Hist Sum, 1 Apr - 30 Jun 58, pp. 11-21.

chain of command; i.e., through AOMC Headquarters to the Chief of Ordnance.

(U) To secure the best possible solution to the materiel requirement, sufficient FY 1958 funds had been provided for preliminary design studies of the four most promising MAULER proposals. Following a detailed analysis of the 32 proposals, an ARGMA technical committee and a panel of consultants at the Office of Ordnance Research, Duke University, recommended for further design study the system concepts proposed by the Sperry Gyroscope Company, General Electric Company, Martin Company, and Convair Division of General Dynamics Corporation. An ARGMA executive committee and the Commanding General of AOMC promptly concurred in this selection, and OCRD approved the award of study contracts following a MAULER presentation at the Pentagon on 23 May 1958. Each of the four companies received a 6-month, $50,000 design study contract on 1 June 1958.[14]

(U) Despite the delay in receipt of authorization for the MAULER study program, the operational availability date originally set by CONARC (FY 1963) was still valid. The final decision to proceed with development, however, would hinge on the outcome of the preliminary design studies which were not due until 1 December 1958. At that time, the proposed system designs would be evaluated on the basis of their capability to fulfill user requirements within the specified time frame. Another important factor to be considered in the evaluation was the estimated development cost. It was already painfully apparent that R&D funds would be extremely limited, and so far, there was no assurance that FY 1959 funds would be available in any amount.

[redacted] Reflecting a sense of deep concern over the uncertainties

[14](1) MAULER CWSP-2, ARGMA, 30 Jan 59, pp. 2, 7. (2) TT, ARGMA Comdr to CofOrd, 11 Apr 58. MPCF, Bx 11-14, RHA.

surrounding the future of the MAULER program, the CONARC Commander, in July 1958, recommended approval of the MC's for the weapon system and urged that a full scale, high priority development program be initiated upon conclusion of the design study phase. He pointed out that "sufficient technical evidence now exists to indicate conclusively that the attainment of the required capabilities . . . is feasible," and that the MAULER weapon was urgently needed to fill a critical gap in the field army air defense.[15] No doubt contributing to the sense of urgency was the decision, in February 1958, to terminate all work on the RADUSTER system, which was to have been developed as an on-the-shelf item for emergency use.[16] As a result of this change in the Army's light antiaircraft program, the field army would have to rely on the M42 40-mm. gun (DUSTER) until the interim 37-mm. VIGILANTE system became available. Hopefully, the advanced MAULER weapon system would be available to replace both the DUSTER and the VIGILANTE in FY 1963.

Evaluation of Contractor Proposals

(U) The four contractors delivered their study reports to ARGMA on 1 December 1958. The most promising system concept would be recommended for development by the ARGMA Selection Board, consisting of BG John G. Shinkle, ARGMA Commander (chairman); COL H. N. Brownson, Chief, Control Office; and COL T. E. Wood, Director, Ordnance Missile Laboratories. To provide the Selection Board with data on which to base a final decision, COL M. R. Collins, Jr., Chief of the R&D Division, had established a Technical Evaluation Committee, an Operations and Effectiveness Committee, and an

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[15] Ltr, ATDEV-4 400.114/40, CG, CONARC, to CRD, DA, 11 Jul 58, subj: USCONARC Apprd MC's for MAULER. MPCF, Bx 11-14, RHA.

[16] MAULER Presentation to Staff Members of the House Armed Services Committee, 17-20 Oct 60.

Industrial Survey Team. The members of the two committees were outstanding scientists and engineers selected from prominent colleges and universities, and none of them was associated with either the Department of the Army or the contractors. The Industrial Survey Team was composed of personnel from ARGMA's three mission divisions.

(U) The Technical Committee, headed by Dr. L. E. Grinter, University of Florida, was to conduct a detailed technical evaluation of the major components of the proposed system concepts, determine their relative order of merit, and recommend one for development. The Operations & Effectiveness Committee, headed by Dr. Lawrence H. O'Neill, Columbia University, was to determine the relative order of merit of the proposed system concepts based upon an evaluation of their overall capability to fulfill the operational requirements. The Industrial Survey Team was to conduct a survey of the contractors' facilities and establish the relative capability of each to undertake development and production of the MAULER system. In addition to these groups, Colonel Collins appointed a panel of consultants from the following organizations to provide advice and assistance in their specialized fields of interest:

Headquarters, CONARC
U. S. Army Air Defense Board, Fort Bliss, Texas
U. S. Army Air Defense School, Fort Bliss, Texas
Ordnance Tank-Automotive Command
Diamond Ordnance Fuze Laboratories
Frankford Arsenal
Picatinny Arsenal
Ballistic Research Laboratories, Aberdeen Proving Ground
Human Engineering Laboratories, Aberdeen Proving Ground
R&D Division, ARGMA
Ordnance Missile Laboratories, ARGMA

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[17] (1) MAULER Eval Briefing for ARGMA Comdr, 12 Nov 58. (2) DF, Cmt 1, Chf, R&D Div, to ARGMA Comdr, 24 Oct 58, subj: MAULER Eval; & Cmt 2, ARGMA Comdr to Chf, R&D Div, 24 Nov 58. (3) Rept, MAULER Eval, 3-23 Dec 58. All in MPCF, Bx 13-649, RHA.

(U) Having begun their appraisal of the contractors' facilities in November, members of the Industrial Survey Team presented their report to the Selection Board on 22 December 1958. The two committees began their evaluation following presentations by the respective contractors during the period 3-5 December. The findings and recommendations of the Technical Committee, presented to the Selection Board on 22 December, served as the authoritative basis for the work of the Operations & Effectiveness Committee, whose report reached the Board early in January 1959. Both of the committees were assisted in their effort by comments and reports from members of the technical advisory group, all of whom attended the contractor presentations in early December.

Initial Conclusions and Recommendations

(U) The Industrial Survey Team found that all four of the contractors possessed the capability to undertake development and production of the MAULER system, but determined the relative order of capability to be as follows: General Electric, Convair, Martin, and Sperry. The findings of the evaluation committees, however, were most discouraging. The members of both committees concluded that none of the proposed MAULER concepts was suitable for direct development into an operational system, but that a combination of subsystem designs advanced by different contractors provided a promising technical basis for the development of an effective weapon system.

([redacted]) In view of the basic conclusion that none of the proposed systems could be accepted without major modification, the evaluation teams concentrated their attention on those aspects of the MAULER system which would most critically affect its operational effectiveness. These clearly consisted of the radar and missile subsystems which provided the MAULER with the ability to "see" its targets and to attack them. To be effective at all, the MAULER would have to be capable of acquiring a target, launching a missile, and accomplishing interception in a very short time. Although development difficulties would very likely be encountered in other areas, the achievement of a fully effective missile and surveillance and acquisition radar would definitely present the greatest challenge.

([redacted]) All four of the design studies proposed the use of missiles having about the same basic dimensions but divergent weights and flight times. When adjusted on a common basis, the Convair missile design was considered to be clearly superior, in that it was the lightest and had the shortest flight time to typical intercept ranges. The General Electric missile design was ranked second; the Sperry design, third; and the Martin design, fourth.

([redacted]) While preferring the Convair approach to the aerodynamic vehicle, both evaluation committees agreed that the radar subsystem designed for Convair by the Raytheon Manufacturing Corporation was wholly unworkable because of a serious lack of subclutter visibility.[18] An analysis of the other three proposals revealed that the surveillance and acquisition radar designed for Martin by the Westinghouse Electric Corporation represented by a substantial factor the best approach in this area. The evaluation team concluded that the proposed Westinghouse radar, if properly designed, would be able to detect targets in very severe clutter and provide surveillance coverage through an entire hemisphere. Moreover, it would be capable of searching through this coverage very rapidly (once per second), and continuing the search through most of the surveillance region after its tracker-illuminator acquired a target and the system engaged it. But for all its desirable

[18] The ability to detect moving targets submerged in a background of echoes from terrain and other reflecting objects.

features, the Westinghouse radar had certain inherent disadvantages. One of these stemmed from the use of the Luneberg lens which, though perfectly sound and well proved in development, was yet untried in operating systems. Two other equally important shortcomings were its vulnerability to enemy countermeasures and its lack of adequate growth potential. Nevertheless, the Westinghouse radar appeared to be based on a well thought out, intelligent set of compromises which produced an adequate and practical subsystem.[19]

(U) The basic vehicles considered in the MAULER design studies were the lightweight, unarmored, tracked chassis comprised of the T114-T116 family of components, and the tracked, armored or unarmored, T113E1[20] vehicle. Both of these vehicles were under development by the Ordnance Tank-Automotive Command (OTAC), the T114-T116 being about 1 year behind the T113. An OTAC evaluation of the ground support sections of the design studies revealed that all four of the proposed MAULER system pods could be mounted on either type vehicle, although the General Electric system would require rearrangement to accomplish this. OTAC indicated a preference for the Convair and Martin concepts because they provided a more desirable gross system weight. The General Electric and Sperry

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[19] (1) "MAULER Evaluation Report of the Committee on Operations and Effectiveness," atchd as incl to Ltr, Dr. Lawrence H. O'Neill, Prof of Elec Engrg, Columbia Univ, to BG J. G. Shinkle, ARGMA, 6 Jan 59. (2) Min of MAULER SB, ARGMA, undated (Board meetings held on 22 December 1958, 7 & 12 January 1959, and 6 February 1959). Both in MPCF, Bx 13-649, RHA.

[20] The basic T113 chassis, later adopted as the mount for the MAULER weapon pod, was an armored personnel carrier developed for Army use and manufactured by the Food Machinery & Chemical Corporation. Its aluminum structure provided adequate ballistic protection with about half the weight of the steel-covered M59 carrier, also manufactured by Food Machinery. The lightweight, armor-protected carrier required less fuel and provided better performance for the power expended than the heavier M59, both on inland waterways and on the ground. MAJ Marvin L. Worley, Jr., New Developments in Army Weapons, Tactics, Organization, and Equipment (Harrisburg, Pa: The Stackpole Co., 1959), pp. 145-46.

systems (rated in second and third place, respectively) weighed considerably more and therefore would effect a somewhat reduced automotive performance.[21]

([redacted]) Since there appeared to be no basic obstacle to combining the Convair and Martin subsystem ideas into an integrated MAULER weapon system, the Operations & Effectiveness Committee recommended that the selected system contractor be encouraged to use the Convair approach in the design of the missile and the techniques suggested by Martin (Westinghouse) for the surveillance and acquisition radar. The Technical Committee agreed with this subsystem approach, but suggested that design studies be continued for about 6 months with two contractors, of which Convair and Westinghouse would represent one strong combination.[22] While this represented the majority opinion of the Technical Committee, one of the members—Dr. Francis H. Clauser, head of the Department of Aeronautics at the Johns Hopkins University—questioned the advisability of proceeding with the MAULER project in any form. Dr. Clauser outlined his views in a letter to the committee chairman on 6 January 1959. He wrote:

> . . . Against aircraft which the Soviet Union is giving to its satellites, the Mauler system is just able to show a margin of utility. Against weapons possessing a sophistication comparable to the Mauler system itself, I believe it will not prove effective. Small homing rockets of lesser complexity than those of Mauler will be able to put Mauler out of action (Rockets from captured Mauler batteries, after undergoing field changes, will be able to be used with telling effect against Mauler units).
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> This vulnerability . . . is not just happenstance or a case of

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[21](1) 1st Ind, CG, OTAC, to CG, ARGMA, 28 Nov 58, on Ltr, ARGMA Comdr to CG, OTAC, 20 Oct 58, subj: Distr of Final Rept. (2) Final MAULER Rept (Eval of Contr Repts), OTAC R&D Div, 12 Dec 58, atchd as incl to Ltr, CG, OTAC, to CG, ARGMA, 16 Dec 58, subj: Xmitl of Final MAULER Rept. Both in MPCF, Bx 13-649, RHA.

[22](1) "MAULER Evaluation Report of the Committee on Operations and Effectiveness," atchd as incl to Ltr, Dr. Lawrence H. O'Neill, Prof of Elec Engrg, Columbia Univ, to BG J. G. Shinkle, ARGMA, 6 Jan 59. (2) Min of MAULER SB, ARGMA, n.d. File same.

poor design which is easily corrected. The fundamental positions of Mauler vis a vis its opponents are as follows:

1. Mauler is essentially a fixed target whose dwell time is measured in tens of minutes whereas its opponents are maneuverable targets that are in view for a few tens of seconds.

2. Mauler detects its targets by strong telltale radiation and it must track its targets with a steady illumination in a ring which is necessarily much larger than the lethal radius of its missiles. Its opponents may, with impunity, stay in this outer ring and, completely passively, detect, locate, and guide missiles to the Mauler units. (Captured Mauler missiles will come ready equipped with home-on-jam provisions to facilitate this operation.)

3. Mauler units must fire missiles upward whereas the opponents may fire missiles downward. This means that missile for missile, the opponents have more than a two to one advantage in range over the Mauler. Consequently the opponents may fire at the Maulers from outside the lethal radius of the Mauler's missiles.

In summary, I believe that the shortcomings of Mauler are sufficiently serious that it is likely to be an ineffective weapons system.[23]

(U) In passing the minority report on to the MAULER Selection Board, Dr. Grinter pointed out that Dr. Clauser's views had been discussed at length during the committee meetings, and that the panel's recommendations dealing with vulnerability of the system were in partial agreement with the views expressed. However, carried to the extreme, he felt that these views neglected the effectiveness of other defense weapons beyond MAULER's range and approached "the conclusion that no ground fire missile can defend against airborne missiles."[24]

Revised Recommendations

([redacted]) Meanwhile, the Operations & Effectiveness Committee had been asked to reconsider its recommendations on the basis of two

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[23] Ltr to Dean L. E. Grinter, Univ of Florida, 6 Jan 59. MPCF, Bx 13-649, RHA.

[24] Ltr, Dr. L. E. Grinter, Chmn, Tech Com, to GEN J. G. Shinkle, 12 Jan 59. File same.

new developments. The Convair Division of General Dynamics had submitted a memorandum report describing a proposed changed in its original (Raytheon) radar design to improve the clutter rejection capability. In addition, an in-house study conducted by ARGMA's R&D Division indicated that the subclutter visibility of the Martin (Westinghouse) radar was equally as limited as that of the originally proposed Convair (Raytheon) system.[25] Asked for his comments on the results of the ARGMA study, Dr. O'Neill presented evidence to the contrary and reaffirmed the original recommendations of the committee.[26] The initial response to the Convair memorandum, however, was evasive and noncommittal. Dr. J. P. Ruina, who prepared the committee's comments, wrote:

> I have no doubt that the new proposal would provide significantly improved subclutter visibility. However I don't believe that one can say with assurance at this time that the proposed system would very clearly detect a slow moving target in the presence of rather strong clutter; but then again none of the radars proposed were [sic.] free of doubts. . . .
>
> Considering the modification, I would certainly not consider the Convair radar proposal as "unacceptable". I still consider the Martin radar proposal as superior to this one.[27]

(C) Based on a comparative analysis of the two radars, the engineers of ARGMA's R&D Division concluded that the modified Convair/Raytheon radar design was superior to the Martin/Westinghouse system. They submitted the study report to the Selection Board with the recommendation that Convair's modified MAULER

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[25] Ltr, Dr. Lawrence H. O'Neill, Chmn, Ops & Effns Com, to Prof J. P. Ruina, Univ of Illinois (Com Mbr), 13 Jan 59. MPCF, Bx 13-649, RHA.

[26] Ltr, Dr. Lawrence H. O'Neill to K. C. Shipp, RE Staff, R&D Div, ARGMA, 13 Jan 59. File same.

[27] Ltr, Dr. J. P. Ruina, Con Sys Lab, Univ of Illinois, to Stanley Bernstein, Chf, Future Projs Ofc, R&D Div, ARGMA, 23 Jan 59. File same.

concept be selected for development.[28] In the light of this action, Dr. O'Neill and two members of his committee met with ARGMA representatives, on 3 February 1959, to reevaluate the relative merits of the proposed subsystem concepts and to reconsider the recommendations previously submitted to the Selection Board. On the basis of this discussion, they finally agreed to go along with the selection of the modified Convair/Raytheon radar subsystem, but rejected the theory that its subclutter visibility was actually superior to that of the Martin/Westinghouse system. The revised conclusions and recommendations, later approved by the full membership of the committee, were as follows:

> With the proposed modification, we are now convinced that a substantial improvement in clutter rejection will be achieved. Although it is possible that clutter rejection will not be as great as claimed in the theoretical analysis presented by Convair/Raytheon . . ., we estimate that if the system is carefully engineered, it is not likely to be less than 60 D.B. [decibels] This figure compares favorably with the clutter rejection of all proposed surveillance radars except that of Martin/Westinghouse.
>
> There are not sufficient data available at this time to state firmly that the clutter rejection of the modified Convair/Raytheon radar will be adequate in all situations in which Mauler will operate. However, it should be adequate in a significant number of such situations. Moreover, even further improved clutter rejection could be achieved by eliminating the use of P.R.F. [pulse repetition frequency] switching in the radar. If this were done, the radar would not provide all information required in the threat evaluation procedure proposed by Convair. However, we believe that the programming of the Convair computer could be changed in such a case, without major difficulty, to make possible a less effective threat evaluation procedure.
>
> On the basis of our earlier detailed study and present consideration of the Convair/Raytheon proposed modification, we now conclude that the Convair/Raytheon proposal presents the greatest technical promise for the development of the Mauler System. This conclusion is strengthened by our belief that the expected overall operation of the Convair/Raytheon system (especially its threat evaluation) and the growth potential of the system are superior to

[28] Min of MAULER SB, ARGMA, n.d. MPCF, Bx 13-649, RHA.

those of the other proposed Mauler systems. . . .

We therefore make the following recommendations:

1. That Mauler be developed along the general lines proposed by Convair/Raytheon.

2. That the selected contractor be required to study the feasibility of including in the system design a secondary mode of operation to be used when clutter levels are very severe. If found feasible and necessary, such a mode of operation should be implemented in the system.

3. That ARGMA undertake a supporting investigation to ascertain if sufficiently severe clutter will be encountered by Mauler often enough to justify the inclusion of the previously mentioned secondary mode of operation in the system.[29]

(U) During a final meeting on 6 February 1959, the ARGMA Selection Board formally approved the MAULER system concept proposed by the Convair Division of General Dynamics, and sent the evaluation file to AOMC for review and final action by higher headquarters.[30]

Characteristics of the Proposed Convair System

([redacted]) The MAULER weapon thus recommended for development in Phase III of the Army's light antiaircraft program was a compact, mobile, self-contained air defense system mounted on a modified T113 fully tracked, amphibious vehicle. Its 4,613-pound unitized weapon pod (housing the fire control equipment, system operator, launcher, radar antennae, and power source) could be demounted from the carrier vehicle, helicopter-transported as a single load, and operated in unprepared locations. The entire system, pod and vehicle, would be air transportable and air droppable. The weapon

[29](1) Ltr, Dr. Lawrence H. O'Neill, Columbia Univ, to GEN J. G. Shinkle, ARGMA Comdr, 3 Feb 59. (2) Also see Ltr, same to same, 20 Feb 59, re Apprl of Recmns by Full Mbrshp of Com. Both in MPCF, Bx 13-649, RHA.

[30]Min of MAULER SB, n.d. File same.

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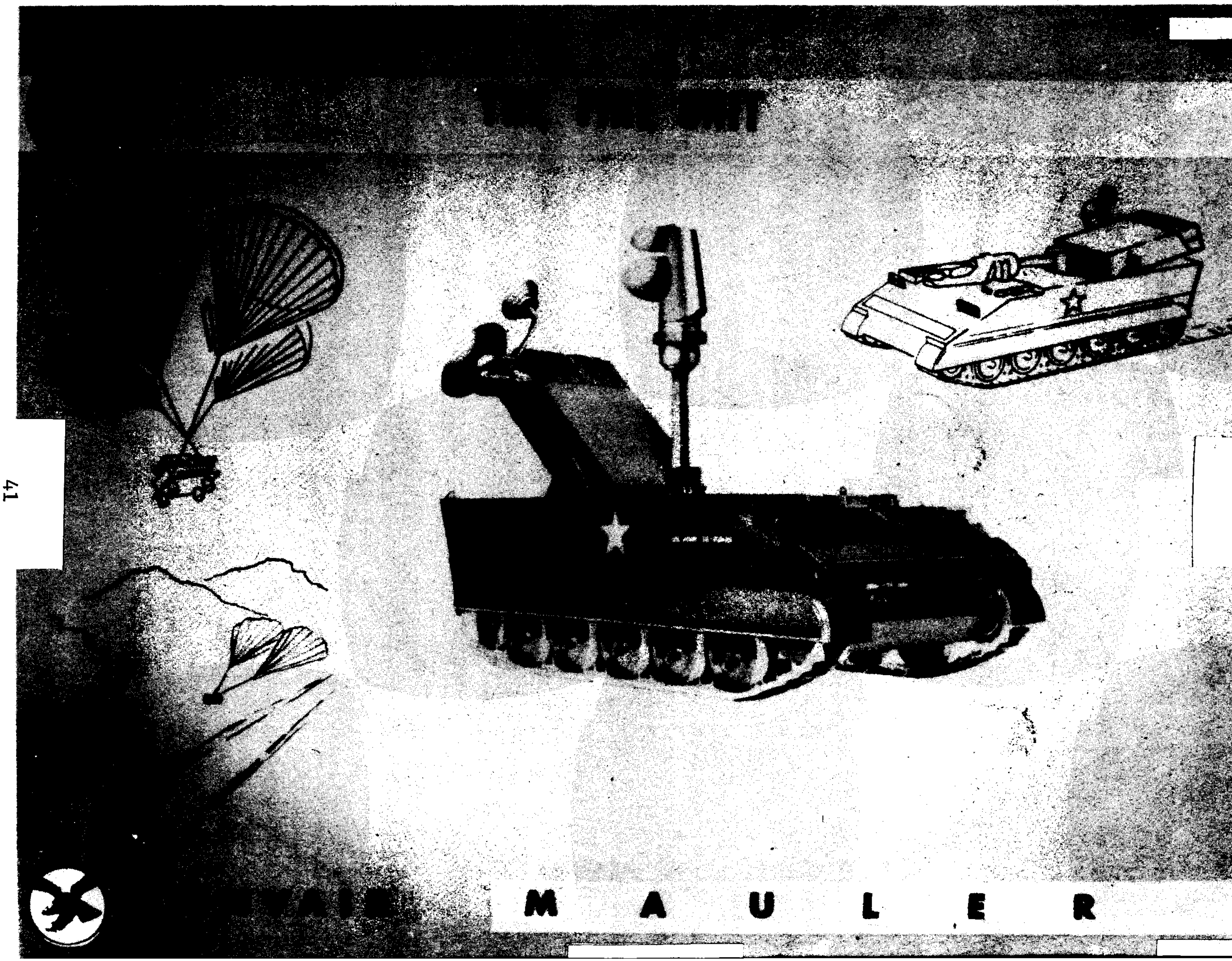

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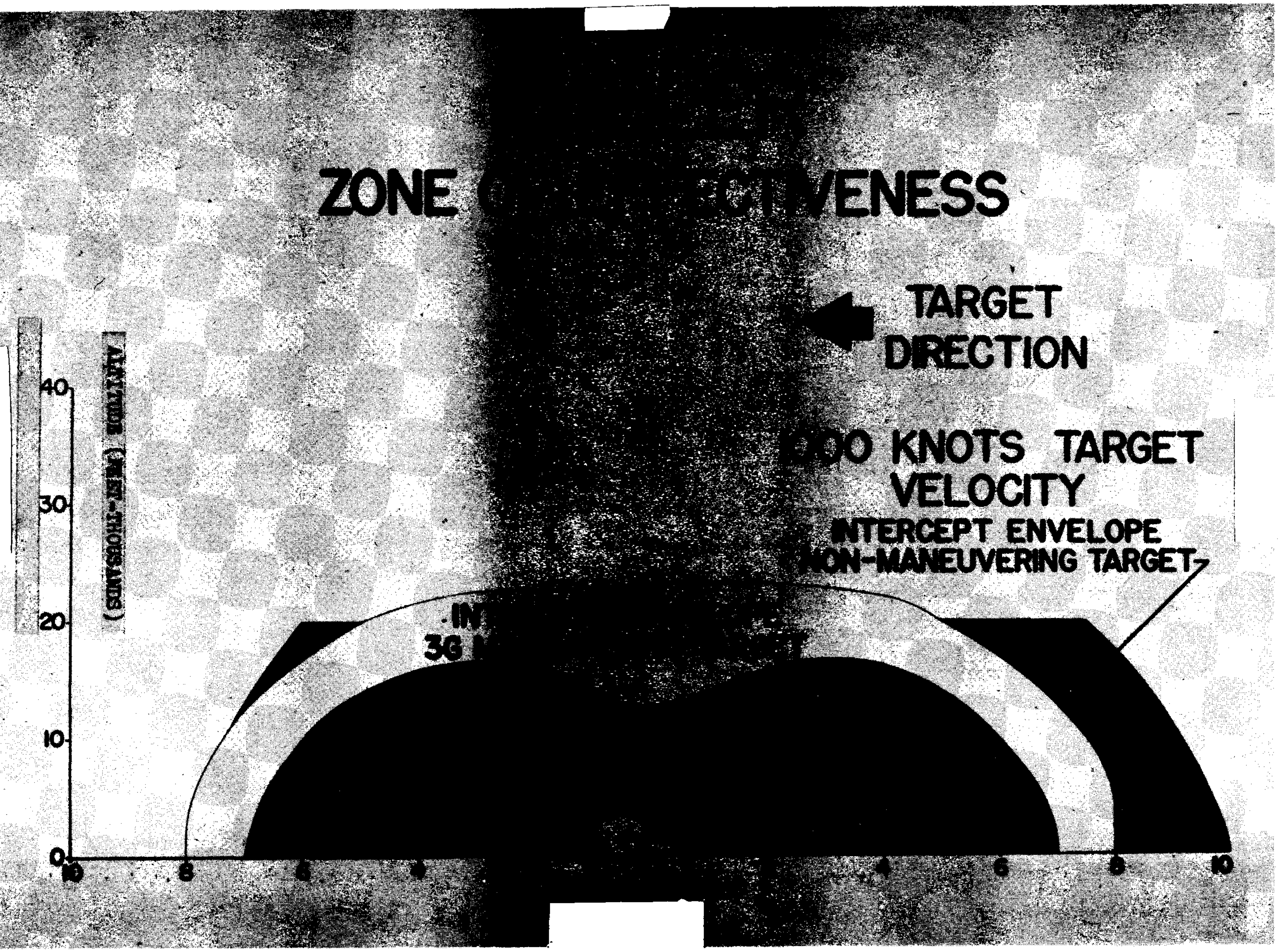

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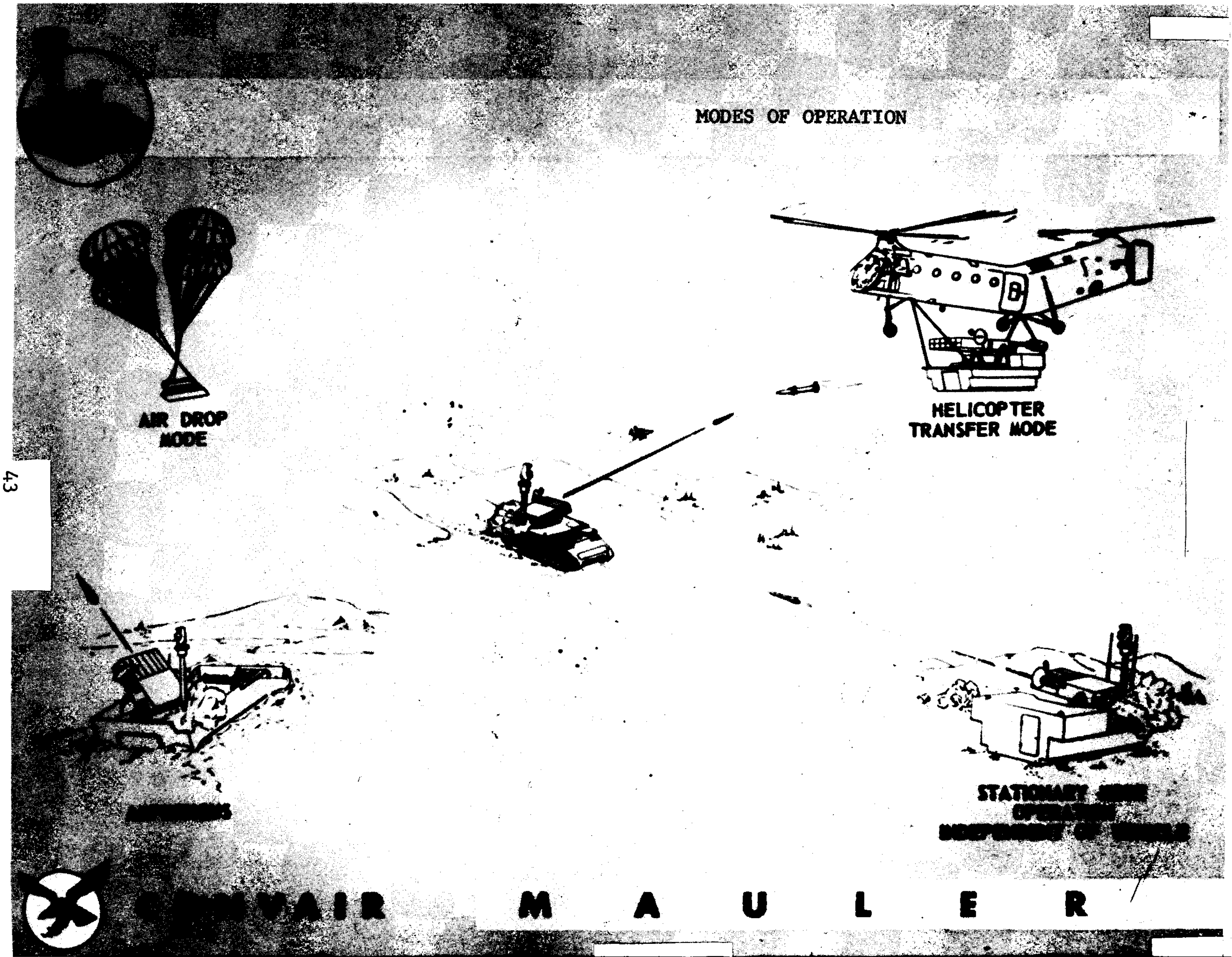

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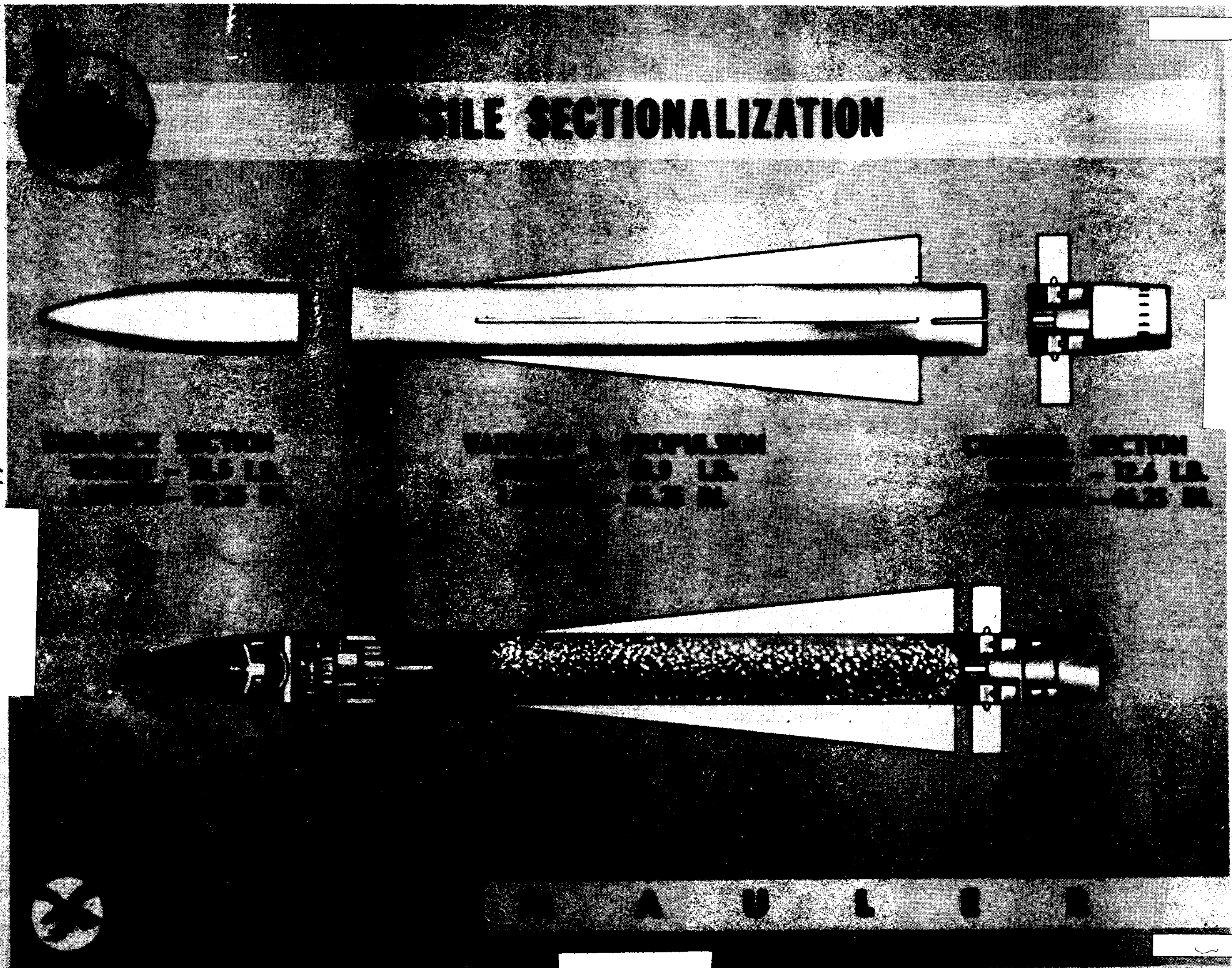

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pod would be capable of performing all the air defense functions either while being transported on its basic vehicle, on a flat-bed truck, or on a landing craft. The weight of the basic (T113) vehicle would be 12,443 pounds with armor and 9,753 pounds without armor. In a mobile, combat-ready condition—i.e., with fuel, 12 missiles, on-vehicle equipment, and a 3-man crew (driver, operator, and relief man)—the complete weapon system would have a gross weight of 19,834 pounds with armor and 17,144 pounds without armor.

[redacted] Designed for completely automatic operation from target detection to intercept, the fire control system consisted of an acquisition radar, a digital fire control computer, and a tracker-illuminator (T-I) radar. The acquisition radar, using pulse-doppler, stacked-beam, track-while-scan techniques, was designed to provide range, bearing, and elevation information from the horizon to 60 degrees elevation and out to ranges of 17 to 20 kilometers (km) against targets with a radar cross section of 1.0^2 meter (later changed to 0.1^2 meter). The digital computer would assist the operator in assessing and interpreting target data received by the acquisition system. Target illumination and refined target location data for the semiactive homing missile would be provided by a continuous wave (CW) T-I radar having its own antenna system. The range of the T-I would be greater than that of the acquisition radar for any given target.

([redacted] The trainable launcher rack would carry 12 missiles packed in individual disposable canisters, the latter serving the dual function of shipping container and launching tube. As originally designed, the MAULER missile was 5 inches in diameter, 71 inches long, and had a launch weight of 87 pounds. Its major components consisted of a solid propellant rocket motor having a 6,300-pound thrust; a 10-pound blast-fragmentation warhead; and a semiactive CW homing guidance system which permitted it to home on targets illuminated by the T-I radar. With an estimated maximum velocity of Mach 3.2 and a 30G maneuver capability, the missile would have a maximum effective range of 10,000 meters.[31]

Conditional Weapon System Plan

([redacted]) In accordance with guidance received from OCO in November 1957 and recommendations made by CONARC in July 1958,[32] MAULER project personnel at ARGMA formulated preliminary plans for a full scale development program on the basis of the proposed Convair system. The conditional weapon system plan, published in late January 1959, reflected the proposed schedule and development data for obtaining an operational MAULER system by FY 1963. The projected target dates were based on the assumption that $3.6 million in FY 1959 funds would be available in time for the initiation of a development contract with Convair by 1 May 1959. Development of the weapon system would begin at that time and continue through FY 1963 at a total estimated cost of $73.6 million. A preliminary R&D release for preproduction preparation would be made in February 1961, followed by the interim R&D release to the Industrial Division in April 1962 and the final release in August 1963, with an assumed Ordnance readiness date of March 1964.

([redacted]) The projected funding requirement of $73.6 million for the 5-year program (FY 1959-63) included $32.6 million in R&D funds and $41 million in PEMA/S* funds for the procurement of R&D prototype

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*Procurement of Equipment & Missiles, Army, in Support of Research and Development.

[31] (1) MAULER CWSP-2, ARGMA, 30 Jan 59, p. 1. (2) Final MAULER Rept (Eval of Contr Repts), OTAC R&D Div, 12 Dec 58, atchd as incl to Ltr, CG, OTAC, to CG, ARGMA, 16 Dec 58, subj: Xmitl of Final MAULER Rept. (3) Convair Rept No. IC-341-42, 25 Nov 58, subj: MAULER Effns Against Ballistic Msls, pp. 2-4. All in MPCF, Bx 13-649, RHA.

[32] *See* above, pp. 23, 30-31.

hardware for test and evaluation purposes. The latter sum would provide for the fabrication of 152 R&D missiles and 10 sets of non-tactical ground equipment (fire units), deliveries of which would begin in FY 1961 and be completed in FY 1963. Initial production deliveries of the complete MAULER weapon system were scheduled to begin during the first half of FY 1963. The tentative industrial plan called for the procurement and production of 17,180 missiles and 538 fire units at a total estimated cost of $411.6 million, including $28 million for production facilities. The projected funding requirement for the 1959-65 period thus came to a grand total of $485.2 million.[33]

MAULER Development Project Established

([redacted]) An Ordnance Technical Committee action approved by the Secretary of the Army on 2 April 1959 formally established the MAULER development project and MC's to fulfill the Phase III materiel requirement of the Army's light antiaircraft program. At that time, the MAULER design studies and the recommendations of the ARGMA Selection Board were still under review in the Pentagon; however, the project had been included in the FY 1959 R&D program and authorization for the initiation of a development contract was expected by 1 May 1959. The proposed development project reflected a total budget estimate of $73.6 million for the 1959-63 period and specified a requirement for initial production deliveries by FY 1963. This advanced antiaircraft guided missile system would replace the standard M42 40-mm. gun (DUSTER) and the 37-mm. VIGILANTE system being developed under Phase II of the light antiaircraft program.

([redacted]) It was recognized that the attainment of an optimum or fully effective weapon system meeting all the military requirements of the forward area "may require the development of new techniques or

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[33] MAULER CWSP-2, ARGMA, 30 Jan 59, pp. 5-6, 15, 25.

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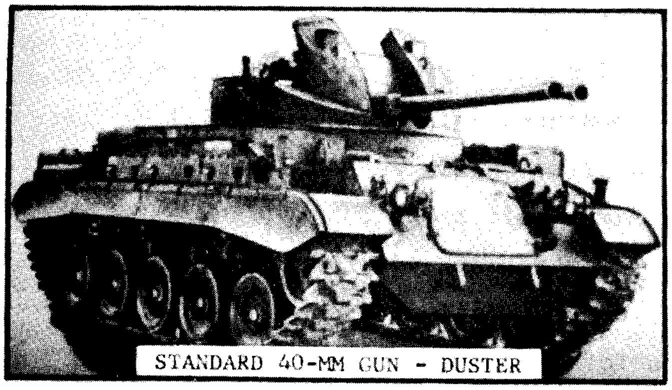
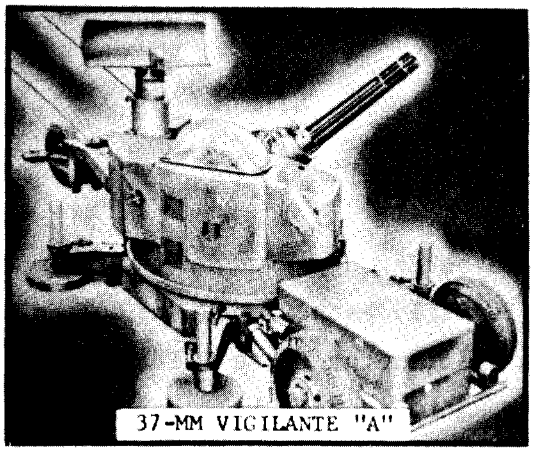
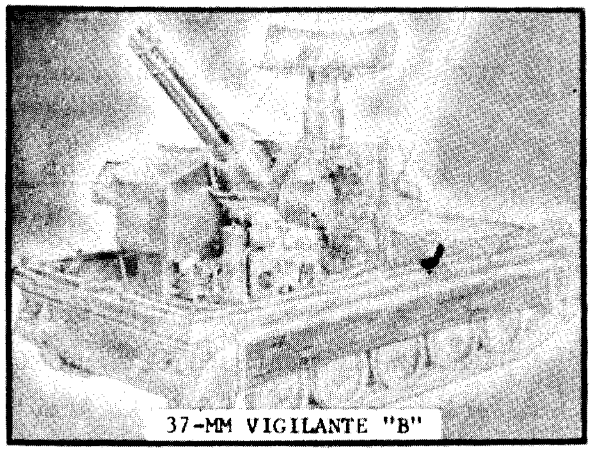

STANDARD 40-MM GUN - DUSTER

EVOLUTION OF THE MAULER CONCEPT 1953 - 1958


37-MM VIGILANTE "A"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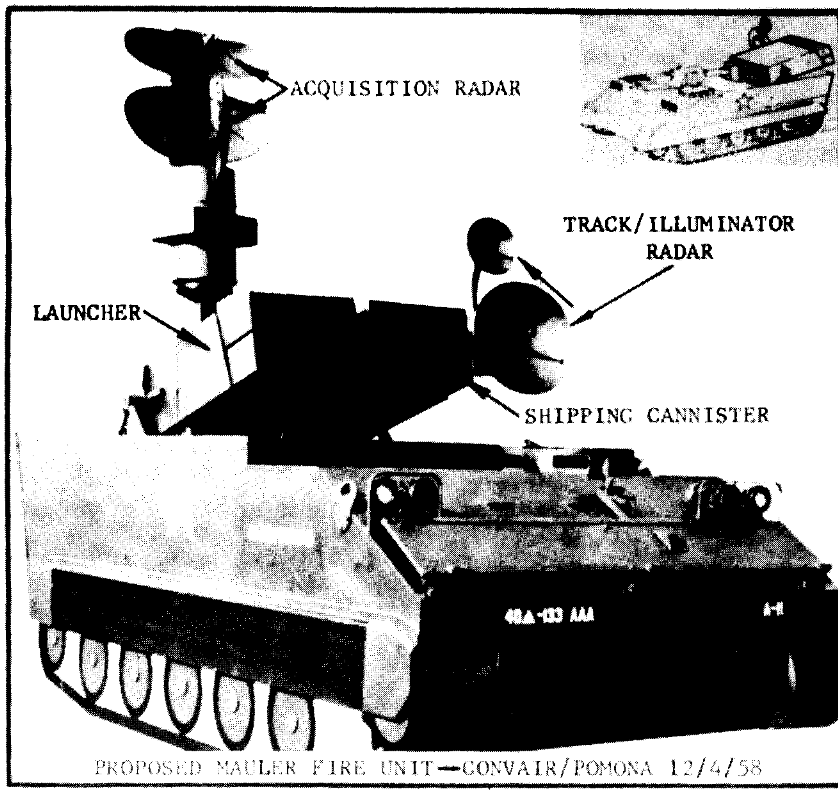

PROPOSED MAULER FIRE UNIT—CONVAIR/POMONA 12/4/58

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major advancements in the fields of propulsion and guidance rather than an extension and refinement of presently known developments." However, the results of initial feasibility studies indicated that the current state of the art would support the development of a guided missile system which would be more effective than any known predicted fire weapon. Hence, the immediate objective was to develop the best possible weapon system within the established time frame using "advanced techniques which are within the state of the art and require no major technical breakthroughs to meet the system requirements." The major problem to be overcome in developing the MAULER system was the "Weight and space reduction of all components . . . to comply with the requirements for Phase I airborne operations."[34]

The Credibility and Funding Gap

> "About the only way Army Ordnance Missile Command can fund many desirable advanced missile projects during 1960 will be by 'bootlegging' small amounts of funds from one project to another."[35]

([redacted]) The high priority MAULER development program that was to have been implemented in May 1959 fell victim to the prevailing budgetary squeeze and the reluctance of Army staff officials to fund new missile projects of a marginal or risky character. Despite the critical need for a fully effective forward area air defense system, the initial guidelines had called for a low-budget "austere program" as a means of providing at least an interim MAULER capability by FY 1963.[36] Moreover, the initial authorization had been qualified by an attached memorandum requiring a review of the program by the Assistant Secretary of the Army (Logistics) before

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[34] OTCM 37041, 2 Apr 59. RSIC.

[35] Donald E. Perry, "AOMC Recommends 'No Funds' for Missile Able," Missiles and Rockets, Vol. 5, No. 13 (30 Mar 59), p. 13.

[36] See above, pp. 23-25.

negotiation with any one contractor.[37]

([redacted]) The project was already in trouble, however, before it reached that level. Contrary to the revised findings of the evaluation teams, AOMC was not convinced that any of the proposed system concepts could successfully combat the threat specified in the MC's. In passing the evaluation file on to OCO, in March 1959, MG J. B. Medaris, then Commanding General of AOMC, agreed that Convair's proposal showed the most promise, but suggested that further discussions be held with the contractors to clear up certain technical questions before making a final selection.[38]

(U) In his reply on 9 April 1959, General Hinrichs conceded that the questions raised were good ones, but declined to make "any further comments on the technical matters . . . because I think they are moot." Besides, he noted, the Army was in a poor position to argue technicalities with potential contractors, since it was "extremely dubious" that the item would be funded in FY 1960. Consequently, there was to be no further discussion with the contractors on technical details. Instead, AOMC was to thank them for their effort, then express regret that funds were not available to pursue the program and, therefore, "no decision has been or will be made in the near future." General Hinrichs averred that this "would be an unanswerable argument, whereas I can foresee a storm of protest if we throw in the technical arguments as a basis for rejection."[39]

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[37]Cl D&F, 6 Nov 58, cited in MAULER CWSP-2, 30 Jan 59, p. 13.

[38]1st Ind, CG, AOMC, to CofOrd, 31 Mar 59, cited in Ltr, MG J. H. Hinrichs, CofOrd, to MG J. B. Medaris, CG, AOMC, 9 Apr 59, n.s.

[39](1) Ltr, MG J. H. Hinrichs, CofOrd, to MG J. B. Medaris, CG, AOMC, 9 Apr 59, n.s. (2) For obvious reasons, the recommendations of evaluation teams are generally handled as a confidential matter pending final action and official notification of all competing contractors. In this case, however, premature information was leaked to the press as early as 30 March. According to reliable sources, one article said, the MAULER "has the entire blessing of AOMC and an arsenal evaluation team has reportedly picked Convair." Donald E. Perry, op. cit., p. 13.

Refinement and Reevaluation of Proposals

(U) Cognizant of the primary weaknesses in, and criticisms of, their original MAULER proposals, the four competing contractors took advantage of the funding gap to bring their designs more in line with the MC's. In July 1959, as funding prospects for the new year became more favorable, the ARGMA R&D Division invited the contractors to submit a review of the advances or changes made in their proposals.[40] Following a study of the updated system designs on 30 July, the design engineers concluded that the improvements offered were not sufficiently significant to justify a change in the original contractor selection.[41]

[redacted] The Convair design, reaffirmed by ARGMA as the best of the four proposals, may have offered potential improvements in system effectiveness, but it introduced complications in other areas. Not the least of these was an increase in size and weight of the MAULER missile, which already exceeded the limits specified in the MC's.[42] To increase system effectiveness against ballistic missiles, the Army had requested an increase in the warhead weight from 10 to 20 pounds. This increased the gross missile weight from 87 to 120 pounds, the missile length from 71 to 78.2 inches, and the maximum outside diameter from 5 to 5.5 inches. Despite the problems resulting from these changes, the development of the proposed weapon system was still considered to be within the state of the art.[43]

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[40] Ltr, Chf, RE Staff, R&D Div, to General Electric Co., 24 Jul 59, n.s. Similar letter sent to Convair, Martin, & Sperry. MPCF, Bx 11-14, RHA.

[41] (1) ARGMA Diaries, 1 Jul - 31 Dec 59, p. 11; 1 Jan - 30 Jun 60, p. 85. (2) MAULER CWSP-2, ARGMA, revised 5 Aug 59, p. 2.

[42] The approved MC's specified a desired maximum missile weight of 50 pounds, with the proviso that the weight was not to exceed the handling capabilities of one man. See above, p. 27.

[43] MAULER CWSP-2, ARGMA, revised 5 Aug 59, pp. 1, 15.

(U) On 11 August 1959, ARGMA personnel gave a presentation to OCO, recommending that the Convair approach be adopted for the MAULER weapon system and that a development contract be awarded.[44] A short time before, OCO had requested that AOMC take $3 million from other R&D projects for allocation to the MAULER program.[45] Authority to obligate the funds, however, would have to await review and approval of the program by higher headquarters.

Updated Weapon System Plans

(U) To assist OSD and Army staff officials in making a final decision, the ARGMA R&D Division prepared a detailed report setting forth the development and production plans for the MAULER and pertinent background data on the proposed contractor. The Agency's Control Office also published an updated conditional weapon system plan reflecting changes made since January 1959.

([redacted] The proposed selection of Convair as the prime development contractor was predicated on several interrelated factors. Aside from the fact that it submitted what was considered to be the best system design, Convair, as a division of General Dynamics, had at its disposal a wide selection of experienced engineering talent and its management staff had gained a wealth of experience and knowledge through Navy and Air Force missile system contracts. No additional facilities would be required for the MAULER development phase, as Convair planned to use the Navy-owned plant at Pomona, California, where it had begun development of the Army's REDEYE guided missile system earlier in 1959. The Navy's Bureau of Ordnance had assured OCO staff that the Pomona facility was adequate and available for

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[44](1) Ibid., p. 2. (2) ARGMA Diaries, 1 Jul - 31 Dec 59, p. 11; 1 Jan - 30 Jun 60, p. 85.

[45]DF, Chf, ARGMA Con Ofc, to Chf, R&D Div, 10 Aug 59, subj: FY 60 RDTE Reprogramming, & incl thereto, TT, CofOrd to CG, AOMC, 31 Jul 59.

both the MAULER and REDEYE programs. Moreover, this arrangement would be of mutual benefit to both services, since the Navy was interested in a shipboard MAULER program. Production facilities for the MAULER would present no problem, as several alternate choices were available at minimum cost to the Government.

([redacted] In the absence of authority to discuss program costs with the contractor, the total estimated cost for MAULER research, development, test, and evaluation (RDTE) remained the same as that originally projected—i.e., $73.6 million. This estimate included an FY 1959 outlay of $131,000, plus funding requirements of $11.969 million in FY 1960; $25 million in 1961 and 1962, respectively; and $11.5 million in 1963.

[redacted] Because of a change in procurement plans, the estimated production (PEMA) cost increased from the original projection of $411.6 to $437.9 million, making a total RDTE/PEMA cost of $511.5 million for the 1959-64 period. The revised plan called for the procurement and production of 12,532 missiles (152 R&D, 12,380 industrial) and 696 fire units (80 non-tactical, 616 tactical). Deliveries of production missiles and non-tactical fire units would begin in FY 1963, followed by the first tactical fire units in FY 1964.[46]

The Die is Cast

(U) The Director of Defense Research & Engineering (DDRE), OSD, approved the proposed MAULER development program on 13 November 1959, and released FY 1960 RDTE funds to the Department of the Army on 30 December. The Assistant Secretary of the Army (ASA)

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[46] (1) MAULER CWSP-2, ARGMA, revised 5 Aug 59, pp. 5-6, 15. (2) Ltr, CG, AOMC, to CofOrd, 19 Oct 59, subj: MAULER Action on OCTI 200-6-59, atchd as Incl 1 to SS XR-REF-98, ARGMA Comdr to CG, AOMC, 6 Oct 59, subj: same. MPCF, Bx 13-649, RHA. (3) TT ORDIZ-SA 4-83, CofOrd to CG, AOMC, 1 May 59. File same.

(Logistics) then issued a Class Determination & Findings, on 22 January 1960, authorizing the negotiation of a MAULER development contract at an estimated cost of $13 million.[47]

(U) To permit the initiation of development work while contract negotiations were in progress, the Los Angeles Ordnance District (LAOD), on 31 March 1960, awarded Convair/Pomona[48] a $5.5 million, 90-day letter order contract, with a $5.5 million contingency.[49] On 30 June 1960, Convair/Pomona signed a definitized, cost-plus-fixed-fee (CPFF) contract for $13,675,896, enough to carry the program through 31 December 1960.[50]

(U) Meanwhile, design and development work in support of the prime contractor effort had been initiated at various Government installations. At the end of June 1960, $1,149,552 had been obligated for work on items to be furnished by the Government, increasing the RDTE outlay for FY 1960 to a total of $14,825,448. This brought the total project cost to $15,511,135 through 30 June 1960, some $559,983 having been spent in FY 1958 and $125,704 in FY 1959.[51]

(U) The initiation of MAULER development in early 1960 thus

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[47](1) MAULER Presentation to Staff Members of the House Armed Services Committee, 17-20 Oct 60. (2) Cl D&F atchd as incl to Ltr, CofOrd, thru CG, AOMC, to ARGMA Comdr, 25 Jan 60, subj: D&F for MAULER. MPCF, Bx 11-14, RHA.

[48]The Convair Division of General Dynamics, Pomona, California (Convair/Pomona) later became known as General Dynamics/Pomona (GD/P).

[49]TT, CO, LAOD, to Chf, Contrs Br, DCSLOG, DA, 1 Apr 60. MPCF, Bx 11-14, RHA.

[50]ARGMA Diary, 1 Jan - 30 Jun 60, pp. 85-86. (R&D Contract DA-04-495-ORD-1951 hereafter cited as Contract ORD-1951.)

[51]Of the total RDTE outlay for the FY 1958-60 period, about $141,012 was allocated to AOMC/ARGMA for program management and supervision, in-house studies, etc. See Add to MAULER TDP, MICOM, 10 Dec 65, pp. 10-12.

marked the beginning of the third and final phase of the Army's light antiaircraft program. It also foreshadowed the beginning of the end of the Phase II VIGILANTE weapon system which was being developed to provide the field army an interim forward area air defense capability. Work on the Phase I RADUSTER, it will be recalled, had been discontinued in February 1958, after the results of engineering and user tests indicated only marginal improvements in effectiveness over the standard M42 DUSTER.[52]

(U) Evidence of serious operational limitations in the VIGILANTE system had been noted by CONARC in July 1957 and again in September of that year; however, it then appeared that this advanced 37-mm. weapon would provide a major improvement over both the standard M42 DUSTER and the improved RADUSTER system. With the subsequent termination of the latter, the VIGILANTE received added support and its development was continued in the hope of providing an early replacement for the M42 DUSTER.

([redacted]) Beginning in early 1961—as the MAULER development effort entered its second year—the VIGILANTE program was hampered by low priority and a consequent lack of funds. Although it had been planned in 1957 to build eight R&D prototypes (four each of the towed and self-propelled models), only one pilot of each system was actually assembled. After undergoing extensive development and engineering tests over a period of some 3 years, these pilots were shipped to Fort Bliss, Texas, in February 1962, for service tests. It was concluded from the service evaluation that the VIGILANTE system was not sufficiently reliable, rugged, or stable to meet requirements of the forward area. With the termination of the Phase II effort in July 1963,[53] the VIGILANTE took its place on the shelf alongside the Phase I RADUSTER and the M42

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[52] See above, p. 31.

[53] TIR CD-1, Suppl III, AMC, Oct 1963, subj: Dev of AD Wpns, p. 14. RSIC.

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DUSTER, which had already been phased out of the active Army except for two lone batteries deployed in the Panama Canal Zone.[54]

[54] MAULER PCP 6.41.21.06.1-2, atchd as incl to DF, MAULER PM to CG, MICOM, 6 May 63, subj: MAULER PCP.

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CHAPTER III

([redacted]) PROGRAM MANAGEMENT AND ORGANIZATION (U)

(U) If proficient management at the operating level were the only prerequisite for a fully successful R&D program, the MAULER guided missile system no doubt would be in the field today. For unlike the development projects initiated at Redstone Arsenal during the early 1950's, the MAULER program was endowed with a dynamic command and management system that assured coherent guidance, clearly defined command channels, responsive local controls, and competent technical supervision. The ultimate success of a complex missile development program, however, requires something more than effective supervision, direction, and control at the field operating level. Decisions and guidance from higher authority must be firm and timely. Program objectives must be clearly defined and realistically planned. And financial support to meet those objectives must be prompt and adequate. Elaborating upon these fundamental principles of economy and good management, in July 1960, COL John G. Zierdt, then Commander of ARGMA and, as such, the MAULER Commodity Manager, said:

> . . . [A] prime condition which influences the effectiveness of management is the absolute necessity of establishing a goal, committing the authority and resources necessary to its realization, and then having the good sense to leave that part of the effort alone.
>
> . . . [Our] inability to obtain solid decisions is, I believe, the most singularly damaging influence and is the most difficult to cope with in any current missile endeavor. I call it "Stop-Start Philosophy." It permeates program funding, technical decisions, and in fact every phase of system activity. Since the days of Newton and Watt and Franklin, society has . . . promoted science from the ranks of things to be tolerated to a level of near adoration. Yet, in applying science to our defense needs, we continue to ignore a simple basic rule of management economy which surely even Adam understood, the absolute necessity of establishing a goal, then

stepping back and permitting the capable party charged with this responsibility to arrive at the desired solution.[1]

(U) From the very outset of the MAULER program, it was abundantly evident that the authority and resources essential for the efficient prosecution of the development effort would not be forthcoming. On the contrary, program guidance from higher headquarters was built around a dilatory, stop-start philosophy that flew in the face of both management economy and the 1A priority accorded the program. Each new fiscal year presented the weapon system manager with a new crisis, as program funding and planning fluctuated from one extreme to the other. There were frequent program reviews, reevaluations, and reorientations, as new technical problems arose and costs increased. The weapon system manager spent an inordinate amount of time preparing alternate proposals, justifying and rejustifying his program to an increasing number of committees, and pleading for guidance and decisions from higher headquarters.

(U) In the light of the unsolved technical problems and compromises in military characteristics, the claim that the development of the weapon system was within the current state of the art appears—on the surface, at least—to have been overly optimistic. It should be noted, however, that efforts to solve

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[1](1) Speech to the DODRE Plcy Council Mtg at Ft Monroe, Va., 6-8 Jul 60, pp. 7-8. (2) Colonel Zierdt served as Chief of Staff for AOMC from 31 March 1958 to mid-January 1960, when he became Deputy Commander of ARGMA (AOMC GO 2, 31 Mar 58; ARGMA GO 1, 16 Jan 60). He succeeded BG John G. Shinkle as ARGMA Commander on 21 June, and was promoted to the rank of brigadier general in December 1960 (ARGMA GO 32, 21 Jun 60; DA SO 293, 21 Dec 60). General Zierdt remained in command of ARGMA until 11 December 1961, when the Agency was merged with AOMC Headquarters (AOMC GO 96, 11 Dec 61). He then became Deputy Commanding General for Guided Missiles (AOMC GO 98, 11 Dec 61), a post he held until June 1962, when he went to Army Materiel Command Headquarters (DA SO 116, 18 May 62). General Zierdt became Commanding General of the Army Missile Command on 23 September 1963, received his second star on 1 January 1964, and retired from active duty on 30 June 1967 (MICOM GO 84, 23 Sep 63; DA SO 321, 31 Dec 63; MICOM GO 71, 29 Jun 67).

those problems were hindered by piecemeal funding and the lack of timely guidance on certain technical aspects of the system. For example, detailed technical requirements for the Battery Command Post and related ancillary items were not established until late 1962. These and other belated requirements not only made the MAULER weapon system more complex, but also accounted for most of the increase in development cost which more than tripled the original estimate.

(U) This chapter deals with the basic aspects of program management and organizational structure at the field operating level, and with the Government-contractor missions and relationships. Ordinarily, the broad topic of management would embrace appropriate treatment of budget and fiscal matters, as well as program guidance, plans, and schedules. However, as noted above, the problems encountered in these particular areas had a tremendous impact on the scope and momentum of the technical development effort, and were, in fact, partially responsible for the untenable situation that ultimately doomed the MAULER to oblivion. These managerial problems are therefore treated in the chapters dealing with implementation of the development program.

AOMC/ARGMA Management Structure

(U) For the first 2 years (1960-61), the responsibility for prosecution of the MAULER program rested with the AOMC Commander as weapon system manager. The Secretary of the Army had created the Army Ordnance Missile Command on 31 March 1958, and appointed as its head MG John B. Medaris[2] who had earned a notable reputation

[2](1) DA GO 12, 28 Mar 58; AOMC GO 1, 31 Mar 58. (2) MG August Schomburg succeeded General Medaris as Commanding General of AOMC on 1 February 1960 (AOMC GO 11) and remained in that post until late May 1962. MG Francis J. McMorrow assumed command of AOMC on 26 May 1962 (AOMC GO 63) and served in dual capacity as commander of the new Army Missile Command (MICOM) during its (continued)

for his dynamic administrative ability as Commander of the Army Ballistic Missile Agency (ABMA). Placed under General Medaris' direct control were ARGMA (established on 1 April 1958[3]); ABMA; Jet Propulsion Laboratory at Pasadena, California; White Sands Proving Ground (later renamed White Sands Missile Range--WSMR); and Redstone Arsenal. The integration of primary research, development, test, and logistical support activities under single direction, together with the administrative streamlining, provided the means to carry out more effectively the existing and future priority missile programs (see Chart 1). The AOMC was charged with management responsibility for assigned guided missiles, ballistic missiles, and rockets, including design, development, production, supply and maintenance, and certain training functions.[4]

(U) Until the general reorganization of December 1961, the ARGMA Commander performed the functions of commodity manager for the MAULER program under the direction of AOMC Headquarters. With the commencement of weapon system development in early 1960, he established a MAULER Section in the Air Defense Branch of the R&D Division, and appointed MAJ John G. Ransier as the Senior ARGMA Representative (SXR) at Convair's plant in Pomona, California.[5]

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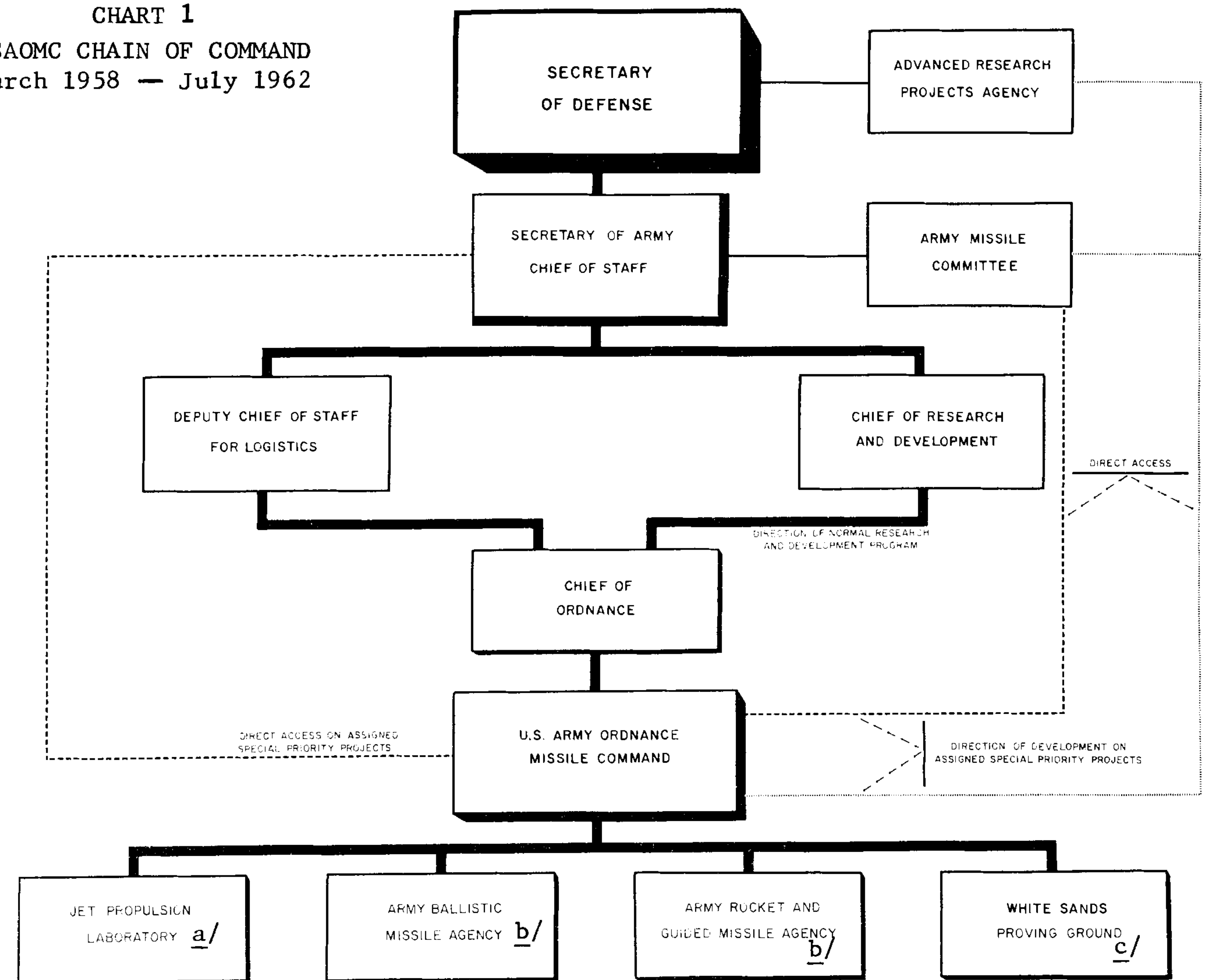
[2](cont) formative stage from 5 June 1962 (MICOM GO 2) to 1 August 1962, when AOMC became known as MICOM. General McMorrow remained in command of MICOM until his death on 24 August 1963 (AMC GO 47, 27 Aug 63). BG H. P. Persons, Jr., served as acting commander from 15 August 1963 (MICOM GO 74) until General Zierdt's arrival on 23 September 1963 (<u>see</u> footnote 1 above).

[3]<u>See</u> above, p. 29.

[4](1) OrdCorps Order 6-58, 31 Mar 58, subj: USAOMC. (2) OrdCorps Order 16-58, 1 Jul 58, subj: Msn of the USAOMC.

[5](1) DF, Chf, Con Ofc, ARGMA, to Chf, Con Ofc, AOMC, 17 Feb 60, subj: Org Chs - ARGMA. (2) DF, Cmt 2, Chf, Mgt Svcs Br, ARGMA Con Ofc, to Chf, R&D Div, 12 Feb 60, subj: Estb of a MAULER Sec, AD Br, R&D Div. (3) DF, Chf, Projs Ofc, ARGMA Con Ofc, to Civ Pers Ofc, ARGMA, 2 Feb 60, subj: Estb of SXR Ofc at the Aeronutronics Plant & Convair. (4) Ltr, ARGMA Comdr to CO, LAOD, 22 Mar 60, subj: Asgmt of ARGMA Fld Rep.

CHART 1
USAOMC CHAIN OF COMMAND
March 1958 — July 1962



a. Reasgd to NASA, 3 Dec 58 (TT, CofOrd to CG, AOMC, 3 Dec 58).

b. Abolished/merged with AOMC Hq 11 Dec 61 (AOMC GO 96, 5 Dec 61; DA GO 47, 26 Dec 61).

c. Renamed WSMR, 1 May 58 (DA GO 14, 19 Apr 58); Reasgd to OCO 1 Jan 62 (Ord Corps Order 16-58, Ch 5, 24 Nov 61).

Initially assigned to the Agency Control Office, Major Ransier served as senior spokesman and contact between ARGMA and the contractor. Matters relating to the formulation of new policy or the resolution of policy conflicts were handled through the Control Office for a coordinated Agency position. Other matters could be resolved directly with the mission element involved, but with a single representative in charge of the overall mission at the contractor's level, effective control and coordination of significant program actions was assured.[6]

(U) The Agency's field liaison personnel remained under the Control Office until 19 September 1960, when they were reassigned to mission operation level. Under the revised policy, operational control of SXR offices was vested in the national mission element having primary responsibility for the weapon system involved—in the case of the MAULER, R&D Operations. All liaison personnel were still appointed by the Agency Commander and they were still assigned to the respective contractor plants under supervision of a single SXR, as before. But the formulation of new policy or resolution of policy conflicts was no longer handled at agency staff level.[7]

(U) The centralized control thus lost under the functional realignment was supplanted by an internal commodity coordination procedure that had been established and implemented earlier in 1960. This procedure was designed to provide the Agency Commander with the supplementary control and coordination necessary to assure integrated commodity managership. It consisted of individual weapon system teams composed of one member from each of the mission operations and one Control Office member who served as chairman.[8]

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[6] ARGMA Cir 7 (later renumbered 600-1), 28 Jun 58, subj: ARGMA Ln Pers at Contrs' Plants & Govt Instls. See also ARGMA Hist Sum, 1 Apr - 30 Jun 58, pp. 37-38.

[7] ARGMA Cir 600-1, revised 19 Sep 60.

[8] ARGMA Cir 1-2, 12 May 60, subj: Agcy Cmdty Coord.

Members of the MAULER team, as of 16 August 1960, were: Mr. Fred Sittason, chairman, CAPT H. D. Mitman (R&D), Mr. J. R. Turner (Industrial), and CAPT H. W. Strohm (Field Service).[9]

The MAULER Project Manager

(U) In early October 1961, the Army Chief of Research and Development directed the establishment of project managership for the MAULER weapon system. This was no reflection on the performance of the AOMC/ARGMA team, but merely an extension of the new project management concept which had been established earlier in 1961 at the behest of the Secretary of Defense. Among the criteria used in the selection of a weapon system for project managership were: the need for accelerating the decision-making process; significant interest in the system expressed by the Congress, the President, or the Secretary of Defense; the essentiality of the item to the Army mission; the high dollar value of the system; or the presence of major managerial or technical problems.[10] That the MAULER project met virtually all of these criteria can be seen from the observations made earlier in this chapter. Moreover, the need for an early MAULER capability was rapidly becoming more critical with the continued loss of momentum in the VIGILANTE development program.[11]

(U) The project manager offices initially established under the new management concept had been physically located in OCO. However, MG H. F. Bigelow, then the Deputy Chief of Ordnance, recommended that the Office of the MAULER Project Manager be placed at AOMC Headquarters where it would be staffed with technical and

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[9] ARGMA Cir 1-2, Ch 3, 16 Aug 60.

[10] Raymond J. Snodgrass, The Concept of Project Management (AMC Hist Ofc, 1964), pp. 89, 92.

[11] See above, pp. 55-56.

managerial personnel to direct the prosecution of the program. The Project Manager would report directly to the Commanding General of AOMC on all matters within the latter's authority, but he would also have direct access to the Chief of Ordnance on all matters relating to decision and information appropriate to the Chief of Ordnance or higher level.[12]

(U) According to Ordnance Corps Order 1-62, dated 3 January 1962, the Office of the MAULER Project Manager was established in AOMC Headquarters effective 16 October 1961; however, it apparently did not become operational until 1 December 1961, when COL B. J. Leon Hirshorn assumed the duties of MAULER Project Director at ARGMA.[13] Ten days later, on 11 December 1961, ARGMA was abolished as a separate agency and its functions were absorbed by AOMC Headquarters. At that time, the MAULER-REDEYE Project Office was established under the newly formed Office of the Deputy Commanding General, Guided Missiles (DCG, GM).[14] Colonel Hirshorn was named MAULER-REDEYE Project Manager effective 12 December 1961.[15]

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[12] SS, Dep CofOrd to CofS, DA, 7 Dec 61, subj: Estb of Ofc of PM, MAULER; & incl thereto, Draft of OrdCorps Order, subj: Ofc of PM, MAULER. (The latter document contained the proposed mission and functional statement which was later approved and published in Ordnance Corps Order 1-62, dated 3 January 1962.)

[13] (1) ARGMA GO 22, 1 Dec 61, subj: Proj Dir, MAULER. (2) The Summary Sheet cited in the foregoing footnote states that OCRD, on 27 October 1961, approved OCO's nomination of Colonel Hirshorn as MAULER Project Manager. At that time, Colonel Hirshorn was Deputy Commander of ABMA, a post he held until 1 December 1961, when he was reassigned to ARGMA (AOMC SO 143, 24 Nov 61; also see Hist of ABMA, 1 Jul - 11 Dec 61, p. 8). On 11 January 1962, AOMC issued an order (GO 2) assigning Colonel Hirshorn as MAULER Project Manager retroactive to 16 October 1961; however, this was apparently a paper assignment made to agree with the effective date shown in the Ordnance Corps order of 3 January 1962.

[14] (1) AOMC GO 96, 5 Dec 61, subj: Reorg of USAOMC. (2) The DCG, GM was later redesignated as Deputy Commanding General, Air Defense Systems (DCG, ADS). MICOM GO 43, 3 Oct 62.

[15] AOMC GO 99, 13 Dec 61.

(U) Mr. Lewis L. Gober succeeded Colonel Hirshorn as Acting MAULER Project Manager on 13 June 1962.[16] Some 6 weeks later, on 31 July, that portion of the project office relating to the REDEYE weapon system was transferred to the newly established Office of the REDEYE Product Manager.[17]

(U) Meanwhile, on 23 May 1962, the U. S. Army Missile Command (MICOM) was created at Redstone Arsenal as a subordinate element of the new U. S. Army Materiel Command (AMC), which assumed responsibility for those functions assigned to the Chief of Ordnance. The MICOM existed with a skeleton staff until 1 August 1962, when it absorbed all the elements and functions of AOMC.[18]

(U) Immediately following the Army reorganization, the MAULER Project Office was realigned in accordance with the AMC concept of centralized management and established as a separate Table of Distribution (TD) unit under the Deputy Commanding General, Air Defense Systems (DCG, ADS). Since its establishment in December 1961, the MAULER Project Office had operated under a decentralized management concept; i.e., it had a very small staff of around six people[19] who controlled and coordinated the program activities conducted by the three national mission elements. The centralized

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[16] AOMC GO 78, 5 Jul 62.

[17] (1) AOMC GO 87, 30 Jul 62. (2) Product Manager Offices were redesignated as Commodity Offices effective 22 October 1962. MICOM GO 54, 5 Nov 62.

[18] (1) AMC GO 4, 23 May 62. (2) DA GO 46, 25 Jul 62. (3) MICOM GO 5, 30 Jul 62. (4) DA GO 57, 27 Sep 62. (5) For a detailed history of the reorganization, see AOMC Smanl Hist Sum, 1 Jan - 30 Jun 62; MICOM Anl Hist Sum, FY 1963; and AMC Anl Hist Sum, FY 1963.

[19] This was equivalent to the previous ARGMA Control Office project staff. For example, of the 73 civilian manpower spaces allocated to the MAULER project on 30 June 1961, 6 were assigned to the Control Office staff and the remaining 67 were distributed among the national mission elements. ARGMA Rept, "Civilian Manpower Allocated by Missile System as of 30 June 1961," n.d.

project management concept (see Charts 2 and 3) stressed maximum integration of the total effort in order to make the best possible use of limited resources, and at the same time attain a high order of stability. It necessarily entailed maximum use of the functional directorates for operational support, but the Project Manager possessed the authority, resources, and capability within his own office for the centralized management, direction, control, and monitorship of the total effort. This included all phases of research, development, test, procurement and production, distribution, and logistic support for the purpose of maintaining a balanced program to accomplish the stated objectives of the Army Materiel Command.[20]

(U) The task of staffing the expanded organization with competent management and engineering talent fell to COL Norman T. Dennis who joined the office as MAULER Project Manager on 20 September 1962.[21] By 31 December, his staff had grown from a skeleton crew of 6 to a total of 66 (8 officers, 58 civilians), against an initial TD authorization of 77 (6 officers, 71 civilians).[22] During 1963, when the MAULER program suffered its greatest setback, AMC Headquarters increased the TD authorization to 132, and at the end of that year the assigned strength stood at 108.[23] The project office staff also included 10 British and 3 Canadian officers who were participating in the management, development, and evaluation of the MAULER weapon system under a pact with the United Kingdom. These foreign representatives joined the

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[20] MICOM Reg 10-2, Sec 1100, 15 Mar 63.

[21] AMC SO 15, 13 Aug 62. (Lewis L. Gober, who had served as acting manager since 13 June 1962, became the Deputy MAULER Project Manager and remained with the program until its termination.)

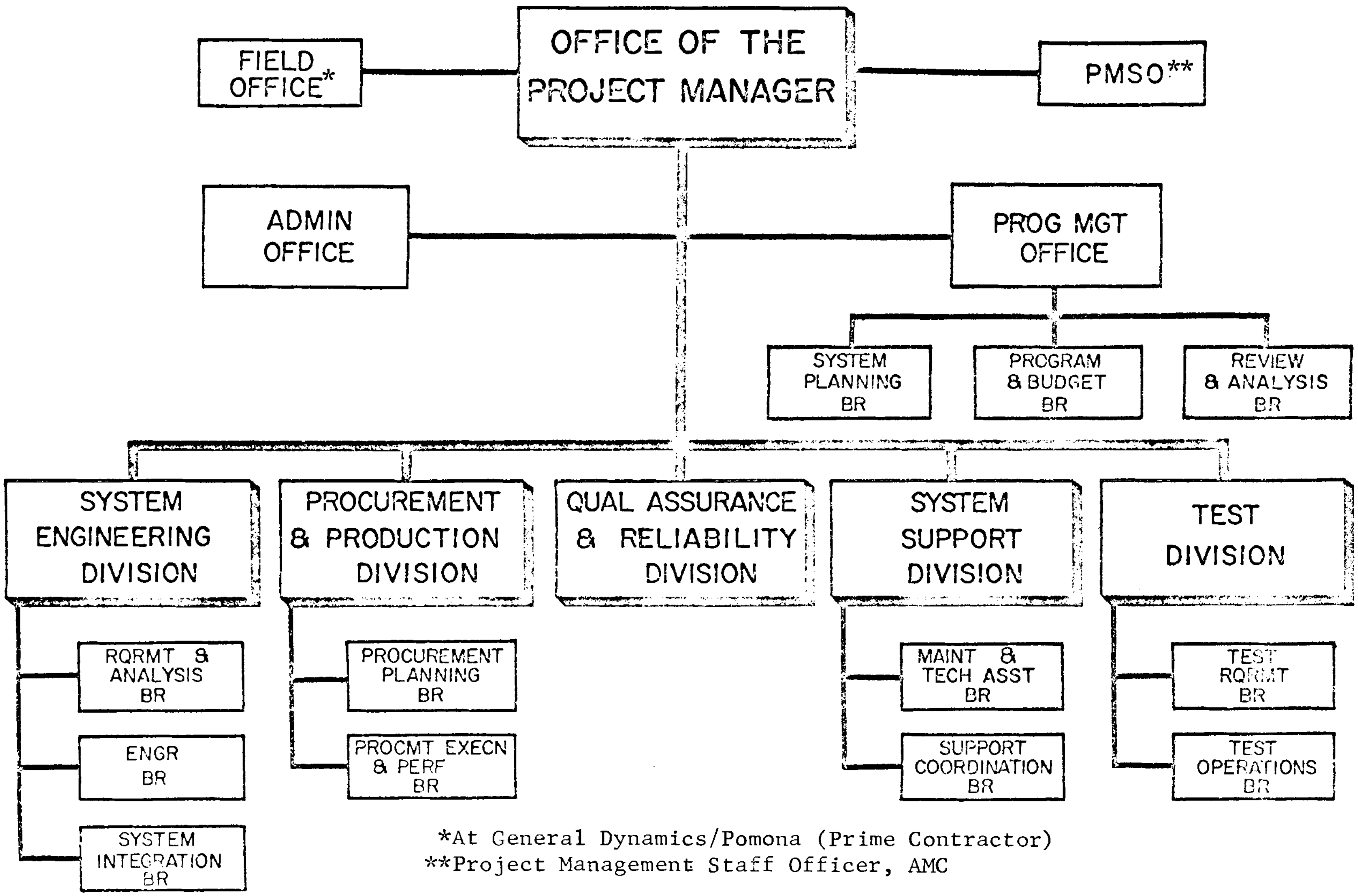
[22] (1) MICOM Pers Status, 31 Dec 62. (2) Hist Rept, MAULER Proj Ofc, 1 Jul - 31 Dec 62, p. 1.

[23] (1) MICOM Pers Status, 31 Dec 63. (2) MICOM Anl Hist Sum, FY 1964, pp. 15, 51.

APPROVED:
DATE 15 MARCH 1963
HOWARD P. PERSONS, JR.
Brigadier General, USA
Commanding

US ARMY MISSILE COMMAND
MAULER PROJECT MANAGER

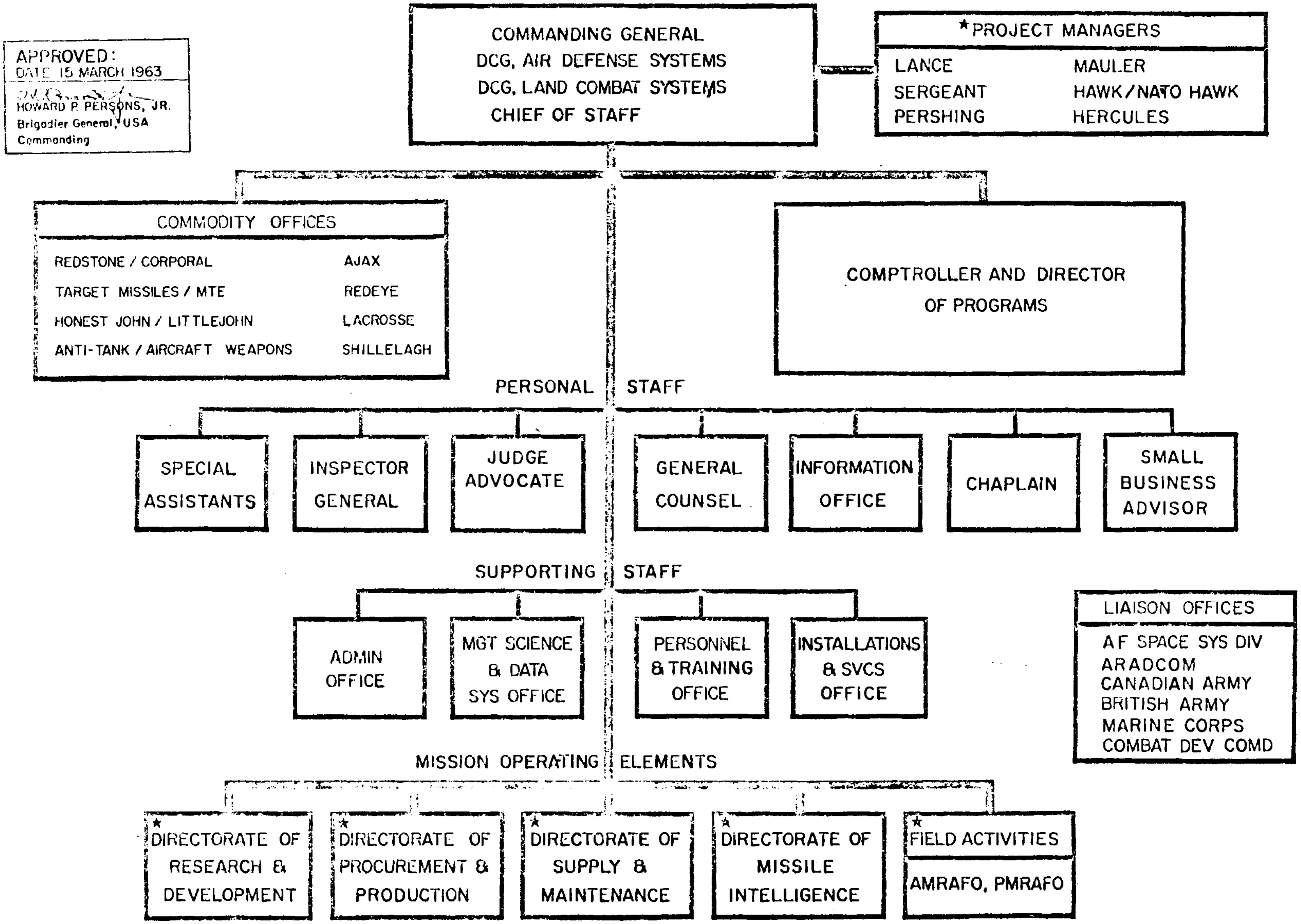
CHART 2



*At General Dynamics/Pomona (Prime Contractor)
**Project Management Staff Officer, AMC

HEADQUARTERS, U.S. ARMY MISSILE COMMAND

CHART 3



**SEPARATE ELEMENTS CARRIED AS SEPARATE T/D'S.*

MAULER project staff at MICOM in 1963, following a decision by the United Kingdom to abandon development of its own forward area air defense system known as the PT-428.[24]

(U) COL Bernard R. Luczak, who succeeded Colonel Dennis as Project Manager on 12 February 1964,[25] steered the program through the final agonizing reappraisals and ultimate termination. In mid-1964 the project office had a peak assigned strength of 123, including 110 U. S. Army personnel and 13 British-Canadian officers. The latter personnel were not chargeable against the office's TD authorization, which had been reduced by 15 spaces, from 132 to 117.[26]

Government-Contractor Missions and Relationships

(U) The primary responsibility for development of the MAULER weapon system rested with the Army Missile Command team at Redstone Arsenal, Alabama. Within the context of the integrated management philosophy just described, the weapon system manager's authority and responsibility embraced the control of resources; formulation of program plans and schedules; technical control, supervision, and coordination of project activities at contractor plants and supporting Government installations; maintenance of competent in-house engineering talent and facilities for effective technical supervision and evaluation of the contractors' performance; and the maintenance of continual liaison with the user and other Army technical services to insure compatibility of the system with

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[24](1) Hist Repts, MAULER Proj Ofc, 1 Jan - 30 Jun 63, pp. 8-9; 1 Jul 63 - 30 Jun 64, p. 1. (2) For further details relating to British and Canadian participation in the MAULER program, see below, pp. 84-86, 92-96.

[25]MICOM GO 14, 11 Feb 64.

[26](1) MICOM Pers Status, 30 Jun 64. (2) Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, pp. 1-2.

established military requirements and objectives.

(U) In its role as prime contractor, the Convair Division of General Dynamics—or GD/P, as it was later known—had responsibility for the design, development, and test of the complete weapon system and for furnishing detailed drawings and specifications for use by Government agencies and contractors participating in the program. Implicit in the prime contractor's mission was the responsibility for general supervision, technical direction, and coordination of the overall development effort. The working relationships among AOMC/ARGMA, GD/P, and the supporting military services were delineated in the prime contract and in formal agreements between the weapon system manager and the respective military commands concerned with items of Government-furnished equipment (GFE).

Technical Control of the Vehicle-Pod Contractor

(U) The precedent for the ground rules governing relationships between the prime contractor and the military was set during the negotiation of the definitized R&D contract. It grew out of a dispute over the contractual and technical control of the MAULER vehicle, one of the key GFE items. As the commodity command having national mission responsibility for development and procurement of all automotive items for Army missile systems, OTAC insisted that it must be given full authority and responsibility for providing vehicles for the MAULER.[27] Under the terms thus proposed for Convair's R&D contract, OTAC would have complete responsibility for technical supervision and control of the vehicle contractor (Food Machinery & Chemical Corporation), and Convair would work with OTAC on design of the item rather than directly with the contractor. In early April 1960, COL Paul H. Scordas, Commanding

[27] Ltr, CG, OTAC, to ARGMA Comdr, 15 Jan 60, subj: MAULER Instl on M113 Vehs. MPCF, Bx 11-14, RHA.

Officer of LAOD, advised General Shinkle that Convair objected to this procedure on the grounds that it would compromise the company's position and responsibility as prime contractor. Convair argued that such a procedure would cause additional administrative and control difficulties, and that it should be allowed to work independently and directly through a subcontractor relationship with full managerial responsibility for the program. In a letter to LAOD, Convair emphasized the extreme importance of having the MAULER pod structure and the vehicle hull designed, constructed, and procured from the same source, and insisted that it be given contractual and technical control of that source.[28]

(U) The basic T113 tracked vehicle proposed as the MAULER weapon carrier had been developed by the Food Machinery & Chemical Corporation (FMC) under contract with OTAC, and that same company had been Convair's subcontractor for the vehicle-pod design during the feasibility study.[29] Consequently, there was no question that FMC represented the only logical source for both the weapon pod and vehicle in the MAULER development program. In view of the interface problems involved in the design of these closely related items and the fact that the prime contractor would be held responsible for the compatibility of the end product, Convair's objections to the split responsibility were not without merit. Moreover, such a split would tend to complicate FMC's task, in that it would be placed in the unpalatable position of serving two masters; i.e., Convair for the weapon pod structure and OTAC for the vehicle. On the other hand, OTAC's participation in the program was both desirable and essential, not only because of its technical knowledge and specialized skills in the automotive field, but also because

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[28] SS ORDXR-RHA-181, ARGMA Comdr to CG, AOMC, 20 Apr 60, subj: Mgt of MAULER Program; & incl thereto, TT, CG, AOMC, to CofOrd, 22 Apr 60. MPCF, Bx 13-649, RHA.

[29] See above, p. 35.

of the need to assure maximum use of standard Ordnance components and spare parts.

(U) In resolving the dispute, the ARGMA Commander had two basic alternatives. He could apply the traditional prime contractor concept, whereby Convair would have full responsibility for the entire system (including support vehicles and ground equipment), with OTAC serving in an advisory capacity; or he could apply the breakout doctrine and assign development responsibility for the vehicle to OTAC, as originally planned. The approach finally adopted was actually a modified form of the latter.

(U) Following a discussion of the matter, General Shinkle and the Commanding General of OTAC agreed that the vehicle for the system would be a modified M113 tracked carrier and that the vehicle modification would be accomplished by FMC. To preclude a cumbersome management procedure and to keep the interface problems at a minimum, they further agreed that Convair would have direct access to FMC with respect to vehicle-pod requirements; however, OTAC would maintain complete control of the vehicle design except in cases involving interface problems. If a problem should arise that could not be mutually resolved, it would be referred to ARGMA for final decision. The entire vehicle effort would be funded through OTAC, and work on the pod structure would be performed under a subcontract with Convair.[30]

<u>Selection of the Motor Contractor</u>

[redacted] Meanwhile, personnel of the ARGMA R&D Division, in coordination with Convair, formulated the technical requirements for the MAULER rocket motor, preparatory to the solicitation of

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[30]Ltr, ARGMA Comdr to CG, OTAC, 4 May 60, subj: OTAC Part in the MAULER Program, & 1st Ind thereto, CG, OTAC, to ARGMA Comdr, 20 May 60. MPCF, Bx 11-14, RHA.

contractor proposals. In late April 1960, they invited 11 prospective contractors[31] to submit development proposals based on the following technical requirements:

Ballistic Requirements:
- Average Thrust - 8,550 lbs at 70°F.
- Maximum Thrust - 12,000 lbs at 160°F.
- Total Impulse - 11,200 lbs sec at 70°F.

Weight Limitations:
- Loaded Weight - 61.9 lbs (less wings)
- Propellant Weight - 45.0 lbs
- Expended Weight - 16.9 lbs (less wings)

Environment:
- Operating - -65 to +160°F.
- Storage - -65 to +130°F.

Reliability - 99.9%

The program schedule for initial flight tests called for Launch Test Vehicle firings to begin on 1 March 1961; Control Test Vehicle firings, on 1 July 1961; and Guidance Test Vehicle firings, on 1 September 1961. The development and delivery schedules to be considered in the motor proposals were therefore as follows:

	Item	Delivery Schedule
1.	Research and Development	Jul 60 - Feb 61
2.	R&D Motors (28)	Nov 60 - Jun 61
3.	Pre-Qualification (30 firings)	Mar 61 - May 61
4.	Engineering Prototypes (52)	Jul 61 - Jul 62
5.	Final Qualification (60 firings)	Feb 62 - Jun 62
6.	Production Prototypes (95)	Aug 62 - Jun 63
7.	Production Motors (17,800)—100 per month for 25 months; 200 per month for 25 months; 400 per month for 25 months.	
8.	Production Tooling to support Item 7.	

([redacted]) All of the prospective contractors submitted proposals except the Rohm & Haas Company, which declined to bid. Personnel of Convair and ARGMA conducted independent evaluations, and both

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[31] Aerojet-General Corp; Atlantic Research Corp; B. F. Goodrich Aviation Products; Grand Central Rocket Co; Hercules Powder Co; Olin Mathieson Chemical Corp; Picatinny Arsenal; Rocketdyne; Rocket Power, Inc; Rohm & Haas Co; and Thiokol Chemical Corp.

groups picked the Grand Central Rocket Company's proposal as the best of the top three. (They ranked Thiokol's proposal as second, and Olin Mathieson's third.) Grand Central proposed a nitrosol or a plastisol double base propellant in a full-length slotted tube grain, and a motor case design using ultra-high yield strength material.[32]

(U) The Chief of Ordnance, on 3 June 1960, approved the selection of the Grand Central Rocket Company to develop the MAULER rocket motor as a subcontractor to Convair.[33] Shortly thereafter, LAOD completed contractual actions with Convair, and development of the rocket motor was begun on schedule.

Responsibility for Training Devices

(U) Although training devices represented a relatively minor portion of the weapon system, they were a source of grave concern to AOMC because of the problems resulting from the divided mission responsibility. Under existing Army regulations, CONARC had primary development responsibility for training devices, with the actual work being done by the Naval Training Device Center (NTDC); and AOMC was responsible for the procurement, production, and field support of the equipment. As a result of this unwieldy procedure, AOMC had experienced serious problems and delays in several of its major missile programs,[34] and it was determined that the MAULER should not fall victim to the same malady.

(U) In consonance with the single weapon system manager

[32] (1) Eval Rept, MAULER Rkt Mtr Ppsls, 27 May 60. (2) TT, ORDXR-RHA-792, ARGMA Comdr to CofOrd, 2 Jun 60. Both in MPCF, Bx 13-649, RHA.

[33] TT, CofOrd to ARGMA Comdr, 3 Jun 60. File same.

[34] See, for example, Mary T. Cagle, History of the LITTLEJOHN Rocket System, 1953-1966 (MICOM, 12 May 67), pp. 164-67.

concept, the Commanding General of AOMC, in June 1960, recommended that an exception be made to the provisions of AR 350-15, and that his Command be assigned complete responsibility for the development, procurement, and support of MAULER training devices. The CONARC, while relinquishing its development responsibility, would retain control over the program through participating in the feasibility study and the determination of requirements, continuous monitoring of the development effort, and service testing the end item.[35]

(U) The Director of R&D Operations at ARGMA completed a proposed plan for the integrated program in August 1960,[36] but later shelved it when CONARC announced that the MAULER training device would be developed by NTDC in accordance with established procedure. As an alternate measure, MG August Schomburg, Commander of AOMC, made arrangements with CONARC for an AOMC team to visit the NTDC contractor at key stages of development and to participate in the engineering test program. In addition, NTDC was to incorporate documentation requirements in the R&D contract, and representatives of AOMC's industrial and field service elements were to participate in the in-process reviews of the program.[37]

The Ordnance-Signal Corps Controversy

(U) The Signal Corps items to be supplied for the MAULER fire unit embraced the communication-electronics system and IFF (identification, friend or foe) equipment. Under the support plan

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[35] Ltr, CG, AOMC, to CG, CONARC, 16 Jun 60, subj: Auth for Dev of MAULER Tng Devices, atchd as incl to Ltr, CG, AOMC, to ARGMA Comdr, same date and subj.

[36] SS ORDXR-RHA-244, Dir, R&DO, to ARGMA Comdr, 2 Aug 60, subj: Auth for Dev of MAULER Tng Devices; & incl thereto, 1st Ind, ARGMA Comdr to CG, AOMC, 2 Aug 60, on Ltr, CG, AOMC, to ARGMA Comdr, 16 Jun 60, subj: same.

[37] Ltr, MG August Schomburg to GEN Herbert B. Powell, CG, CONARC, 27 Mar 61, n.s.

proposed by General Schomburg and concurred in by MG H. F. Bigelow, the Deputy Chief of Ordnance, the commodity manager (ARGMA) would provide funds for development of the communication-electronics system, and the Signal Corps would fund for the development of IFF equipment and for the vulnerability studies to be conducted by the U. S. Army Signal Missile Support Agency (USASMSA). Technical supervision of the prime contractor's effort concerned with the communication-electronics system would be provided by an agency to be designated by the Chief Signal Officer. The designated technical supervisor, subject to the management control of the commodity manager, would prepare detailed specifications for the equipment and provide technical direction over the prime contractor to assure compatibility of the equipment with the MAULER fire unit. The appropriate Signal Corps agency would develop IFF equipment compatible with the weight and space requirements of the fire unit, subject to approval by the weapon system manager. The AOMC Signal Officer would act as the agent of the weapon system and commodity managers for overall coordination of the program, with technical coordination being effected directly between the commodity manager and the designated Signal Corps agencies.[38]

(U) MG R. T. Nelson, the Chief Signal Officer, concurred in all aspects of the proposed coordination and management procedure with exception of the funding arrangements for IFF equipment. Funds for this equipment, he argued, should be included in the overall system funding and not placed in competition with unrelated items. General Nelson advised that the U. S. Army Signal R&D Laboratory (USASRDL), Fort Monmouth, New Jersey, would be his authorized agent to exercise technical supervision over the development of Signal equipment for the MAULER, and that the Laboratory

[38] Ltr, CG, AOMC, thru CofOrd, to CSigO, 6 Jul 60, subj: SigC Spt of the MAULER Msl Sys FU; & 1st Ind thereto, Dep CofOrd to CSigO, DA, 1 Aug 60.

would have full responsibility and authority to act for him consistent with the funds to be provided by AOMC or other sources.[39]

(U) In early October 1960, General Bigelow advised AOMC that its proposed support plan was approved, but that a final agreement was yet to be reached on RDTE funding for IFF equipment. Referring to General Nelson's opposition to the proposed funding arrangement, he noted that RDTE funds for that purpose were not available and that none had been requested through Ordnance channels. Before agreeing to assume this responsibility, he said, "I feel that we must receive staff assurance that the additional funds required for the development will be available on a timely and continuous basis . . . . Any other course of action could lead to still further shortages in our critical RDT&E funds." Meanwhile, AOMC was to implement that portion of the plan dealing with the communication-electronics system and initiate technical coordination with USASRDL for the development of a repackaged IFF system that would be compatible with the space and weight limitations of the MAULER fire unit.[40]

[redacted] Although a firm decision had not been made on the specific IFF system to be used in the MAULER, the developing agencies announced in early October 1960 that the fire unit was being designed to be electronically compatible with the Mark XII IFF system, and that 2 cubic feet of space and 200 pounds of weight were being allowed for that purpose. Convair, AOMC, USASRDL, and CONARC all agreed that it was both feasible and desirable to develop a miniaturized version of the Mark XII system for the MAULER fire unit. They also agreed that such equipment should be developed concurrently with the rest of the MAULER system.[41] There the points

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[39] 2d Ind, CSigO to CofOrd, 31 Aug 60, on Ltr cited in fn 38.

[40] 3d Ind, Dep CofOrd to CG, AOMC, 4 Oct 60, on Ltr cited in fn 38.

[41] Ltr, CG, CONARC, to CSigO, 17 Nov 60, subj: IFF for MAULER.

of agreement ended and 2 years of disagreement and indecision set in.

(U) The Ordnance-Signal Corps dispute over funding responsibility stemmed primarily from the fact that IFF equipment was a general use item specified jointly by the three services and, as such, was not unique to any specific weapon system or aircraft. Since the Signal Corps was the responsible agency of the Army for this tri-service effort, General Bigelow contended that it should assume primary development and funding responsibility for MAULER IFF equipment. In mid-December 1960, he advised the Chief Signal Officer and the Commanding General of AOMC that funds for minor modification to adapt the IFF equipment to MAULER would be made available through Ordnance, but reiterated that RDTE funding for the overall program was the Signal Corps' responsibility and definitely would not be a part of his weapon system budget request.[42] This official Ordnance position had been established in coordination with AOMC and had been fully concurred in by General Schomburg.[43] The Chief Signal Officer, however, refused to be moved from his originally stated position. Writing OCO in late December, he declared that the development of IFF equipment was a vital, indivisible part of the MAULER program and funding for it should be included in the overall weapon system budget.[44]

(U) Shortly thereafter, an intra-Ordnance dispute erupted when the OCO hierarchy blamed AOMC for the prevailing difficulties on the grounds that it had not properly informed the Signal Corps of the requirements for the MAULER program. Harking back to the

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[42] Ltr, Dep CofOrd to CG, AOMC, 13 Dec 60, subj: SigC Spt of the MAULER Msl Sys FU Program; & incl thereto, DF, Dep CofOrd to CSigO, same date and subj.

[43] Ltr, CG, AOMC, to CofOrd, 3 Nov 60, subj: SigC Spt of the MAULER Msl Sys FU Program.

[44] DF, Cmt 2, CSigO to CofOrd, 29 Dec 60, subj: SigC Spt of the MAULER Msl Sys FU Program.

"great deal of effort" that had gone into attempts to "straighten out the funding and development responsibility," General Bigelow chided the Command for what he termed "this waste of effort [which] could have been avoided if the Signal Corps had participated more in the early formative stages of the development of MAULER."[45] If there was in fact any wasted effort involved in the handling of the program, it undoubtedly resulted from this buck-passing exercise, which accomplished absolutely nothing at the expense of much unnecessary paperwork. General Schomburg unequivocally refuted the charge in a lengthy chronology showing that Signal Corps agencies had actively participated in the MAULER program since November 1958 (the month before receipt of the four feasibility study reports), and further, that they were fully aware of and had helped to formulate the requirements for Signal equipment. He asserted that the program had been handled in strict compliance with established OCO policies, and that changes in current coordination procedures were neither contemplated nor necessary.[46]

(U) LTG Arthur G. Trudeau, then the Army Chief of R&D, settled the Ordnance-Signal Corps funding dispute in early July 1961. While recognizing OCO's overall management responsibility for the MAULER weapon system, he ruled that the Chief Signal Officer was responsible for developing IFF equipment and therefore RDTE funds would be furnished directly to that agency from other sources. He emphasized, however, that the specific IFF system to be incorporated in the

[45]Ltr, Dep CofOrd to CG, AOMC, 3 Feb 61, subj: SigC Part in Ord Msl Sys, atchd as Tab B to SS ORDXM-R-249, ACofS, R&D, to CG, AOMC, 7 Mar 61, subj same.

[46]1st Ind, CG, AOMC, to CofOrd, 7 Mar 61, on above ltr, atchd as Tab A to SS ORDXM-R-249. The chronology (Incl 3 to 1st Ind) outlined 39 separate actions (correspondence, conferences, briefings, visits, telephone conversations, etc.) with Signal Corps agencies during the period November 1958 to November 1960. Nearly half of these actions (15, to be exact) predated AOMC's proposed Signal Corps support plan of July 1960.

MAULER still had not been determined, and that RDTE funds would not be authorized until the Joint Chiefs of Staff (JCS) reached a final decision regarding joint operational implementation of the Mark XII IFF system.[47]

(U) When the JCS decision finally came 15 months later, in October 1962, the offices of both the Chief of Ordnance and the Chief Signal Officer had been abolished and their functions and installations had been reassigned to the newly organized Army Materiel Command.[48] In consonance with the realigned Army management structure, OCRD, on 30 October 1962, furnished RDTE funds for the MAULER IFF equipment directly to GEN F. S. Besson, Jr., Commanding General of AMC. General Besson then authorized the U. S. Army Electronics Command (USAECOM) to begin work on the equipment, and furnished the MAULER Project Manager at MICOM an information copy of the action.[49]

(U) The developing agencies, meanwhile, had continued preliminary studies of the miniaturized IFF package for the MAULER fire

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[47] DF, Cmt 2, CRD/R-27312, CRD, DA, to CofOrd, 5 Jul 61, subj: IFF & Other Equip for MAULER. MPCF, Bx 13-649, RHA.

[48] The reorganization of 1 August 1962 removed the statutory status of the Chief of Ordnance and the Chief Signal Officer, the former being eliminated outright and the latter being retained as a special staff office with responsibility for Army-wide communications and photographic services. All other elements of the Signal Corps were reassigned to AMC Headquarters, whose major commands consisted of MICOM; Army Electronics Command, Fort Monmouth, N. J.; Army Mobility Command, Detroit Arsenal, Centerline, Mich.; Army Munitions Command, Picatinny Arsenal, Dover, N. J.; Army Supply & Maintenance Command, Washington, D. C.; Army Test & Evaluation Command, Aberdeen Proving Ground, Md.; and Army Weapons Command, Rock Island Arsenal, Ill. For further details, <u>see</u> DA GO 46, 25 Jul 62, subj: Trfs of Instls & Actvs to the USAMC; and DA GO 57, 27 Sep 62. <u>Also</u> <u>see</u> above, p. 65.

[49] 3d Ind, CRD/R-12133, OCRD, DA, to CG, AMC, 30 Oct 62, and 4th Ind, CG, AMC, to CG, USAECOM, 3 Dec 62, on Ltr, CO, USASRDL, to CG, USAECOM, 21 Aug 62, subj: IFF for MAULER Msl Sys. MPCF, Bx 13-649, RHA.

unit. Convinced that the Mark XII was the only IFF system that would permit the tactical potential of the MAULER to be fully realized, they had designed the engineering model of the fire unit to be electronically compatible with the Mark XII, and had established preliminary data as to the size and weight of the equipment. In addition, the USASRDL had obtained an acceptable development proposal for the MAULER IFF package from the Hazeltine Corporation, which was developing the tri-service Mark XII system under a Signal Corps contract.[50] This advance planning and ground work enabled the USAECOM to expedite contractual actions, and the Hazeltine Corporation began work on the program definition phase early in 1963. As then planned, the Mark XII IFF package for the MAULER fire unit would be procured through USAECOM as an item of Government-furnished equipment to General Dynamics/Pomona.[51]

Working Agreement with the Corps of Engineers

(U) Aside from a minor dispute over component development responsibility, the negotiation of a mutually agreeable working arrangement between AOMC/ARGMA and the Office of the Chief of Engineers (OCE) presented no problem. The MAULER components falling within the R&D and logistical support missions of the Corps of Engineers (CE) embraced the functional items of power generation, air conditioning, heating and ventilating, and land navigation equipment.

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[50](1) Ltr, DCG,GM, AOMC, to CofOrd, 8 Mar 62, subj: MAULER Monthly Prog Rept for Feb 1962. (2) Sum, Mark XII-IFF for MAULER Wpn Sys, 6 Aug 62, atchd as incl to Ltr, CO, USASRDL, to CG, USAECOM, 21 Aug 62, subj: IFF for MAULER Msl Sys. Both in MPCF, Bx 13-649, RHA.

[51](1) Ltr, COL Norman T. Dennis, MAULER PM, to CG, AMC, 17 Dec 62, subj: MAULER IFF Problem. (2) 5th Ind, CG, USAECOM, to CO, USAERDA, 8 Jan 63, on Ltr, CO, USASRDL, to CG, USAECOM, 21 Aug 62, subj: IFF for MAULER Wpn Sys. Both in MPCF, Bx 13-649, RHA.

(U) Because of the complexity and compactness of the weapon pod design and the consequent severe limitations imposed on the weight, volume, and technical characteristics of the CE components, AOMC proposed that the primary development responsibility be retained by the prime contractor until the design was essentially proven. The appropriate CE agencies would actively participate in the program as technical supervisors of the contractor's effort, with overall supervision and control being exercised by ARGMA.[52] LTG E. C. Itschner, the Chief of Engineers, initially indicated full concurrence in AOMC's proposal;[53] however, a draft working agreement later prepared by his office reflected an entirely different view in the area of development responsibility. Under his proposal, OCE, under the overall supervision of ARGMA, would assume complete authority and responsibility for design and development of the items and furnish them as GFE to the prime contractor, which would be held responsible for system compatibility and the input of technical and dimensional requirements.[54]

(U) Representatives of AOMC, ARGMA, OCO, OCE, and the Engineer R&D Laboratories (ERDL) met in General Itschner's office early in February 1961 to resolve their differences and formalize the essential responsibilities and staff relationships for effective support of the program. The working agreement reached during that meeting and published later in February generally conformed to the terms of AOMC's initial proposal. During the R&D phase—i.e., until the design release review of the weapon system, or a date to be specified

[52]Ltr, CG, AOMC, thru CofOrd, to CofEngrs, 16 Jun 60, subj: CE Spt of the MAULER Msl Sys. MPCF, Bx 11-14, RHA.

[53]2d Ind, CofEngrs to CofOrd, 15 Aug 60, on above ltr.

[54]Ltr, CofEngrs, thru CofOrd, to CG, AOMC, 14 Sep 60, subj: CE Spt of the MAULER Msl Sys; & incl thereto, Draft Working Agrmt Governing the Dev of CE Items for the MAULER Wpns Sys, atchd to 3d Ind, CofOrd to CG, AOMC, 4 Oct 60, on Ltr cited in fn 52. MPCF, Bx 11-14, RHA.

by AOMC—the Corps of Engineers would function relative to the prime contractor as a member of the AOMC/ARGMA staff. In their capacity as technical supervisors, the designated CE agencies would have technical directive authority over the prime contractor's effort, with the proviso that any decisions or directives affecting other elements of the system would be referred to ARGMA. Agencies delegated the authority to act for the Chief of Engineers as technical supervisors were the U. S. Army Engineer R&D Laboratories (USAERDL) and the Geodesy Intelligence and Mapping R&D Agency (GIMRADA), both located at Fort Belvoir, Virginia.[55]

(U) Meanwhile, representatives of ARGMA, USAERDL, Convair, and FMC met at Fort Belvoir in October 1960 to review contractor proposals and select the best design approach for the MAULER power unit and air conditioner. They chose the AiResearch Manufacturing Division of the Garrett Corporation to build the power unit, and the Stratos Division of the Fairchild Aircraft Company to build the air conditioner. Both of these items, of course, would incorporate standard CE equipment to the maximum extent possible.[56] The Belock Instrument Corporation had been selected to develop the navigation unit—Stable Reference & Position (STRAP) assembly—on the basis of competitive bids received and evaluated in August 1960.[57] This work would be done by the Astro Space Laboratories, Inc., of Huntsville, Alabama, a subsidiary of the Belock Instrument

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[55]Ltr, CofEngrs, thru CofOrd, to CG, AOMC, 21 Feb 61, subj: Working Agrmt Governing the Dev of CE Items for the MAULER Wpn Sys, w/incl, same subj, 20 Feb 61; & 1st Ind thereto, CofOrd to CG, AOMC, 21 Mar 61. MPCF, Bx 11-14, RHA.

[56](1) Ltr, ARGMA Comdr to CO, LAOD, 26 Oct 60, subj: MAULER Contr DA-04-495-ORD-1951 (Convair). (2) DF, Chf, MAULER Br, TSPO, R&DO, thru Dir, R&DO, to ARGMA Comdr, 14 Nov 60, subj: Air Condg Sys for MAULER. Both in MPCF, Bx 11-14, RHA.

[57]MAULER Actv Rept, Aug 1960, atchd as incl to DF, Asa Edens, Act SXR, Convair/Pomona, to Chf, Con Ofc, ARGMA, 30 Aug 60, subj: Monthly Actv Rept, Aug 1960 (RCS OR-C-1). File same.

Corporation, which signed a fixed-price subcontract with Convair in October.[58]

(U) With the Army reorganization of August 1962, the management and coordination procedure for CE support of the program was considerably simplified. The Chief of Engineers retained his statutory status as a part of the special staff, with responsibility for mapping, civil works, construction, and real estate; however, the military functions of the Corps of Engineers were reassigned to other Army elements, most of them to AMC Headquarters. Among the CE installations and activities transferred to AMC were the Granite City Engineer Depot in Illinois; the Army Engineer Depot Maintenance Shops located in Georgia, Tennessee, New York, and Utah; the Engineer Proving Ground at Fort Belvoir, Virginia; and nine other R&D, engineering, and test activities, including the ERDL at Fort Belvoir.[59]

Contract Agreement with the Canadian Government

(U) The development-sharing pact with the Canadian Government for work on the MAULER infrared acquisition (IRA) unit represented the first cooperative effort of its kind in the development of a major missile system. Equally important, it relieved the Army of some of the financial burden for the MAULER program at a time when RDTE funds were extremely scarce. The IRA subsystem was originally scheduled for development under the prime R&D contract (ORD-1951), and Convair quoted on the effort in its FY 1962 proposal. In

[58](1) DF, Chf, MAULER Br, SAM Sys Div, R&DD, to Chf, MAULER Br, Low-Alt AD Wpn Sys Div, Indus Dir, 26 Apr 62, subj: Belock Instrument Corp. (2) Ltr, DCG,GM, AOMC, to CofOrd, 8 May 62, subj: MAULER Monthly Prog Rept for Apr 1962. Both in MPCF, Bx 13-649, RHA.

[59]DA GO 46, 25 Jul 62, subj: Trfs of Instls & Actvs to the USAMC.

subsequent negotiations, however, the requirement was deleted because of funding limitations.[60] During concurrent discussions at a meeting of the Tripartite Standing Working Group on Low-Altitude Air Defense, held in London in August 1961,[61] representatives of the Canadian Government expressed an interest in developing the IRA unit under a cooperative, cost-sharing program. In a formal proposal submitted in September 1961, the Washington Office of the Canadian Department of Defence Production (CDDP) offered to assume two-thirds of the total cost of development, which would be carried out by a Canadian contractor in accordance with technical requirements to be provided by appropriate agencies of the U. S. Army.[62] In early October 1961, following a series of meetings CDDP representatives, MG Dwight E. Beach, the Deputy Chief of R&D, formally accepted the proposal and directed the Chief of Ordnance to proceed with contract negotiations on a priority basis.[63]

(U) Subsequent negotiations between the Contracting Officer of the Detroit Ordnance District and Canadian Commercial Corporation[64]

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[60] DF, P&P Div, MAULER Proj Ofc, to MAULER PM, 14 Mar 63, subj: Contr DA-20-018-ORD-23980. MPCF, Bx 13-649, RHA.

[61] At that time the U. S., United Kingdom (U. K.), and Canadian armies had an agreed operational requirement for a mobile, forward area guided missile system to counter the low-altitude air threat in the late 1960's. The U. S. MAULER and the U. K. PT-428 weapon systems were being developed under the terms of that tripartite agreement, and the Ad Hoc Mixed Working Group (AHMWG) of the North Atlantic Treaty Organization (NATO) was closely following both programs with a view toward adopting the best system to meet NATO requirements. For details relating to the MAULER/PT-428 competition, see below, pp. 92-95.

[62] Ltr, J. A. Teeter, Dir, CDDP, Washington, D. C., to CRD, DA, 28 Sep 61, subj: IRA Unit for MAULER SAM. MPCF, Bx 11-14, RHA.

[63] (1) Ltr, DCRD, DA, to Dir, CDDP, 4 Oct 61, subj: IRA Unit for MAULER SAM. (2) TT, CofOrd to CG, AOMC, 12 Oct 61. Both in MPCF, Bx 11-14, RHA.

[64] A corporation owned and controlled by the Government of Canada, with offices in Ottawa, Ontario, and Washington, D. C.

resulted in a $2,489,344 contract for the performance on a best efforts basis of all work and services required for the design, development, fabrication, and testing of the MAULER IRA unit.[65] The services would be performed by DeHavilland Aircraft of Canada, Ltd., Downsview, Ontario, under a subcontract with the Canadian Commercial Corporation. Pursuant to provisions of the defense development sharing agreement,[66] the Canadian Commercial Corporation would contribute two-thirds of the allowable cost and the U. S. Government one-third of the cost, plus a fixed fee of $55,191 payable to DeHavilland. The Army Missile Command, in coordination with the prime contractor (GD/P), would be responsible for technical guidance, supervision, and control of DeHavilland's performance. The responsibility for preliminary inspection and acceptance of all material completed under the contract would rest with the Canadian Department of National Defence Inspection Service.[67]

(U) On 1 March 1962, the U. S. Army assumed plant cognizance of DeHavilland Aircraft for the U. S. Government, relieving the U. S. Air Force of this responsibility. The Department of the Army promptly assigned a 9-man staff to coordinate the tri-service

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[65] The contract (DA-20-018-ORD-23980) was entered into in accordance with and subject to the provisions of the Letter of Agreement between the CDDP and the Departments of the Army, Navy, and Air Force, dated 27 July 1956, as revised 6 January 1961 and set forth in Armed Services Procurement Regulation (ASPR) 6-503, revised 1 May 1961 (later renumbered 6-506). The initial 90-day letter contract, issued in late October 1961, was extended to 180 days in December, thence to 210 days in March 1962. TT ORD-4987, CofOrd to CG, AOMC, 20 Mar 62. MPCF, Bx 11-14, RHA.

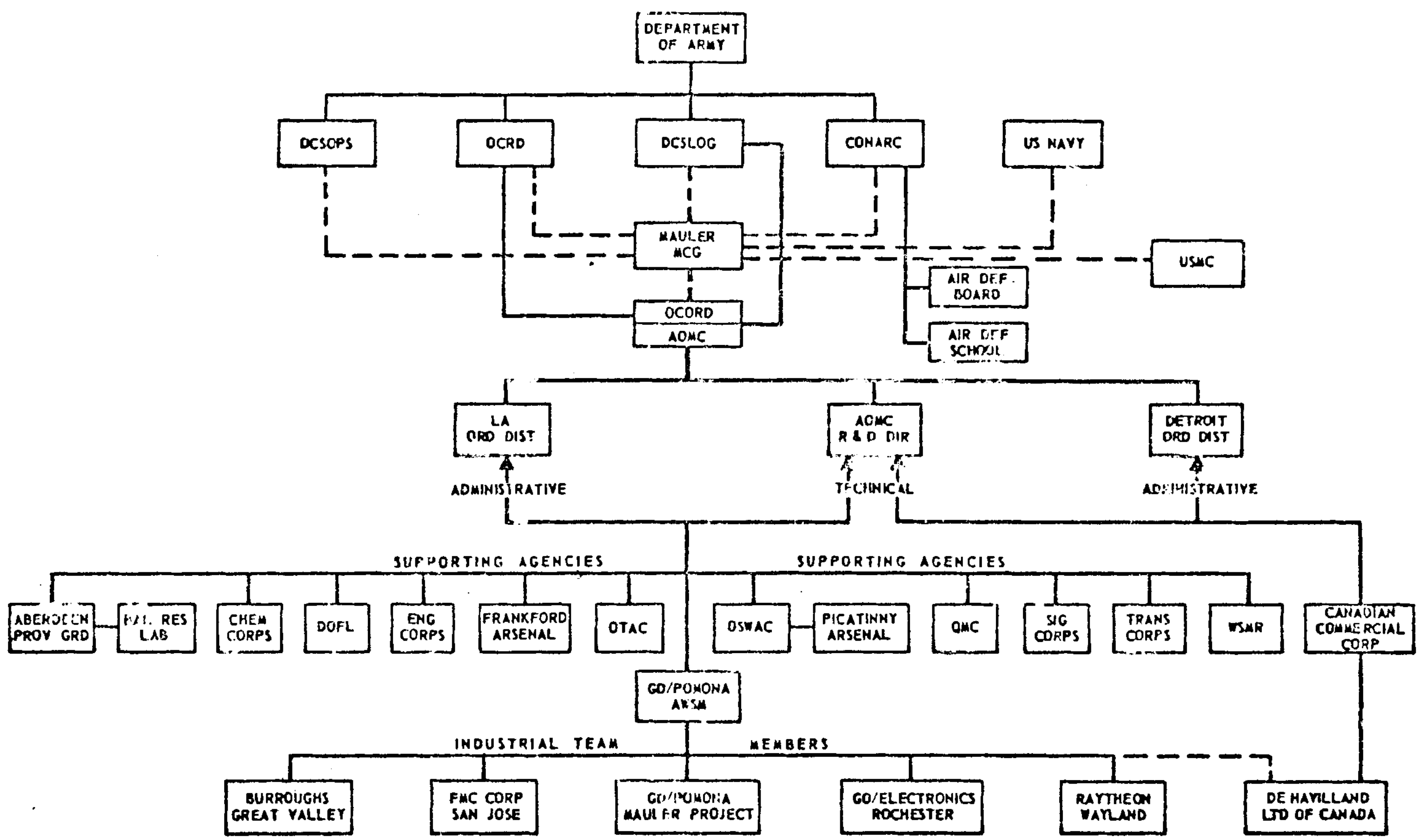
[66] Later complemented by a formal Memorandum of Understanding between the U. S. Secretary of Defense and the Canadian Minister of Defence Production. See ASPR 6-507.

[67] (1) TT, CofOrd to CG, AOMC, 18 Oct 61. (2) TT ORDXR-IHPM-1808, CG, AOMC, to CO, Detroit Ord Dist, 20 Oct 61. Both in MPCF, Bx 11-14, RHA. (3) DF, P&P Div, MAULER Proj Ofc, to MAULER PM, 14 Mar 63, subj: Contr DA-20-018-ORD-23980. Same Files, Bx 13-649.

MAULER

CHART 4

ARMY & INDUSTRIAL TEAM ORGANIZATION



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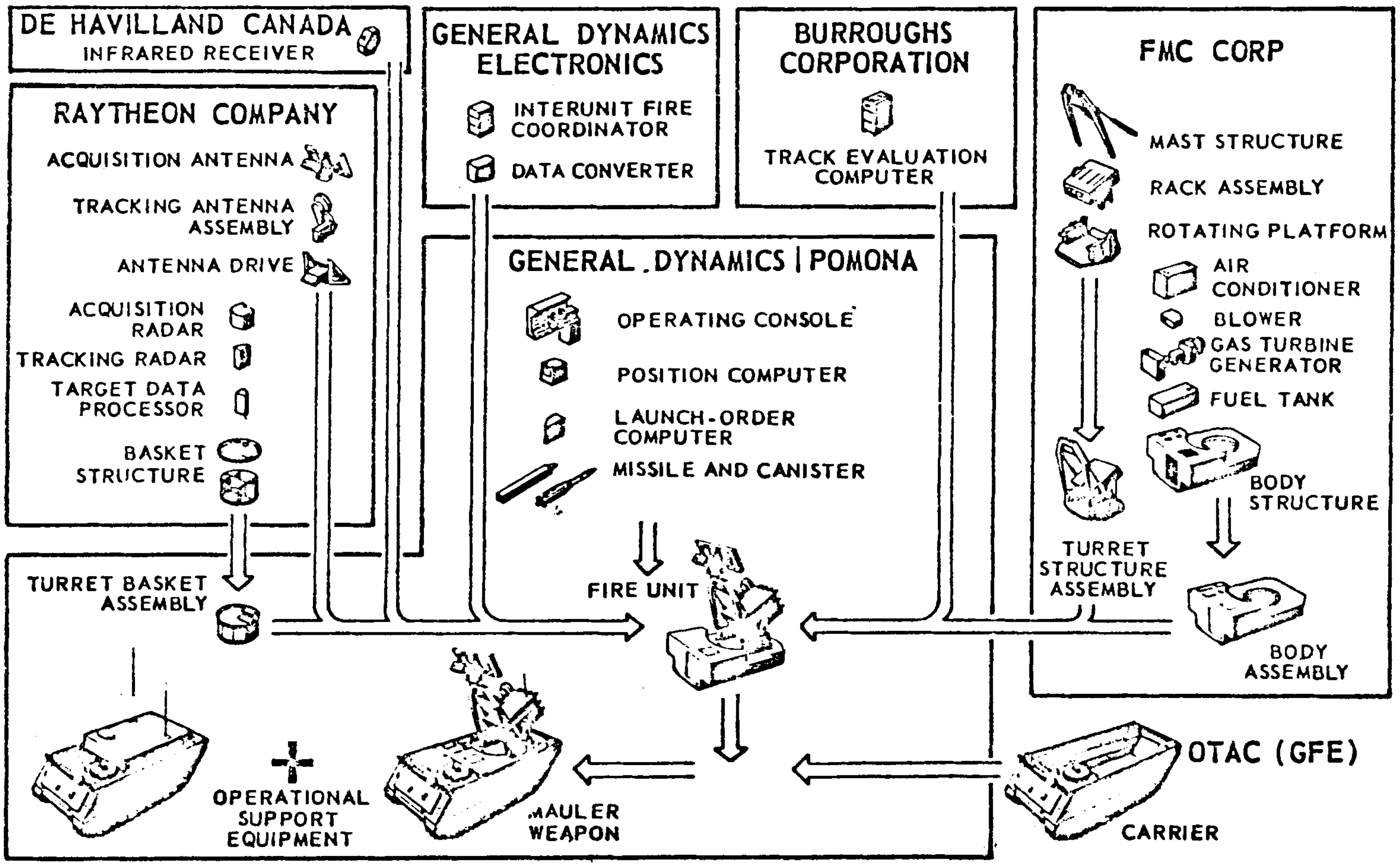
MAULER

CHART 5

INDUSTRIAL TEAM AND TASK ASSIGNMENTS



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contract activities and assure the smooth and rapid flow of information between the contractor and the customer.[68]

Other Supporting Services and Contractors

(U) Other Government agencies and contractors providing R&D support services and/or hardware for the MAULER weapon system included the following:[69]

Picatinny Arsenal	Warhead
Harry Diamond Labs (HDL)*	Fuze/Safety & Arming Devices
Chemical Corps (Edgewood Arsenal)	Filter for Air Conditioner
White Sands Missile Range (WSMR)	Flight Test Support
Ballistic Research Labs, APG**	Sys Effectiveness Studies/Tests
Human Engineering Labs, APG	Human Engrg Studies/Tests
Jet Propulsion Laboratory	Wind Tunnel Test Facilities
Hughes Aircraft Company	Battery Command Post
Universal Match Corporation	Control Equip for Target Msls
Ryan Aeronautical Company	Target Missiles
Radio Corporation of America	Multisystem Test Equipment
General Electric Company	Acquisition Radar Eval Study

*Formerly known as the Diamond Ordnance Fuze Laboratories (DOFL).
**Aberdeen Proving Ground, Maryland.

Joint Programming Aspects

(U) Though originally programmed for primary use by the U. S. Army, the MAULER weapon system was seriously considered for possible employment by several other users, both domestic and foreign. Among these were the U. S. Navy and Marine Corps and members of NATO. In addition to the proposed multilateral use of the MAULER by member countries of NATO, the weapon system was selected for joint

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[68](1) Ltr, MAJ Richard S. Demory, Plant Rep, U. S. Army Ofc, to DeHavilland Acft of Canada, Ltd., 9 Mar 62, n.s. MPCF, Bx 11-14, RHA. (2) For policies and procedures governing the purchase of supplies and services from Canadian contractors, see ASPR 6-501 thru 6-507. Also see fn 65 above.

[69]MAULER TDP, 31 Mar 61, pp. 17-18. MPCF, Bx 14-256, RHA.

standardization under a tripartite agreement among the U. S., U. K., and Canadian Governments.

Negotiations with the Navy and Marine Corps

([redacted] Both the Navy and Marine Corps expressed an official interest in and closely followed the MAULER program from its inception. The Department of the Army began negotiations to secure funding assistance for the development program as early as 1960;[70] however, neither of the services could make a firm commitment until specific operational requirements had been established. Meanwhile, their participation in the program was limited to observing the progress of development through attendance at conferences, briefings, presentations, design reviews, and steering committee meetings.

([redacted] The Marine Corps maintained a somewhat aloof, wait-and-see attitude toward the program throughout the 1960-62 period. The Commandant, in March 1961, reaffirmed that the Corps still had a requirement for a low-altitude air defense system "which possibly may be fulfilled by the MAULER." He noted, however, that a specific Marine Corps requirement for the MAULER was yet to be approved, and pending such action the Corps wished to furnish only an observer to the steering committee meetings.[71] Some 29 months later, in August 1963, the Marine Corps Landing Force Development Center issued for field coordination a "Proposed Specific Operational Requirement for a Mobile Surface-to-Air Missile System," which substantially paralleled the MAULER materiel requirement.[72]

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[70] Ltr, CofOrd to CG, AOMC, 7 Sep 60, subj: Presn on MAULER Dev Program.

[71] (1) Ltr, 004C-6061, Comdt, USMC, to CG, AOMC, 9 Mar 61, subj: MAULER Steering Com. MPCF, Bx 14-256, RHA. (2) Also see Ltr, 004A-11060, Comdt, USMC, to CofS, DA, 31 May 60, subj: MAULER AD Wpn Sys. File same.

[72] DF, Marine Corps Ln Off, MICOM, to CG, MICOM, 16 Aug 63, subj: Ppsd Marine Corps SOR, MSAMS.

By that time, the MAULER program was in serious technical trouble and it appeared highly doubtful that the weapon system could be developed within reasonable time and cost—with or without Marine Corps support.

([redacted] The extent of the Navy's involvement in the MAULER program was much greater than that of the Marine Corps, chiefly because of the difference in operational concept and the modifications required to adapt Army equipment to shipboard use. In early June 1961, the Chief of Naval Operations issued a proposed Navy supplement to the MAULER MC's for consideration by the MAULER Steering Committee.[73] Shortly thereafter, the Bureau of Naval Weapons gave the Applied Physics Laboratory, Johns Hopkins University, an engineering study contract to investigate the feasibility of the shipboard installation and to define the special ancillary equipment needed for that mode of operation. Tentative plans called for the procurement of hardware for shipboard tests in FY 1963, followed by the initial buy of production equipment in FY 1964.[74] Based on the results of the engineering study and data obtained during a visit to Convair's plant,[75] the Chief of Naval Operations, on 21 March 1962, established a specific operational requirement for the SEAMAULER weapon system.[76]

([redacted]) In late March 1962, representatives of AOMC, OCO, and the Bureau of Naval Weapons met in Washington, D. C., to discuss the tasks and hardware requirements for the SEAMAULER. The Navy indicated that it was prepared to spend about $6 million for FY 1963

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[73]Ltr, CNO to HQ CONARC, 9 Jun 61, subj: MAULER MC's, Fwdg of; & incl thereto, Navy MC's Suppl to Army MC's for MAULER Wpn Sys. MPCF, Bx 13-649, RHA.

[74]MAULER Program Plan, 21 Nov 61. MPCF, Bx 13-643, RHA.

[75]MAULER Prog Rept, Jan 1962, p. 1.

[76]Ltr, CNO to Chf, Bu of Nav Wpns, 21 Mar 62, subj: SOR W17-10 (Surface-to-Air Wpn Sys SEAMAULER). MPCF, Bx 13-649, RHA.

development, but overall control of the program would be retained by the Army. AOMC recommended that the Navy establish a single manager for the program with authorities similar to those of the Army project manager, and further, that the Navy place all of its requirements on the Command for inclusion in a single contract.[77] The MAULER Project Manager advised the Bureau of Naval Weapons that funding support in the estimated amount of $17.796 million would be required for hardware procurement, testing, and support services during the 1963-65 period.[78] Navy officials later indicated that the design problems being encountered in development of the mobile Army system would not adversely affect the shipboard installation.[79] Nevertheless, plans for procurement of the SEAMAULER were subsequently cancelled along with the rest of the program.

NATO Considerations: MAULER versus PT-428

[redacted] In May 1960, shortly after the initiation of MAULER development, the U. S. Army began a series of presentations to the NATO Ad Hoc Mixed Working Group (AHMWG) and the Tripartite Standing Working Group, both of which had a requirement for a forward area, low-altitude air defense system. At that time, the armies of the U. S., U. K., and Canada had an agreed operational requirement for such a weapon to counter the air threat in the late 1960's, and the U. S. Army hoped to sell the MAULER concept

[77](1) Hist of HQ AOMC, 1 Jan - 30 Jun 62, pp. 60-61. (2) Trip Rept, Fred B. Stevenson, Dep Chf, Low Alt AD Wpn Sys Div, Indus Dir, 19 Apr 62, re: Conf on Navy Part in MAULER Program, OCO, 27-29 Mar 62. MPCF, Bx 14-256, RHA.

[78]Ltr, COL B. J. Leon Hirshorn, MAULER-REDEYE PM, to Chf, Bu of Nav Wpns, 5 Apr 62, subj: MAULER Funding & Scd Info. MPCF, Bx 13-649, RHA.

[79]Hist Rept, MAULER Proj Ofc, 1 Jul - 31 Dec 62, p. 5.

for both tripartite and multilateral NATO use. The U. K., however, chose to reserve its position on the matter pending completion of studies which were then in progress. The British Government concluded in September 1960 that the MAULER approach was deficient in certain important respects and introduced the PT-428 system concept as a better solution to the problem.[80]

(U) Following a comparative evaluation of the two systems, conducted in February 1961 at the behest of NATO and OCO, ARGMA engineers concluded that the MAULER offered a significantly greater overall capability than the PT-428.[81] Members of the Tripartite Standing Working Group then met at Redstone Arsenal in May to make a joint technical evaluation and comparison of the two system concepts. These discussions revealed a number of important differences in technical opinion which obviously could not be fully resolved until both systems had been developed and tested under field conditions. Instead of wasting available R&D talent and resources on two different systems for the same basic purpose, the Group suggested that the United Kingdom cooperate with the United States in developing the MAULER for the tripartite standardization list. On that basis, the U. S. delegation decided to defer further action until receipt of a proposal from the U. K. However, this position was reversed in early June, when a team of top-level U. S./U. K. defense officials agreed that the United States should take the initiative in the matter. Specifically, AOMC was to prepare a recommended cooperative development proposal, complete with a list of components and management procedures, for

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[80](1) MAULER Program Plan, 21 Nov 61. MPCF, Bx 13-643, RHA. (2) Also see Introduction to U. K. Position Paper on PT-428/MAULER presented during Rubel/Zuckerman Talks in London, 31 Oct - 3 Nov 61. Same Files, Bx 13-649.

[81]Ltr, CofOrd to CG, AOMC, 30 Dec 60, subj: Eval of Wpn PT-428; and Ltr, CG, AOMC, to CofOrd, 9 Mar 61, subj: Comparative Eval of PT-428 & MAULER AD Sys, atchd as incls to SS ORDXR-R-420, 23 Feb 61.

consideration at the next meeting of the tripartite task force.[82]

([redacted]) During the tripartite conference held in London in August 1961, the U. S. delegation solicited Canadian and British cooperation in the development of certain MAULER components, including the IRA unit and an improved engine/generator set. Shortly thereafter, the Canadian Government endorsed the MAULER system for standardization between the U. S. and Canada, and entered into a cooperative cost-sharing agreement to develop the IRA subsystem.[83] The British Government, in September 1961, expressed a definite interest in developing an improved power unit for the MAULER, but declined to make a formal commitment without the detailed specifications which were not then available.[84] After a review of the specifications in February 1962, U. K. representatives announced that they would be unable to develop a power unit meeting the MAULER requirements within the prescribed time frame.[85]

([redacted]) Meanwhile, a team of American and British officials met in London for further discussions of the MAULER/PT-428 problem. The 4-day conference—known as the Rubel/Zuckerman Talks—ended

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[82] (1) MAULER Prog Rept, May 1961, p. 1. (2) TT DA-997508, CofOrd to CG, AOMC, 13 Jun 61, atchd as incl to DF, Chf, Wpn Sys Div, ARGMA Con Ofc, to Chf, R&DO, 19 Jun 61, subj: Cooperative Dev of MAULER Comps. (3) SS ORDXR-R-660, ARGMA Comdr to CG, AOMC, 20 Jun 61, subj: MAULER Tripartite Agrmt, & Incl 3 thereto, TT ORDXR-RHB-400, CG, AOMC, to CofOrd, 20 Jun 61. (4) TT OCO-004, CofOrd to CG, AOMC, 28 Jun 61. MPCF, Bx 13-649, RHA.

[83] See above, pp. 84-86.

[84] (1) TT CRD-AE-GM-1080, USA Stdzn Gp, U. K., to ARGMA Comdr, 15 Sep 61. (2) Ltr, ARGMA Comdr to CofEngrs, 9 Oct 61, subj: Spec for the MAULER Power Unit. (3) Ltr, ARGMA Comdr to CofOrd, 24 Oct 61, subj: Dev of a MAULER Power Unit by the U. K. All in MPCF, Bx 13-649, RHA.

[85] AOMC Rept on MAULER Power Unit Status, atchd as Incl 3 to 1st Ind, CG, AOMC, to CofOrd, 19 Feb 62, on Ltr, CofOrd to CG, AOMC, 23 Jan 62, subj: Status of MAULER Power Unit. MPCF, Bx 13-649, RHA.

on 3 November 1961 with no sign of a settlement.[86] During a joint meeting of the NATO AHMWG and SHAPE (Supreme Headquarters, Allied Powers, Europe), on 27 November, the U. S. and U. K. teams briefed the group on the status of the MAULER and PT-428 programs, both claiming that their respective system would meet the operational and technical requirements specified for the NATO low-altitude air defense system. The U. K. made a very strong bid for support of its PT-428, stating that funds to develop the system without outside help had been requested, and to "get in on system development" other countries would have to commit themselves by 1 April 1962. The Group concluded, however, that it was too early to determine whether either or both of the systems would or would not meet the stated requirements, and that a final decision on the matter should be deferred.[87]

The Tripartite Working Agreement

([redacted] Four months later, in March 1962, the United Kingdom abandoned its plans for developing the PT-428 system and advised OCRD of its desire to share in development of the MAULER weapon system for both tripartite and NATO use. Representatives of AOMC, OCO, and DA Staff met at the Pentagon on 26 April to discuss the British proposal and establish certain ground rules for the joint development effort. The general philosophy was that the U. S.

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[86] The U. S. delegation to the "Rubel/Zuckerman Talks" included Mr. John Rubel, Assistant Secretary of Defense; Mr. John Guthrie, GD/P; and representatives of DDRE, OCRD, and OCO. The U. K. delegation was headed by Sir Solly Zuckerman, Chief Scientific Advisor to the Minister of Defence. For details on the areas of disagreement and arguments relating thereto, see U. S. & U. K. Position Papers, Rubel/Zuckerman Talks, 31 October - 3 November 1961. MPCF, Bx 13-649, RHA.

[87] TT DEFTO-9153, USRO, Paris, France, to OSD, Washington, D. C., 4 Dec 61, subj: AHMWG on Low Alt Surface-to-Air Wpn Sys. MPCF, Bx 13-649, RHA.

would welcome the participation of the U. K. in the MAULER R&D program. Members of the U. K. team would be placed on the staff of U. S. Army activities engaged in the management, development, test, and evaluation of the system, but they would have no authority to direct or control such effort. The U. S. would integrate U. K. requirements into the combined development-engineering-service tests without reimbursement; however, any additional materiel or tests needed to satisfy U. K. requirements would be reimbursable.[88]

(U) During a meeting in July 1962, members of the Tripartite Standing Working Group made plans for the assignment of U. K. and Canadian personnel to the MAULER Project Office. In keeping with the Group's recommendations, Brigadier Francis Grant, U. K., visited MICOM in February 1963 to work out the final details of the agreement. It was agreed that a team of 10 British officers, all with backgrounds in missile engineering, would be integrated with the project staff. These officers, together with three highly skilled Canadian missilemen, would supplement the staff of the MAULER project at no cost or increase in authorized personnel spaces.

(U) The commander and two members of the British team arrived at MICOM in May 1963. LTC Dennis Ewart-Evans, the team commander, was assigned as Assistant to the MAULER Project Manager, and the two team members as Operations and Tactical Research Analysts. The rest of the British team and three Canadian officers joined the project staff later in 1963.[89]

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[88] (1) "Talking Paper - MAULER Missile System Status," atchd as incl to MFR, Info Off to BG J. G. Zierdt, et al., 6 Dec 63. (2) Hist of HQ AOMC, 1 Jan - 30 Jun 62, pp. 61-62. (3) TT ORDXM-XGM-46, CG, AOMC, to CO, LAOD, 27 Apr 62. MPCF, Bx 13-649, RHA.

[89] (1) TT AMSMI-OS-8, CG, MICOM, to CG, AMC, 25 Jan 63. (2) MFR, Info Off to GEN Persons & COL Dennis, 10 Apr 63, and incl, Text of News Rel re Asgmt of British Offs to MAULER Proj. (3) Hist Rept, MAULER Proj Ofc, 1 Jan - 30 Jun 63, pp. 8-9. (4) Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, p. 1. (5) MAULER PM$_2$P, 30 Jun 65, p. 9. (6) Also see above, pp. 66, 69.

Program Management Aids

Program Evaluation & Review Technique (PERT)

(U) The PERT control scheme, originally developed in 1958 in conjunction with the Navy's POLARIS project, was adapted to the MAULER program in 1962-63. Lauded by many in the Defense community as the greatest management breakthrough of the decade, this technique provides a systematic method for effectively accomplishing the five classical functions of weapon system management: planning, organizing, coordinating, directing, and controlling. It can be adapted to the management needs of most any type of organization or activity, using one of several basic factors as the controlling element. In some instances, for example, time is used as the controlling factor, and manpower and money are built around the time element; while in others, money is used as a controlling factor with time and manpower depending upon the dollar sign. All three of these elements are essential to the ultimate success of a project, but if the technical effort has not been planned properly and realistically in terms of time, the money is not going to accomplish the work effort. In its basic form then, the PERT scheme enables the manager to plan his work effort in a logical manner, with time as the controlling factor.

(U) The Army Materiel Command was early to recognize the value of the PERT control scheme and included guidelines for its use in the provisional plans for the project management system. The new system supplanted the weaponization and commodity plan concept which used bar charts to plot and keep track of progress in sequential-step weapon developments.[90] This old method of depicting and evaluating program progress and control data had been adequate under the decentralized or functional-type organization;

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[90] See, for example, MAULER Commodity Plan, 30 Jun 61, p. 119.

but with the shift to vertical project management, or the mission-oriented type of organization, the manager needed a management tool that would give him a greater in-depth perception of his total activity. Specifically, he needed a definitive system of checks and balances that would relate more precisely how what was happening in one subassembly would affect what was happening in another. The PERT management process cycle fulfilled that need by providing a more systematic method of monitoring the time-program relationship, thus enabling the project manager to identify critical problem areas and potential slippages in time for corrective action. It also enabled the manager to assess definitively the development risks he might or might not want to take to save time or money or both.

(U) Official PERT directives were not issued until after the formal activation of AMC Headquarters in August 1962. However, during the formative stage of the Command, all project managers had been familiarized with, and encouraged to make use of, the PERT/Time control scheme in their respective programs.[91] Preliminary work leading to the adaption of the PERT/Time system to the MAULER development program was thus begun early in 1962.[92] The DOD/NASA* PERT Coordinating Group later completed a guide for the PERT/Cost system design, and the OSD directed the three services to pilot test the new management technique. In September 1962, General Besson advised MICOM that the MAULER weapon system had been selected as the Army's vehicle for the pilot test, and that a target date of June 1963 had been established for having the

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*Department of Defense/National Aeronautics & Space Administration.

[91]For background data on the origin and development of the PERT system and its application to the project management process, see Raymond J. Snodgrass, The Concept of Project Management (AMC Hist Ofc, June 1964).

[92]DF, Asa Edens, SCR Ofc-GD/P, to SAM Sys Div, R&DD, 9 Feb 62, subj: SCR Ofc Actv Rept for Pd Ending 9 Feb 62. MPCF, Bx 13-649, RHA.

PERT/Cost system in full operation.[93] This second-generation PERT system was designed to bring the type of managerial control to resources that the original PERT/Time scheme brought to the management of time and schedules. The purpose of the tri-service pilot test was to establish uniform DOD procedures and reporting requirements, and thereby ease the impact of the new management system on defense contractors doing work for more than one service.[94]

(U) The MAULER contractor's reaction to the PERT system was somewhat less than enthusiastic. While evincing oral support of the system as a good management planning and control tool, GD/P personnel had a definite tendency to stall and hedge when it came to applying the technique as an integrated, working part of the total program. In February 1962, Mr. Asa Edens, the Senior Command Representative at the GD/P plant, reported that contractor personnel had expressed confidence in the PERT system but had not attempted to expand the technique to its full effectiveness. He further stated that GD/P personnel would not object to a contract amendment making PERT a mandatory requirement, but indicated that some resistance could be expected if the wording were "too restrictive."[95]

(U) The attitude of GD/P personnel showed little improvement during the MAULER PERT/Cost pilot test. As late as May 1963, with the target completion date just 30 days away, MG F. J. McMorrow, the MICOM Commander, admonished the company president for what he

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[93](1) Ltr, CG, AMC, to CG, MICOM, et al., 19 Sep 62, subj: Dsgn of the MAULER Wpn Sys for the PERT/Cost Pilot Test. (2) Hist Rept, MAULER Proj Ofc, 1 Jul - 31 Dec 62, p. 7. (3) Ltr, MAULER PM to Mr. Charles F. Horne, President, GD/P, 27 Nov 62 [re Impln of MAULER PERT/Cost Sys].

[94]John S. Herrick, "Where Army Managers Rely on PERT," Armed Forces Management, Vol. 9, No. 4 (January 1963), p. 45.

[95]DF, Asa Edens, SCR Ofc-GD/P, to SAM Sys Div, R&DD, 9 Feb 62, subj: SCR Ofc Actv Rept for Pd Ending 9 Feb 62. MPCF, Bx 13-649, RHA.

termed a lack of "tangible as distinguished from the oral evidence of support and cooperation." Here again, the chief complaint stemmed from the contractor's reluctance to expand the technique to its full effectiveness, and the resultant lack of required detail in proposed work packages covering the balance of the RDTE program.[96] Despite these and other obstructions, the MAULER Project Manager completed implementation of the pilot test essentially on time. In commenting on the results of the exercise, Colonel Dennis reported that the PERT/Cost system had proved to be of extremely great value to management and would continue to be used on the MAULER program. With regard to the contractor's apparent conviction that "PERT/Cost is too revealing," he emphasized that it was in the Government's best interest to have the maximum practical information concerning a cost contract.[97]

PERT vis-a-vis Roles of the Project Manager

(U) As the architect of the MAULER PERT/Cost program, the project manager enthusiastically embraced the new system with an abiding faith in its intrinsic value as a management tool but with the sobering knowledge that it could not of itself guarantee good management. Being thoroughly familiar with both the potentialities and limitations of the system, he recognized that it was not a panacea, nor a palliative, for the lack of good management, but rather an aid to management—a tool to assist the manager in achieving the stated end objectives at a reasonable cost in optimum time. Its ultimate success would depend upon a number of interrelated factors, not the least of which were the accuracy of program

[96]Ltr, CG, MICOM, to Mr. Charles F. Horne, GD/P, 29 May 63, n.s., atchd as incl to SS AMCPM-MAM-12, 29 May 63, subj: Level of Detail for Contr Negotiations - MAULER.

[97]Ltr, COL Norman T. Dennis, MAULER PM, thru CG, MICOM, to CG, AMC, 31 Jul 63, subj: MAULER PERT/Cost Pilot Test.

data used in charting individual and collective tasks (i.e., the degree of success achieved in eliminating the inherent uncertainties in time and cost projections), and the judicious use of output information in the program direction and control process.

(U) In essence then, the effectiveness of PERT/Cost as a management tool would be measured by the user's own skills and capabilities; for, as with computers, the injection of bad information was bound to beget bad analysis. It represented a truly significant step forward in the science of management by virtue of its planning discipline, criticality analyses, and predictive ability; however, it could no more be insulated against human error than equipped with built-in solutions to problems or mistakes. As with any management control system, it could only highlight those problems, mistakes, or deviations from the charted course in ample time for corrective measures. The efficacy of the decisions or actions based upon this knowledge would depend solely upon the project manager's competence in directing and controlling the operation; i.e., his ability to correlate effectively the physical and fiscal progress of key program tasks and to effect the necessary replanning and reallocation of resources on a timely basis.

(U) It was with these and certain other considerations in mind that Colonel Luczak enacted the MAULER Program Management Charter in early April 1964. The purpose of the charter was to provide the systematic means for monitoring the PERT/Cost network activities and keeping top management aware of program status and progress. Initially established on 3 April and revised on 13 May 1964, the charter prescribed the mission, organization, functions, and operating procedures for conducting the total MAULER program. It provided for the continuous review of MAULER network activities by a Program Management Staff and six working panels. The program changes recommended by the working panels were subject to approval by the Program Management Staff which met quarterly to determine the status of tasks, isolate technical problems, and assign responsibility and resources for their solution.[98]

(U) Another management control measure enacted in May 1964 provided for regularly scheduled meetings between key management personnel of MICOM and executives of prime contractors and principal subcontractors. The purpose of these meetings was to afford a positive means of keeping top management officials aware of the status and progress of all efforts being expended on the system.[99]

[98] (1) AMCPM-MA Procedure 1-1, 13 May 64. (2) Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, pp. 12-13.

[99] Ibid., p. 12.

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CHAPTER IV

([redacted]) PRELIMINARY DESIGN PHASE (U)

(U) The MAULER development program, which was to have started in May 1959, finally got underway in March 1960. In recognition of the critical need for an early operational capability, the Army General Staff had accorded the project the highest possible priority and, by implication, had committed itself to fund the program accordingly. With the MAULER's technical feasibility no longer in question and adequate financial support virtually assured, the project engineers at AOMC were confident that an operational weapon system meeting the established MC's could be evolved within a 52-month time frame. In practice, however, the Army Staff fell miserably short of its funding commitment and AOMC's initial plan turned out to be overly optimistic in terms of both time and cost.

The May 1960 Development Plan

([redacted]) The AOMC, in May 1960, issued a formal technical development plan which updated and superseded the provisional weapon system plan of August 1959.[1] It consisted of several substantially telescoped phases covering a period of some 4 years (1960-64). The initial effort would be devoted to preliminary design studies, with a view toward finalizing specifications for the engineering model weapon system by the end of 1960. The next step would embrace the fabrication and test of breadboard components and subsystem mockups to reconcile the differences between theoretical and actual performance, and to establish the necessary design changes for the

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[1] <u>See</u> above, pp. 52-53.

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interim R&D release of the engineering model. In the ensuing phase, the complete engineering model would be evaluated, culminating in an R&D prototype of the tactical configuration for production release by the first quarter of CY 1963. The Ordnance Support Readiness Date (OSRD)[2] was set for July 1964.[3]

This schedule, of course, was predicated on the assumption that adequate RDTE funds would be made available on a timely basis. The program was initially funded for $14,825,448 during the final half of FY 1960—enough to carry the effort through the first half of FY 1961 (December 1960).[4] To maintain the development effort at a level commensurate with the July 1964 readiness date, a minimum of $27.3 million would be required in FY 1961; $34.1 million in FY 1962; $23.8 million in FY 1963; and $8.2 million in FY 1964. The total estimated RDTE cost of $108.2 million for the 4-year program represented an increase of $34.6 million over the original estimate of $73.6 million, and $31.2 million over the preliminary estimate reported early in 1960.[5]

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[2] The date by which it was planned to furnish the first acceptable complete weapon system to the field and to have all initial capabilities (e.g., trained manpower, technical publications, repair parts, equipment, and facilities) needed for sustained supply, maintenance, and other Ordnance support consistent with established weapon system plans.

[3] (1) Min of MAULER Briefing for CG, AOMC, 25 May 60. (2) DF, ARGMA Comdr to CG, AOMC, 15 Jun 60, subj: Ppsd MAULER ECI.

[4] See above, p. 54.

[5] (1) Min of MAULER Briefing for CG, AOMC, 25 May 60. (2) 1st Ind, CG, AOMC, to CofOrd, 13 May 60, subj: TDP's (RCS CSCRD-21), cited and summarized in Ltr, DCG, AOMC, to CofOrd, 19 Aug 60, subj: The MAULER Program. MPCF, Bx 14-256, RHA. (3) In numerous paper exercises explaining subsequent increases in program cost, project personnel at AOMC cited $77 million as the "original" 1958 estimate. The aforementioned letter of 19 August 1960 and the documents cited in Chapter II indicate otherwise; however, to obviate the need for repeated explanations, the $77 (rather than the $73.6) million figure is hereinafter cited as the original estimate.

[redacted]

(C) This initial escalation in program cost was the cumulative result of circumstances attending the feasibility studies in 1958 and the subsequent funding gap. It will be recalled that the four competing contractors conducted their feasibility studies on the basis of preliminary technical requirements which specified a radar cross-section target threat of 1.0^2 meter. In December 1958, shortly after completion of the studies, the Army reduced this requirement to 0.1^2 meter to provide a capability against the ballistic missile threat. It then announced that funds would not be available to proceed with development of the weapon system, and the contractors took advantage of the gap to update their proposals at no additional cost to the Government. In August 1959, the Chief of Ordnance approved the selection of Convair (GD/P) as the prime contractor and indicated that FY 1960 funds would be authorized for the initiation of development. However, a directive issued by the ASA (Logistics) prohibited any discussion of program cost with the contractor pending final review and approval of the project by higher authority. The proposed development and production plans later approved by DDRE and Army Staff officials thus reflected a distorted, unrealistic view of RDTE costs, the projected total remaining at the $73.6 million level.[6]

(U) Early in 1960, AOMC raised the cost estimate to $77 million, but the full effect of program changes occurring between 1958 and 1960 could not be determined until contract negotiations began in March 1960. Consideration of such factors as increased warhead weight, radar performance, and material and labor costs resulted in an estimated budgetary requirement of $108.2 million for the 4-year program. It should be noted, however, that this estimate still did not include some key line items for which firm requirements were yet to be defined. Chief among these were

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[6] <u>See</u> above, pp. 26-28, 40, 45-46, 49-52.

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certain items of ancillary equipment (such as the battery command post and control center, support and service pods, van installations for repair parts and resupply, and training devices) whose cost definition would have to await final approval of the MAULER operational concept. In addition, the full scope of requirements for R&D, engineer, and service test hardware had not been sufficiently defined to permit an accurate cost estimate.[7]

(U) The orderly prosecution of the MAULER program within the framework of the established 4-year plan would thus require a firm and early decision regarding the undefined weapon requirements and the timely receipt of adequate funds to support the total effort. The achievement of the end objective, however, would ultimately turn on the MAULER contractor's ability to produce solid solutions to the exceedingly complex technical problems posed by the stringent logistical and operational requirements of low-level air defense in the forward area. The big question to be answered and proved in the MAULER program centered around the current state of technology in self-contained, highly mobile, all weather air defense systems. Was it technically feasible to develop a weapon system meeting the basic capabilities required by the MAULER MC's? The design engineers at AOMC were convinced that it was. And the General Dynamics Corporation stood ready to prove it.

(U) The ink had scarcely dried on the 4-year, $108-million MAULER program when AOMC planners realized that they had been gazing into a clouded crystal ball blindfolded. The required financial support failed to materialize. Firm guidance from higher authority was non-existent. The preliminary design studies

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[7] (1) Ltr, DCG, AOMC, to CofOrd, 19 Aug 60, subj: The MAULER Program. MPCF, Bx 14-256, RHA. (2) Analysis of MAULER RDTE Cost Trends, 29 Mar 62. MPCF, Bx 11-14, RHA. (3) MFR, Lewis L. Gober, Act MAULER PM, 17 Sep 62, subj: MAULER Program Hist. MPCF, Bx 13-410, RHA.

[redacted]

brought into sharp focus certain interface problems that forced compromises in the MC's. By the end of the design phase in December 1960, the envisioned program had literally collapsed, and there was talk of its impending cancellation. The funds authorized under GD/P's initial contract had been spent; a hold-order had been imposed on FY 1961 program authority; and a substantial portion of those funds had been reprogrammed to the SERGEANT project.

Development Approach

([redacted]) The development approach adopted at the outset of the program was predicated on results of the feasibility studies which indicated that the system could be evolved "using advanced techniques which are within the state of the art and require no major technical breakthroughs to meet system requirements." At the same time, the weight and space reduction of all components was recognized as "a major problem to be overcome in developing the MAULER system to comply with the requirements for Phase I airborne operations."[8] This early assessment of the problem proved to be a prophetic one indeed. Although the MAULER was, ostensibly, within reach of existing technology, the developer eventually had to face the fact that critical requirements in such areas as component packaging, launch environment, reliability, and maintainability, were in truth "pushing the state of the art."[9] Colonel Dennis very aptly described the magnitude of the packaging problem when he said: "Actually we are essentially compressing a HAWK system into 1/30th of the HAWK volume."[10]

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[8] MAULER CWSP-2, ARGMA, 5 Aug 59, p. 15.

[9] Min of MAULER Proj Staff Mtg, 3 Sep 64, p. 6, atchd to MFR, COL B. R. Luczak, MAULER PM, 10 Sep 64, subj: Trip Rept, 26 Aug - 2 Sep 64. MPCF, Bx 13-410, RHA.

[10] MAULER Reliability Presn to DOD, 24 Jun 63, p. 2, atchd to MFR, COL Norman T. Dennis, MAULER PM, 26 Jun 63, subj: Trip Rept, Washington, D. C., 24-25 Jun 63. File same.

[redacted]

Early Waivers in System Requirements

(C) The preliminary design studies had been in progress for less than 2 months when it became apparent that a waiver would be required in the MC's.[11] The original MC's approved in April 1959 had specified a requirement that the weapon system, with missiles, be transportable in Phase I airborne operations. The weight limitations imposed by this requirement were governed by the provisions of AR 705-35 which stated that the C123B aircraft, with a weight capacity of 13,000 pounds, would be used in the assault landing mode, and the C130A aircraft, with a weight capacity of 30,600 pounds, would be used in the air delivery mode. The weight requirement for air delivery by C130A aircraft presented no immediate problem, but it was evident that the weight of the MAULER fire unit would exceed the 13,000-pound limitation for transport by C123B assault aircraft. In May 1960, the AOMC Commander advised CONARC that the MAULER fire unit (weapon pod and M113-type vehicle) with 4 missiles and 20 percent fuel load would weigh about 18,400 pounds. The assault mode, he said, could be satisfied by landing the system in two C123B aircraft (the pod in one and the vehicle in the other); however, the requirement for immediate effective employment would have to be waived, since the mating of the vehicle and weapon pod would take between 10 and 30 minutes.[12]

(C) Rather than degrade the MAULER system to satisfy the weight capacity of the C123B aircraft, the Commanding General of CONARC recommended to OCRD that the weight limitation imposed for the assault landing mode be waived and that development of the MAULER be continued in its present configuration and weight.

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[11] For a complete summary of the original MC's, see above, pp. 26-28.

[12] Ltr, CG, AOMC, to CG, CONARC, 17 May 60, subj: MAULER Transportability Rqrmts. MPCF, Bx 14-256, RHA.

[redacted]

[redacted]

While the split-load delivery concept admittedly would not satisfy the Phase I requirement for immediate operation, he pointed out that the weapon pod could be operated away from the vehicle, thus affording an immediate air defense capability. Moreover, the REDEYE antiaircraft weapon, which would be operational well before MAULER, could be brought in to furnish interim air defense until the MAULER could be assembled.[13] Pending Army Staff action on CONARC's recommended waiver, AOMC instructed ARGMA to proceed with the engineering concept studies on the basis of the existing system configuration and weight.[14] Approval of the proposed split-load concept finally came toward the middle of 1961, and will be discussed in the next chapter. For present purposes, it will suffice to note that the action was followed by changes in the MAULER MC's which added a firm requirement for a helicopter lift capability; deleted the parachute delivery mode because of vehicle weight problems; and established a belated requirement for resupply of missiles by air drop.[15]

[redacted] The need for yet another waiver in the original MC's arose in September 1960, when ARGMA and GD/P encountered a problem in meeting the 2-minute system warm-up time; i.e., warm up from cold start of radars, fire control, etc. They advised CONARC that the 2-minute time would require a very comprehensive and expensive tube development program, but that a 3-minute warm-up time would be feasible with existing vacuum tubes and other components. In view of the MAULER's continuous operation and "shoot on the move" characteristics, coupled with the potential economy of time and

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[13] 1st Ind, CG, CONARC, to CG, AOMC, 27 Jun 60, on Ltr cited in fn 12, & incl thereto, Ltr, CG, CONARC, to CRD, DA, 15 Jun 60, subj: Waiver of Wt Lmtn Imposed by MC's (MAULER). MPCF, Bx 14-256, RHA.

[14] Ltr, CG, AOMC, to ARGMA Comdr, 17 Jul 60, subj: MAULER Transportability Rqrmts. File same.

[15] See below, pp. 129-32.

[redacted]

money, CONARC concluded that a warm-up time not to exceed 3 minutes would be acceptable.[16] Following approval by OCRD in November 1960, the Ordnance Technical Committee formally amended the specification as follows: "Equipment warm-up time, timing delays and other pre-firing operation functions which may be necessary before the system can be considered ready to engage a target effectively from a 'cold start' [should] be as short as feasible but will not exceed three minutes."[17] The additional minute allowed by this change might seem trivial to the lay reader, but it was critically important to the MAULER electronic engineers. They were stretching the state of the art to meet even the 3-minute warm-up time, and it appeared very likely that the requirement would have to be further relaxed to 5 minutes. The need for an extension from 3 to 5 minutes was brought out during the Engineering Concept Review held in early December 1960; however, CONARC later nonconcurred in the action and the item was deleted from the approved list of waived requirements.[18]

Engineering Concept Review

([redacted]) The MAULER program passed its first major milestone on 6-7 December 1960, when some 200 representatives of interested Army agencies gathered at Redstone Arsenal, Alabama, for the Engineering

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[16] Ltr, ATDEV-4 400.114, CG, CONARC, to CRD, DA, 16 Sep 60, subj: MAULER MC's. MPCF, Bx 14-256, RHA.

[17] OTCM 37658, 28 Nov 60 (Read for Record 26 Jan 61), subj: GM Sys AD (MAULER) - Staff Apprd Revision of MC's. RSIC.

[18] (1) Draft OTC "Read for Record" Action, atchd as incl to 1st Ind, ARGMA Comdr to CG, AOMC, 30 Dec 60, on Ltr, CofS, AOMC, to ARGMA Comdr, n.d., subj: MAULER ECR "Read for Record." (2) Ltr, 00/61S-1639, CofOrd to CG, AOMC, 3 Apr 61, subj: GM Sys, AD (MAULER), Sum of Rev - Engrg Concept of Proj DA-516-04-010, OMS Code 5210.12.117. (3) Ltr, ARGMA Comdr to CG, CONARC, 3 Jul 61, subj: same. All in MPCF, Bx 13-649, RHA.

Concept Review (ECR).[19] During that conference, the characteristics of the system engineering concept were reviewed and compared to the existing MC's. Although some design changes could be expected as developmental work progressed, it was determined that the system concept would meet all of the required MC's with exception of the one-man missile handling capability; the alternate power source for the weapon pod; radar performance under rainfall conditions; and low-speed target engagement. As noted above, the 3-minute system warm-up time also fell in this category, but it was later deleted from the official minutes of the ECR.

[redacted]) The desired missile weight of no more than 50 pounds and the required one-man handling capability specified in the original MC's were sacrificed in order to get a higher kill probability, heavier warhead for use against ballistic missiles. The maximum design weight of the complete round of ammunition in its canister was initially set at 131 pounds (111 for the missile and 20 for the canister), but this was scaled up to 140 pounds because of a change in structure of the canister walls. The contractor hoped to reduce the canister weight by using a lighter material such as fiberglass.[20]

[redacted] The weapon pod power unit presented two problems worthy of mention. First, the requirement for an alternate power source had to be waived when it became apparent that the use of the vehicle for this purpose would be unsatisfactory. Another problem concerned the high fuel consumption of the proposed AiResearch gasoline turbine which had been selected on the basis of its availability, size, weight, performance, and minimum development cost.

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[19] MAULER Chronology, 12 Oct 61, p. B-1.

[20] (1) OTCM 37907, 2 Nov 61, subj: GM Sys, AD (MAULER) - Sum of Rev - Engrg Concept of Proj DA-516-04-010, OMS Code 5210.12.117. RSIC. (2) Ltr, ARGMA Comdr to CG, CONARC, 3 Jul 61, subj: same. MPCF, Bx 13-649, RHA. (3) Convair/Pomona TM 592-036, 15 Nov 60, pp. 1.1, 1.2.

ARGMA and ERDL personnel recommended that development of the AiResearch turbine be continued for the engineering model, and that a parallel program be initiated to provide an improved regenerative or recuperative turbine capable of meeting both the technical and logistic requirements of the weapon system.[21]

([redacted]) While recognizing that the radar range performance would be degraded under the extreme rainfall conditions stated in AR 705-15, CONARC was reluctant to accept this as a bona fide reason for waiver. The problem to be solved in the course of development concerned the attenuation of radio frequency (RF) energy by rain, fog, and clouds. An early theoretical study done at ARGMA revealed that the effective range performance of the tracker-illuminator radar would be reduced from 13.3 kilometers (13,300 meters) under moderate rainfall conditions (12 inches in 12 hours) to 2.3 kilometers (2,300 meters) under intense rainfall (2 inches in 5 minutes).[22]

[redacted]) Yet another complex problem to be resolved concerned the system performance in low-speed target engagement. At the time of the ECR, it was concluded that a low-altitude crossing jet with a radial speed under 60 knots probably would not be engageable by a single MAULER fire unit. Studies of this problem would be continued.[23]

(U) As can be seen in the accompanying illustration, the

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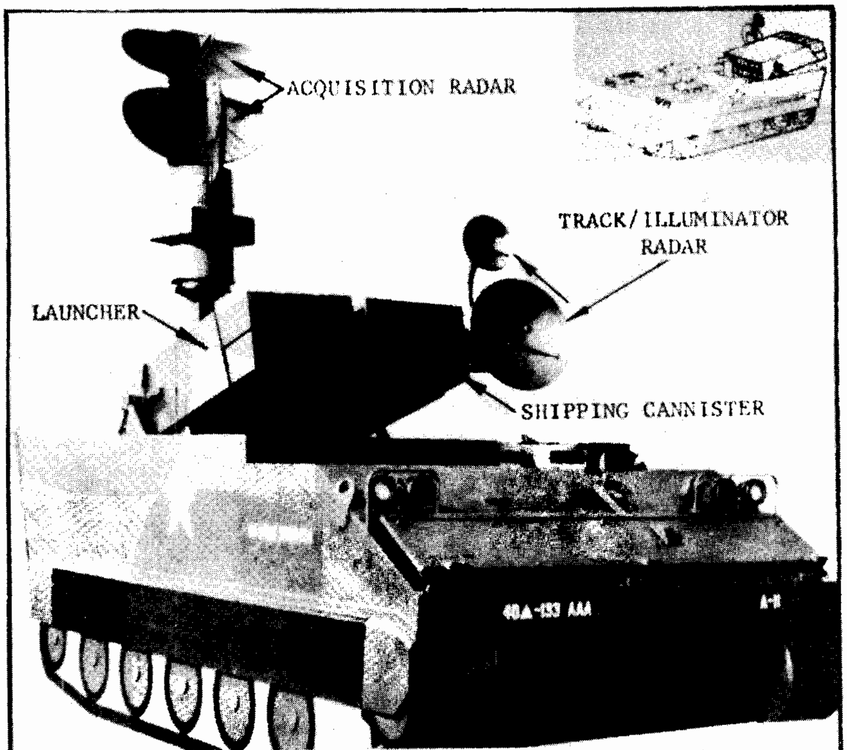
[21](1) OTCM 37907, 2 Nov 61. RSIC. (2) TT, CofOrd to CG, AOMC, 1 Dec 60. (3) Ltr, ARGMA Comdr to CofOrd, 13 Jan 61, subj: MAULER Power Supply Study. Both in MPCF, Bx 13-649, RHA.

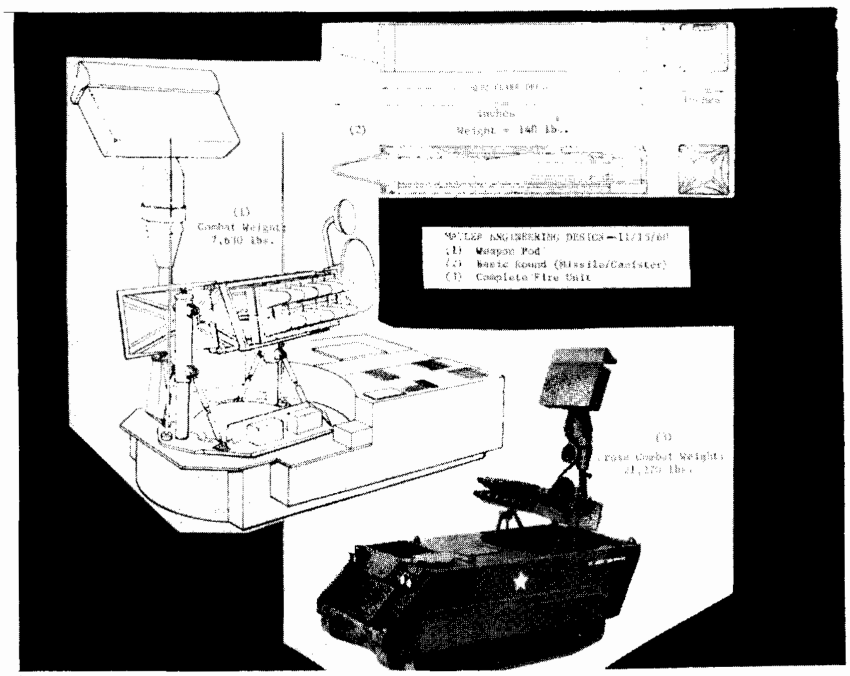
[22](1) Draft OTC "Read for Record" Action, atchd as incl to 1st Ind, ARGMA Comdr to CG, AOMC, 30 Dec 60, on Ltr, CofS, AOMC, to ARGMA Comdr, n.d., subj: MAULER ECR "Read for Record." (2) Ltr, ARGMA Comdr to CG, CONARC, 3 Jul 61, subj: GM Sys, AD (MAULER), Sum of Rev - Engrg Concept of Proj DA-516-04-010, OMS Code 5210.12. 117. Both in MPCF, Bx 13-649, RHA. (3) OTCM 37907, 2 Nov 61. RSIC.

[23]Ibid.

[redacted]



PROPOSED MAULER FIRE UNIT—CONVAIR/POMONA 12/4/58



[redacted]

basic configuration of the MAULER engineering design was strikingly similar to that of the system originally proposed by Convair in December 1958. The weapon system shown here represented the extent of the preliminary design effort, official guidance for the design of ground support equipment having been delayed. CONARC-approved maintenance and logistic concepts had been in the hands of OCRD since April 1960; however, final action was not forthcoming until September[24] and development authority still had not been released at the time of the ECR in December.[25] During the review, it was announced that the program was on a schedule which would permit an R&D release to industrial by the end of CY 1962.[26] But that target date, as well as the OSRD of July 1964, hinged on the provision of adequate FY 1961 RDTE funds and the early receipt of guidance and authority to proceed with the design of ground support equipment.

Piecemeal Funding and Program Stretchout

[redacted]) Neither of the aforementioned conditions was met. In fact, the program was already in financial trouble as early as August 1960. The FY 1961 RDTE guidance fell below the required level and, in the process of considering alternatives for a schedule stretchout, there was some talk of cancelling the project.[27] Instead of the $27.3 million needed for the programmed effort in FY 1961, the RDTE guidance for that year was $20.7 million; and the indicated guidance

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[24] DF, CRD, DA, to CofOrd, 6 Sep 60, subj: MAULER Org & Log Concept. Cited in OTCM 37584, 10 Nov 60. RSIC.

[25] (1) Ltr, CG, AOMC, to CofOrd, 21 Oct 60, subj: MAULER Spt Pods. MPCF, Bx 14-256, RHA. (2) Rept, MAULER Wpn Sys ECR - Areas for Further Action, atchd to Ltr, CG, AOMC, to ARGMA Comdr, et al., 9 Dec 60, subj: MAULER Wpn Sys ECR. MPCF, Bx 13-649, RHA.

[26] OTCM 37907, 2 Nov 61. RSIC.

[27] To compound the problem, someone leaked this information to Convair officials who immediately questioned the Government's intention to pursue the program. Journal Entry, COL S. C. Holmes, 5 Aug 60, subj: Tel Call fr COL Hirshorn.

for FY 1962 fell even shorter of the projected level—$22.3 million versus $34.1 million. Following a reexamination of the program requirements on the basis of these figures, AOMC presented the Chief of Ordnance with three possible alternatives:

1. Attempt to obtain money from other sources (such as the Navy, Marine Corps, and NATO) to provide the additional funds necessary for the current $108.2-million, 4-year program.

2. Defer the July 1964 readiness date by 1 year, which would result in a 5-year, $109.3-million program.

3. Defer the July 1964 readiness date by 2 years, resulting in a 6-year, $124.5-million program.

[redacted]) AOMC considered the latter program to be the least acceptable, because the capabilities currently specified for the MAULER were predicated on 1964 usage and not necessarily the anticipated requirements of the 1967 time frame. If additional FY 1961 funds could not be obtained to meet requirements for the current 4-year plan, the 5-year plan with an OSRD of July 1965 would be the only logical choice. Based on the $20.7 million RDTE guidance for FY 1961, and the normal cost increase resulting from the 1-year stretchout, this alternate program was costed at $109.3 million for the FY 1960-65 period. The Deputy Commanding General of AOMC emphasized, however, that this estimate did not include the cost of certain items of ground support and ancillary equipment, formal requirements for which were yet to be established. In the event of any reduction in the current FY 1961 guidance, he recommended that the MAULER program be terminated and the recovered funds applied to meet money shortages in other missile programs.[28]

(U) Having determined that no immediate financial help could be expected from outside sources,[29] the Chief of Ordnance, in late

[28]Ltr, DCG, AOMC, to CofOrd, 19 Aug 60, subj: The MAULER Program. MPCF, Bx 14-256, RHA.

[29]For details relating to the outcome of negotiations with the Navy, Marine Corps, and NATO, <u>see</u> above, pp. 89-96.

August, recommended to OCRD that the MAULER program be reoriented along the lines of AOMC's 5-year plan.[30] Inaction on OCRD's part left the program in a highly uncertain state throughout the next 4 months. In the absence of firm guidance on which program plan to pursue, AOMC, in mid-November 1960, broke off contract negotiations with Convair and placed a hold order on further obligations for the MAULER system.[31]

(U) In December, while the future of the project was still being debated, AOMC reprogrammed $737,000 of the $20.7 million RDTE program to the SERGEANT project.[32] Then, on 30 December, just as the R&D contract was running out, the Deputy Chief of Staff for Logistics (DCSLOG) authorized AOMC to award Convair a letter contract for the continuation of MAULER development, with the restriction that the cost incurred in any 1 month was not to exceed $2 million. The letter agreement was to be definitized 180 days from the date of execution at an estimated cost of $12 million.[33]

(U) The restriction imposed on monthly obligations under the letter order was lifted in late February 1961. But it was not until the fourth quarter of FY 1961 that OCRD rendered a final decision on the future course of the program. Based on guidance from Army Staff, AOMC placed the program on the 5-year schedule (see Chart 6) and supplemented the R&D contract for 3 additional months, increasing the total value of the FY 1961 supplement to

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[30] MAULER Chronology, 12 Oct 61, p. B-1.

[31] (1) Journal Entry, Chf, ARGMA Con Ofc, 15 Nov 60. (2) MFR, Fred B. Stevenson, Dep Chf, AD Sys (Low Alt) Div, Indus Ops, 15 Nov 60, subj: Hold Order on MAULER.

[32] MFR, Lewis L. Gober, Act MAULER PM, 17 Sep 62, subj: MAULER Program Hist. MPCF, Bx 13-410, RHA.

[33] TT ORDXR-IH-1826, ARGMA Comdr to CO, LAOD, 30 Dec 60. MPCF, Bx 13-649, RHA.

$18.27 million. Since $737,000 of the $20.7 million RDTE program had been lost to the SERGEANT project, this left AOMC only $1.7 million for all other program tasks, including in-house support.[34]

(U) While the project staff at AOMC thus prepared for a repeat performance of the funding wrangle for FY 1962, Convair (GD/P) proceeded with the component design and development test phase of the program.

[34](1) MFR, Lewis L. Gober, Act MAULER PM, 17 Sep 62, subj: MAULER Program Hist. MPCF, Bx 13-410, RHA. (2) Add to MAULER TDP, 10 Dec 65, pp. 11-12.

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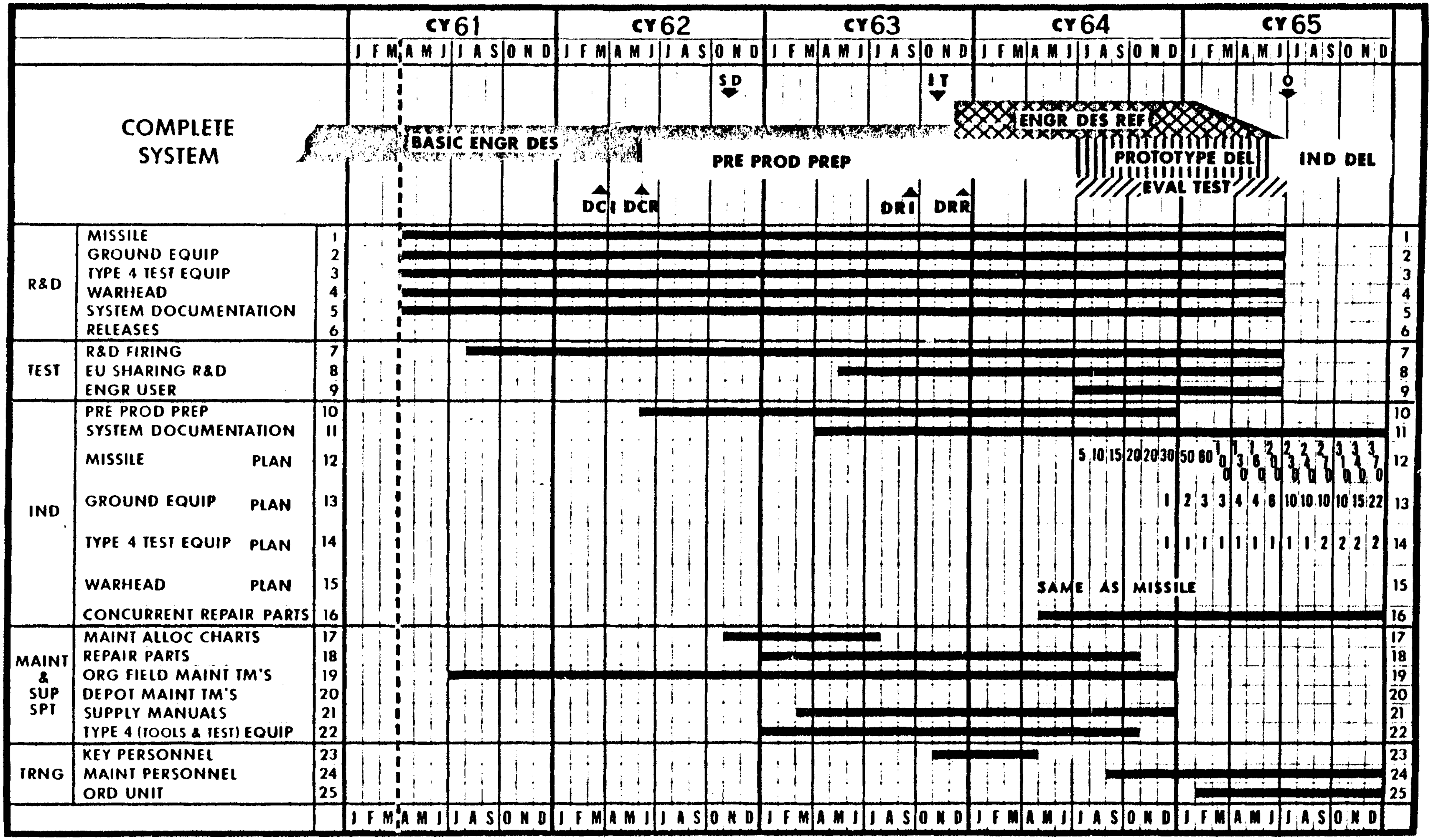
CHART 6 RCS XMC - 5

MAULER

COMMODITY PLAN (U)



PLAN
PROGRESS
DELAY
DELAY ELIMINATED
POTENTIAL PROB AREA
SPECIAL NOTES

AD FUNDED DELIVERY
B BUDGET PROP SUBM FOR FUNDS TO
BD BUDGET PROP SUBM FOR DEL TO
D DEPLOYMENT
E IND ECO CONTROL
F FUNDS REQUIRED

IT BEGIN INSTRUCTOR TRAINING
O ORD READINESS DATE
P PROGRAM AUTH REQ
SD SYSTEM DEMONSTRATION
T BEGIN ORD UNIT TRAINING

ECI ENGR CONCEPT INSP
DCI DESIGN CHARACT INSP
DRI DESIGN RELEASE INSP
PEI PROD EQUIP INSP
SCI SPEC COORD INSP

ARMY ROCKET AND GUIDED MISSILE AGENCY
argma
CONTROL NO. M 786
MICS REV D DATE 30 JUN 61

CHAPTER V

(~~C~~) THE BREADBOARD MODEL WEAPON SYSTEM (U)

(~~C~~) Designed to meet a unique set of deployment circumstances, the MAULER presented a singular challenge. Using state-of-the-art hardware and straightforward engineering methodology, AOMC and GD/P proposed to place in the hands of troops by July 1965 a mobile, completely automatic, fast-reacting guided missile system for defense against high performance, low-altitude aircraft and short-range missiles and rockets. In general, the approved MAULER engineering concept consisted of a lightly armored, fully tracked XM-546 vehicle with an especially tailored welded hull, and a weapon pod containing the fire control system and a rack with 12 missiles and containers which doubled as shipping containers and launchers. A driver for the vehicle and an operator for the weapon pod comprised the basic crew, but space was provided in the pod for a third man who might be a platoon commander or a relief operator. Aside from the useful functions the third man could perform, his presence was calculated to relieve the mental tensions of the primary operator. To enable these men to perform skilled, decisive operations in close confinement, under the continuous physical and emotional stresses imposed by both system and battlefield environments, it was essential that the MAULER meet stringent reliability requirements. It would have to be safe and comfortable, and at the same time be highly effective in all operational situations, in all physical environments.[1]

(U) The breadboard model weapon system took shape during the initial phase of the basic engineering design effort which began

[1] Convair/Pomona TM 592-034, MAULER Wpn Sys Tech Description, 15 Nov 60, pp. 1.1 - 1.6, 6.1 - 6.3.

in the fall of 1960 and continued through 1961. Early in that period, primary attention was focused on the fabrication and test of breadboard components and subsystem mockups to obtain the necessary data for establishing firm design parameters. The results of the experimental Launch Blast Simulator tests were relayed on a continuous basis to all members of the development team for application to the system design. As these firings progressed and the design parameters became firm, the various contractors began a series of laboratory tests to demonstrate the operational capabilities of particular subsystems and their compatibility with interfaced units. Concurrently with these experimental activities, GD/P engaged a group of enlisted men in an aggressive human factors engineering test program, and the vehicle developers completed a series of transport mode tests to provide the necessary data for design of the XM-546 vehicle.

The Launch Blast Simulator Test Program

([redacted]) The purpose of the Launch Blast Simulator (LBS) test program was to reconcile the difference between theoretical and actual performance, and to provide the environmental and blast data required for component design. Theoretical thermodynamic and dynamic analytical approximations had been established in a series of one-tenth scale model tests conducted at GD/P's Cold Air Jet Facility.[2] Based on the data collected in these tests, GD/P and its subcontractors fabricated the LBS test hardware which included full-scale mockup-type weapon pods with a multiple-cell canister rack, dummy radar antennae, and ZUNI rocket motors assembled with other hardware to approximate the general configuration expected of the MAULER missile.

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[2] GD/P Rept CR-830-152-003, Feb 1962, subj: MAULER Wpn Sys Dev Test Program Plng Docu, p. 68. MPCF, Bx 14-424, RHA.

(~~C~~) The ZUNI[3] rocket motor, whose thrust was about two-thirds that of the MAULER motor, was selected for these initial experimental firings on the basis of its availability as a production motor to reasonably approximate the blast characteristics expected of the motor being developed by the Grand Central Rocket Company. The blast data provided by these LBS firings would enable the early definition of component design which would later be confirmed by a follow-on series of Launch Test Vehicle firings using the actual MAULER motor.[4]

(~~C~~) In the course of the LBS test program, 30 missiles of the ballasted ZUNI rocket configuration were installed in foam-lined canisters and fired at pre-set launch angles with the following overall objectives:[5]

1. To obtain launch blast environmental data as related to safety of personnel in and near the weapon pod.

2. To validate assumptions of and/or to define structural loads imposed by missile launching on the hardware located on the weapon pod in the immediate vicinity of the rocket blast.

3. To determine the effect of launch blast on the fire missile canister, adjacent canisters, and the canister rack assembly.

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[3] An unguided Navy rocket used in both air-to-surface and air-to-air operations, the ZUNI was developed by the Naval Ordnance Test Station for the Bureau of Ordnance and produced by the Hunter-Douglas Division of Bridgeport Brass Company at a unit cost of $150. Like the MAULER, the solid-propellant ZUNI rocket was launched from a disposable canister which also served as a shipping container. It was 9.2 feet long and 5 inches in diameter, with a gross weight of 107 pounds. Frederick I. Ordway, III, & Ronald C. Wakeford, International Missile and Spacecraft Guide (McGraw-Hill Book Co., New York, 1960), pp. USA/30-31.

[4] (1) PSAC MAULER Program Status Rept, 14 May 63, pp. 3-5. MPCF, Bx 13-410, RHA. (2) GD/P Rept CR-830-152-003, Feb 1962, op. cit., pp. 77-78. MPCF, Bx 14-424, RHA.

[5] (1) Ibid., p. 78. (2) Five additional LBS rounds were reserved for future range instrumentation use and as backup rounds for the Launch Test Vehicle program. MAULER Prog Rept, Aug 1961, p. 1.

4. To obtain environmental data required for component design.

The GD/P test crew fired the first round (LBS-1) at the nearby Naval Ordnance Test Station on 16 September 1960, then moved to the White Sands Missile Range (WSMR) where the remaining 29 rounds were test fired between 12 October 1960 and 22 September 1961.[6]

([redacted]) One of the most difficult problems facing the development contractor concerned the design of a canister that would meet the weight requirement and, at the same time, withstand the blast effects of the rocket motor without appreciable distortion or bulging. Though removed from the rack assembly and discarded after a missile firing, the canister would have to be structurally strong enough to preclude distortion and consequent damage to, or interference with, the live missiles in adjacent canisters. Members of the test crew addressed themselves to this problem in the first four LBS firings completed in early November 1960. They evaluated mockups of the heavy-wall canister in two of the firings (LBS-2 and -4) and the light-wall type in the other two (LBS-1 and -3). Although all four of the canisters sustained varying degrees of distortion and considerable styrofoam erosion (see photographs of LBS-3), the light-wall design was selected for use in the remainder of the LBS program.[7]

[redacted]) The next two LBS rounds were fired from the B-1 mockup canister rack removed from the pod and mounted on the launch pad. During the period 31 January to mid-June 1961, the test crew evaluated the B-1 pod (a steel mockup simulating only that portion of the pod assembly from the turntable and above) in a variety of

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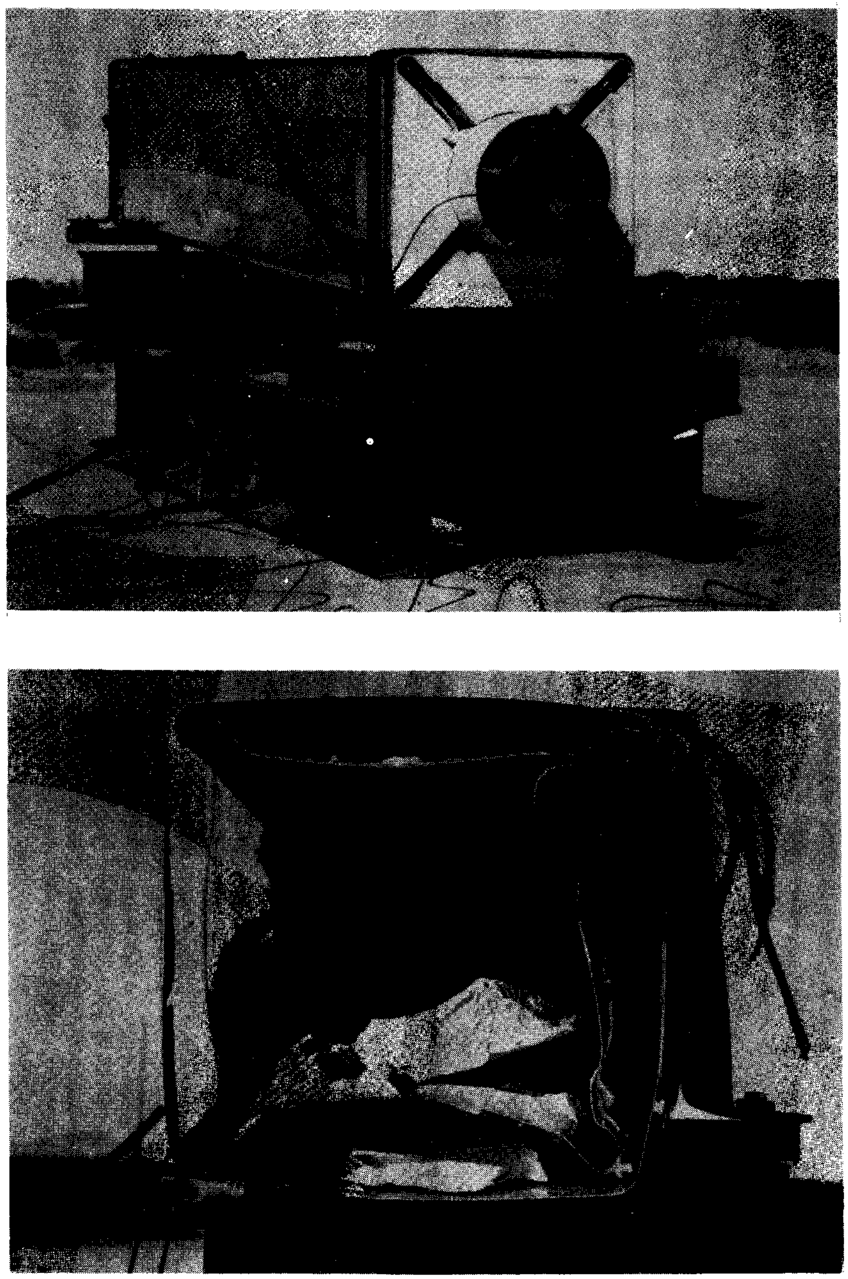
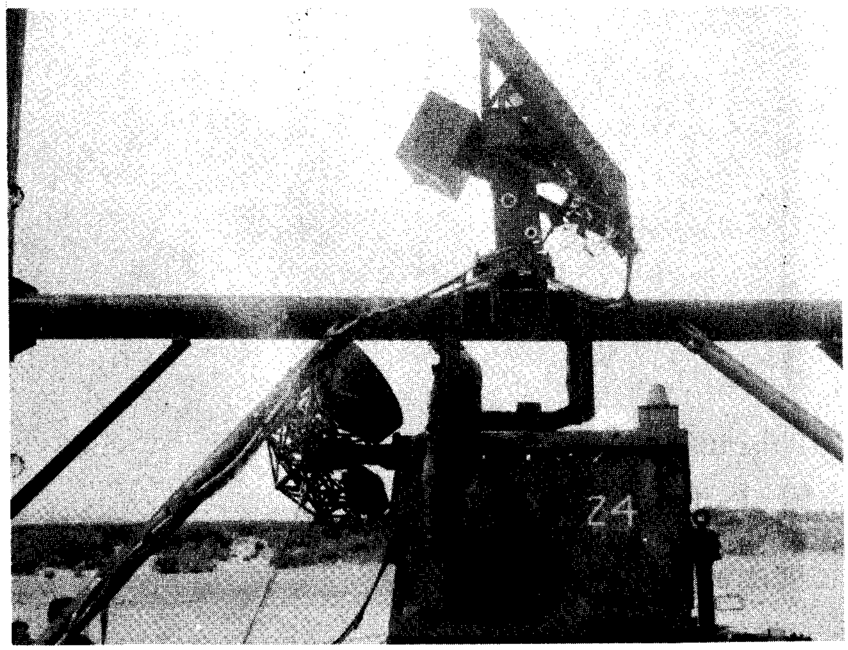
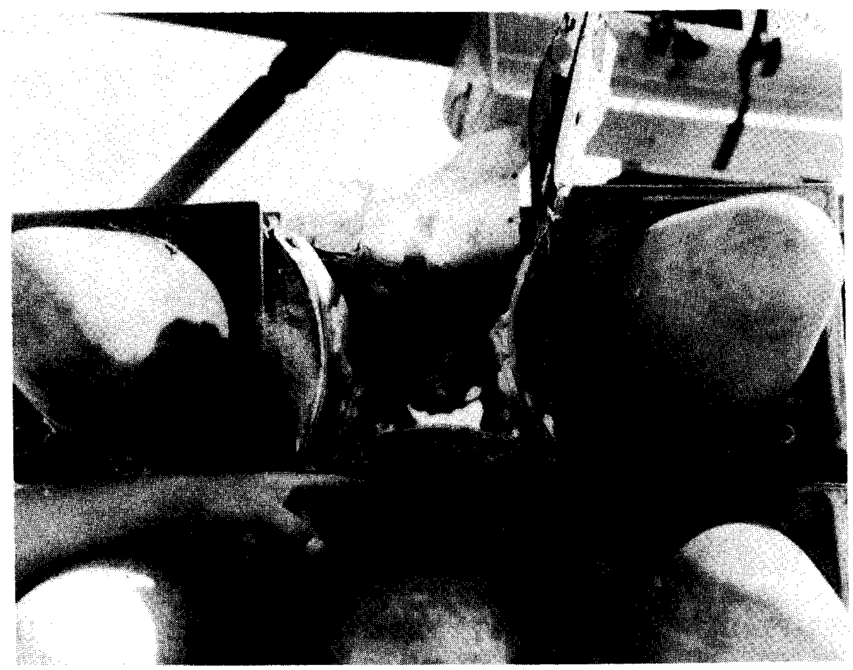
[6](1) WSMR MAULER Actv Rept, atchd to Ltr, CG, WSMR, to ARGMA Comdr, 30 Mar 61, subj: Ltr of Xmitl. MPCF, Bx 13-649, RHA. (2) Convair/Pomona TM-830-11, MAULER LBS Program Firing Repts, 16 Sep 60 - 22 Sep 61. MPCF, Bx 14-424, RHA.

[7]Ibid., pp. II.1 - II.18.



(U) PRE-FIRING AND POST-FIRING REAR VIEW OF THE LBS-3 FIBERGLASS-COATED, PRE-FOAMED, LIGHT-WALL, OPEN-ENDED CANISTER, AT WSMR, 1 Nov 60—About 50% of the foam was ejected during launch and the rocket pressure at firing distorted the canister as shown in the bottom photograph. (In an earlier test of the light-wall design—LBS-1, 16 Sep 60—the canister ruptured along one of the two spot-welded seams, with resultant loss of all the foam lining, and the force of the blast broke the 2 x 3/16-inch strap iron which restrained the canister at the aft end.)





LBS-24, 26 May 61 (top)—Test set-up of B-1 pod assembly, new acquisition radar design and IR receiver, and new arrangement of T-I radar assembly.

LBS-25, 2 Jun 61 (bottom)—Post-firing view of B-1 rack with dummy IFF antenna visible in upper right corner. Front end of firing canister badly damaged and most of styrofoam lost; front of adjacent dummy round canister opened by blast.

test set-ups to determine the blast effect on the pod, adjacent dummy missiles and nose covers, dummy radars and IFF antenna, and different types of paint and hardware samples. These firings (LBS rounds 7-26), together with concurrent laboratory tests, culminated in a number of design changes and improvements, not the least of which were a new thick-wall fiberglass nose cover, a flat-array acquisition radar, and a new tracker-illuminator (T-I) radar design with the 15-inch receiving antenna mounted below rather than above the 30-inch transmitting antenna (see accompanying photographs of LBS-24 and -25).[8]

([redacted]) In mid-June 1961, GD/P shipped the first D-2 pod and XM-546 vehicle (less engine and transmission) to WSMR for use in the last four LBS firings and the follow-on Launch Test Vehicle program. For these firings, the MAULER test crew moved from the Army Launching Area #2 (ALA-2) to the Small Missile Range, where a special Tracking Test Vehicle (TTV) firing was conducted in late June to evaluate camera instrumentation.[9]

([redacted]) In the July 1961 progress report (distributed to higher headquarters and user agencies), the MAULER project staff at ARGMA described the results of the first three firings from the D-2 pod and XM-546 vehicle (LBS-27, -28, and -29) as follows: "All firings were successful; no damage to the pod or vehicle was experienced and there was no abnormal damage to the canisters." To the extent that these tests provided valuable blast effects data, they

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[8] Ibid., pp. II.25 - II.119.

[9] (1) The missile used in this special test was one of the five reserve LBS-type rounds. GD/P TM-330-31A, 7 Nov 62, MAULER TTV Sp Firing Tests, p. 1. MPCF, Bx 14-424, RHA. (2) It had been assumed that the existing Small Missile Range facility would be adequate for both the R&D and engineering test program; however, a closer study of the data requirements revealed that new test facilities would have to be constructed for adequate support of the Guidance Test Vehicle firings. See below, pp. 151-52.

were indeed successful; but the rest of the analogy was not borne out by the contractor's test reports. On the contrary, the results of these three July firings and the last LBS test in September 1961 clearly indicated a continuing structural problem with the canister, significant blast damage to exposed surfaces, and a potentially serious human engineering problem arising from the collection of smoke in the driver and operator compartments.

[redacted] In the LBS-27 test firing, for example, the canister's rear cover blew out satisfactorily, but it split from front to rear because of a weld failure, and deposited a large amount of caked styrofoam on the lower part of the turret compartment which was dented from the rocket blast. Other significant post-firing observations showed two pod mounting studs separated from the vehicle because of a weld failure; dummy canisters on two cells separated from the rack; paint damage on exposed surfaces of wooden canisters; and the driver, engine, and operator compartments filled with smoke.[10]

[redacted] Similar conditions were noted in the other three firings. The firing canister in one test was deformed inward from front to rear; in another, it expanded and made contact with adjacent canisters and the T-I antenna mount; and in the last test, it was deformed about 3/4-inch outward on three sides. Paint erosion from the rocket blast was observed on exposed surfaces of the D-2 pod and vehicle; foam from the firing canister caused severe paint chipping on the lower side of the acquisition antenna; the cover of the dummy T-I receiver antenna sustained a large triangular tear; and excessive smoke collected in the driver and engine compartments.[11] Such were the problems requiring a solution in the upcoming Launch Test Vehicle and Control Test Vehicle programs.

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[10]Convair/Pomona TM-830-11, <u>op</u>. <u>cit</u>., pp. I.27, II.124.

[11]<u>Ibid</u>., pp. I.28, II.136 - II.142. <u>Also</u> <u>see</u> App. I.

[redacted]

Changes in System Transport Requirements

([redacted]) The XM-546 vehicle hull and D-2 pod assembly delivered to WSMR in June 1961 had been designed and fabricated by the Food Machinery & Chemical Corporation (FMC) on the basis of data obtained from the LBS test firings and extensive transport mode tests conducted during the first quarter of CY 1961. The design of the MAULER fire unit presented a particularly difficult problem because of the weight and size restrictions imposed by the air lift requirements and the space needed to house all of the on-board equipment and personnel. The XM-546 vehicle was a modified version of the standard M113 armored personnel carrier, the main difference being in the extended length to accommodate the weapon pod and the lightened hull to meet air lift requirements.[12]

([redacted]) In January 1961, the XM-546 vehicle underwent lateral, longitudinal, and vertical vibration tests at GD/P. In early March, the vehicle and simulated pod went through environmental tests over various courses at Aberdeen Proving Ground, followed by a series of static air drop tests at the Yuma Test Station in Arizona. The latter tests were concluded when structural failures occurred in the vehicle hull. Before sending the vehicle to WSMR for use in the final LBS tests, FMC redesigned the hull for a greater shock capability, adding about 300 pounds to the vehicle weight and compounding an already serious transportability problem.[13]

([redacted]) As noted earlier, the initial design weight of the fire unit exceeded the 13,000-pound capacity of the C123B assault landing aircraft, resulting in the need for a waiver to permit

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[12] Ltr, ARGMA Comdr to MG John A. Barclay, AOMC, 10 Feb 61, n.s., & incl thereto, MAULER Veh Spare Parts Study.

[13] (1) ARGMA Diary, 1 Jan - 30 Jun 61, p. 102. (2) ARGMA Hist Sum, 1 Jan - 30 Jun 61, p. 81.

[redacted]

[redacted]

delivery of the vehicle and weapon pod in separate loads, and the sacrifice of an immediate effective employment capability because of the time required for mating the vehicle and pod.[14] The gross combat weight of the fire unit, with a full load of fuel (85 gallons), 12 missiles, on-vehicle equipment (OVE) and material (OVM), and three personnel, had been set at 21,270 pounds—13,640 for the vehicle and 7,630 for the weapon pod. The reducible weight for airlift had been set at 18,738 pounds—12,788 for the vehicle, with 20 percent fuel, airlift OVM, and driver; and 5,950 for the weapon pod, with 20 percent fuel, 4 missiles, and 1 operator.[15] These weights met the payload capacity of the C123B aircraft for delivery in two loads; however, with the 300 pounds added to the vehicle hull to meet the parachute delivery requirement, the air lift weight of the XM-546 vehicle exceeded the capacity of the C123B aircraft by nearly 100 pounds. To compound the problem, a change to AR 705-35, in June 1961, reduced the assault landing capacity of the C123 aircraft from 13,000 to 11,080 pounds, a weight utterly impossible to meet in the vehicle design.[16]

[redacted] Meanwhile, CONARC established a belated requirement for a helicopter lift capability for the MAULER weapon pod. Though not included in the original MC's published in April 1959, the need for a helicopter lift capability for both the vehicle and weapon pod had been established by the Army Air Defense School as early as January 1959, and the ARGMA R&D Division had learned of it through an unofficial communication in June.[17] Twenty-two months

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[14] <u>See</u> above, pp. 108-110.

[15] Convair/Pomona TM 592-037, 15 Nov 60, pp. 1.13 - 1.15.

[16] MAULER Prog Rept, June 1961, p. 2.

[17] Ltr, USAADS to CG, CONARC, 20 Jan 59, subj: Hel Transport of MAULER, partially quoted in Ltr, LTC William M. Stowell, USARADBD, to COL M. R. Collins, Jr., ARGMA R&D Div, 1 Jun 59, n.s. MPCF, Bx 11-14, RHA.

[redacted]

later, in April 1961, CONARC established a formal requirement for a helicopter lift capability for the MAULER weapon pod only, and urged that the pod weight be limited to the lift capacity of the CHINOOK class helicopter. Under standard atmospheric conditions, the CHINOOK would be able to lift 8,000 pounds to an altitude of 8,000 feet or to a range of 20 miles. The requirement for helicopter-lift of the weapon pod, approved by OCRD in May 1961, therefore limited the pod weight to 8,000 pounds, including 4 missiles and 20 percent fuel load.[18]

[redacted]) The aforementioned problem of vehicle weight was partially solved in late June 1961, when CONARC decided that the limited requirement for MAULER delivery by parachute did not necessitate further development for that particular mode. The need for initial air defense of the airhead would be satisfied by the REDEYE, the MAULER weapon pod assault landed by C123B aircraft, and command of the air necessary to mount an airborne operation. The CONARC Commander therefore recommended that no further emphasis be placed on parachute delivery of the MAULER, but that development be continued to meet requirements, as follows:[19]

1. Overall weight of the mobile fire unit not to exceed the capacity of the C130A aircraft.

2. Weight of the vehicle and pod, when delivered separately, not to exceed the capacity of the C123B aircraft.

3. Weight of the weapon pod not to exceed the lift capacity of the CHINOOK helicopter.

[redacted]) The OCRD subsequently concurred in these recommendations,

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[18] (1) Ltr, CG, CONARC, to CRD, DA, 3 Apr 61, subj: Hel Lift of the MAULER Wpn Pod. MPCF, Bx 14-256, RHA. (2) OTCM 37792, 29 Jun 61, subj: GM Sys, AD (MAULER) - Ch in MC's. RSIC.

[19] Ltr, ATDEV-4 452.161, CG, CONARC, to CRD, DA, 29 Jun 61, subj: Prcht Dlvry of MAULER. MPCF, Bx 14-256, RHA.

thus obviating the need for the structural change and resultant 300-pound vehicle weight increase.[20] Guidance on the other part of the problem came in August 1961, when AOMC advised ARGMA that the 13,000-pound C123B payload limit was still valid, the change to AR 705-35 notwithstanding.[21] Then in January 1962, after GD/P had completed the Launch Test Vehicle (LTV) firings, CONARC decided that the resupply of MAULER missiles by air drop was a firm requirement and should be considered during the design of the missile and canister.[22] This belated requirement did not, of itself, present a particularly difficult problem. It was, however, another typical example of the piecemeal fashion in which weapon system requirements were established and furnished to the prime contractor.

Weapon Pod Engineering Design

([redacted] The engineering design and laboratory test of subsystem breadboards and mockups for the MAULER weapon pod proceeded concurrently with, and on the basis of data obtained from, the LBS test program. At the conclusion of the latter tests on 22 September 1961, the design of the pod structure, key on-board equipment, and the MAULER missile had been established, and pre-qualification firings of the rocket motor were nearing completion

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[20](1) Ltr, CRD-C2 30820, CRD, DA, to CG, CONARC, 8 Aug 61, subj: Prcht Dlvry of MAULER. MPCF, Bx 14-256, RHA. (2) Also see OTCM 37908, 2 Nov 61, subj: GM Sys, AD (MAULER) - CRD Pos with Regard to Prcht Dlvry. RSIC.

[21]TT, CofOrd to CG, AOMC, 7 Aug 61; and Ltr, CG, AOMC, to ARGMA Comdr, 28 Aug 61, subj: Ch 1 to AR 705-35. Both cited in incl to DF, Chf, MAULER Br, TSPO, R&DO, to XO, R&DO, ARGMA, 20 Oct 61, subj: ARGMA Hist Sum for the Six Months 1 Jan - 30 Jun 61.

[22](1) 1st Ind, ATDEV-4 471.94, CG, CONARC, to CG, AOMC, 18 Jan 62, on Ltr, CG, AOMC, to CG, CONARC, 22 Dec 61, subj: Resupply of MAULER Msls by Air Drop. (2) Ltr, MAJ Henry D. Mitman, AOMC, to GD/P, 20 Jan 62, n.s. Both in MPCF, Bx 14-12, RHA.

in preparation for the first LTV flight test in late September. By the end of 1961, three LTV test rounds had been fired from the D-2 Pod/XM-546 vehicle assembly and work on the integrated F-1 breadboard weapon pod was nearing completion.

[redacted] Designed to fit into the rear hull of the XM-546 tracked, amphibious, lightly armored vehicle, the weapon pod was a self-contained missile launching system capable of functioning independently of the carrier vehicle without sacrificing fire power. The aluminum pod structure housed the power unit[23] and air conditioner in the right front compartment, and the fire control and communication center in the left front compartment with space for two men. The turret compartment at the rear of the pod supported the 12-missile launcher rack assembly, the acquisition and T-I radars, and subsidiary equipment such as the electronic IFF (Identification, Friend or Foe) system.[24]

[redacted] The major elements of the fire control system embraced the operator's console and display unit, Stable Reference and Position (STRAP) unit, Target Data Processor, Track Evaluation Computer, Launch Order Computer, and interunit fire coordination equipment. The accompanying illustration depicts the multifarious components and subassemblies of the MAULER weapon system as initially designed. Some of the major design changes made in the course of the LBS test program are briefly mentioned earlier in this chapter.[25] The present discussion deals with the function, operational relationship, and laboratory test of the major

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[23] The primary power unit consisted of a gas turbine driving an alternator and turret azimuth drive hydraulic pump through a common gearbox. The AiResearch GTP-70-54 unit was selected for the breadboard model, but because of its excessive fuel consumption, the Solar T-150 turbine was evaluated as a backup system. MAULER TDP, 31 Mar 61, p. 9. MPCF, Bx 14-256, RHA.

[24] Ibid., p. 7.

[25] See, for example, the photograph of round LBS-24, p. 126.

components and subsystems.

Operator's Console

([redacted]) The heart of the MAULER system was the operator's console and display unit. The operation of all elements of the weapon was controlled from this panel which provided a comprehensive visual display of the surrounding air traffic and the operational status of all equipment. Here, in one compact area, either or both of the operators had access to all displays and controls needed to assess the tactical situation, insert human knowledge and judgment into machine decisions, select various modes of operation, and control the complete weapon system.

([redacted]) The unique features of the MAULER system required that the machine fit the man almost like a second skin. To assure that this man-machine would perform as specified, a staff of military psychologists and operations research specialists from the APG Human Engineering Laboratories (HEL), in coordination with GD/P, began an aggressive human factors study program very early in the basic design phase. In support of this effort, the Army Air Defense Command furnished 12 enlisted men for participation in a painstaking human engineering test and evaluation program, using a mockup of the operator's compartment. Only part of the elaborate theoretical, experimental, and field studies to be included in the program, the human factors console evaluation began at GD/P in April 1961, following a 1-week personnel orientation and training period. It embraced studies in such areas as the console layout, seating, long term habitability, and general operator performance under a variety of conditions.[26]

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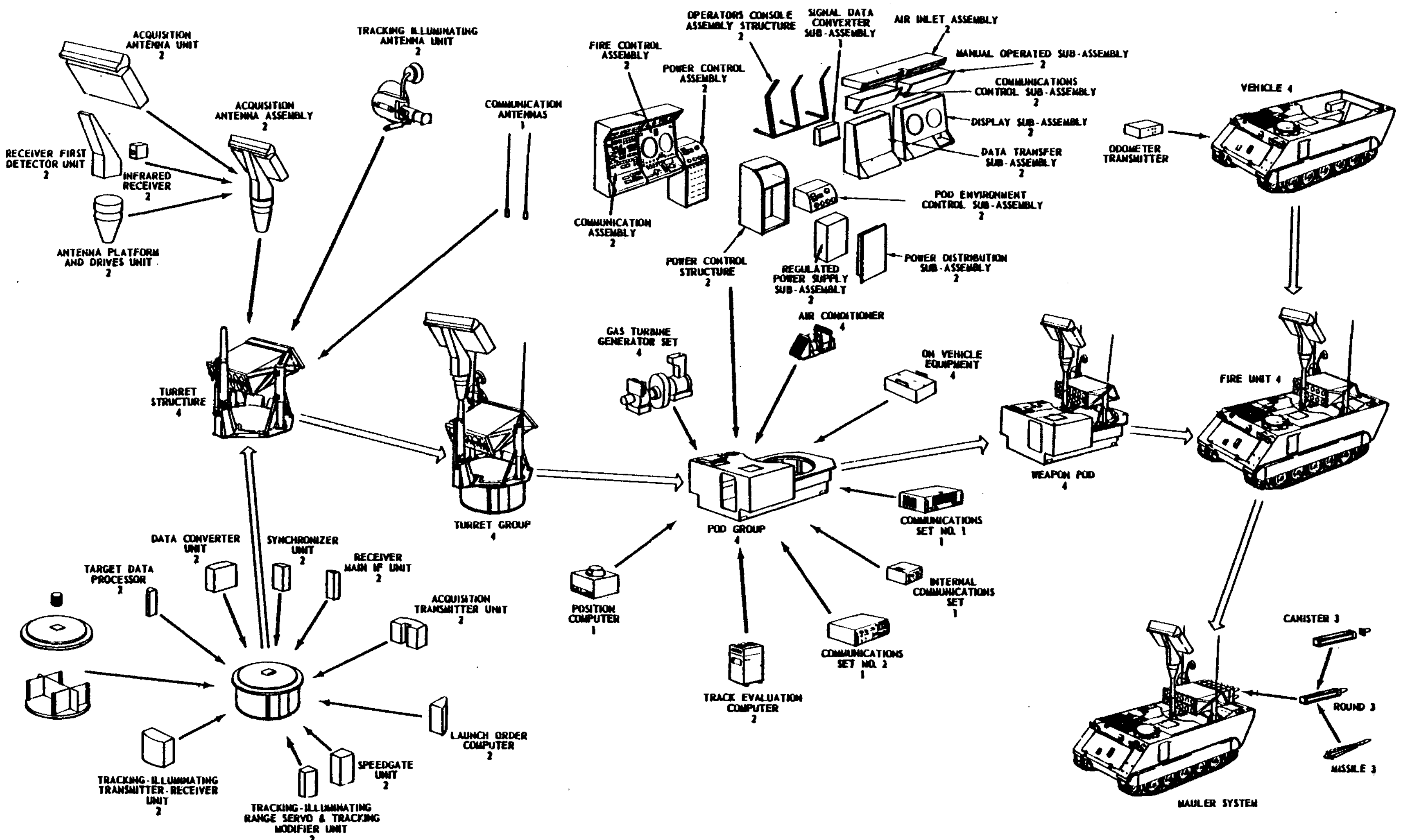
[26] (1) MAULER TDP, 31 Mar 61, p. 10. MPCF, Bx 14-256, RHA. (2) Ltr, ARGMA Comdr to CO, LAOD, 12 Apr 61, subj: Req for 2000 Hrs of Radar Oriented Mil Enl Pers Time in Spt of MAULER Contr ORD-1951. (3) ARGMA Hist Sum, 1 Jan - 30 Jun 61, p. 86.



COMPONENTS OF
MAULER System, Nomenclature.

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[redacted]

(U) Based on the results of the initial evaluation, GD/P fabricated the subassemblies for the console breadboard, and began the second series of human factors studies in June 1961. It froze the console face layout in September and devoted subsequent effort to packaging and design refinements. The electrical and mechanical interface designs for the fire control and power control units were frozen in October, thus permitting development of both units to proceed at an accelerated pace. By the end of December, the fire control unit specification for the R&D phase and the design of the engineering model passive display unit had been completed. The initial human engineering evaluation continued through the completion of the breadboard phase in the spring of 1962. A similar human factors program for the R&D prototype console was later initiated with another group of enlisted personnel.[27]

Stable Reference and Position (STRAP) Unit

([redacted]) A vital element of the MAULER weapon pod, the STRAP unit provided stabilization outputs for the radar and infrared acquisition sets; vehicle orientation data for the launch order computer; a stabilized north orientation for the track evaluation computer; and position computation to the fire unit. It was composed of a stable platform which detected pitch, roll, and azimuth of the fire unit; a computer section which computed the motion of the unit in grid coordinates; and an electronic section.[28]

(U) Development of the STRAP unit was begun in the fall of 1960 at the Astro Space Laboratories, Huntsville, Alabama, a subsidiary of the Belock Instrument Corporation, which had a fixed-

[27] (1) Ibid., p. 87. (2) MAULER Prog Repts, Sep - Dec 1961. (3) Ltr, Act MAULER PM, AOMC, to CG, USARADCOM, Ent AFB, Colo., 28 Aug 62, subj: Mil Pers Spt of the MAULER Sys Dev Program. MPCF, Bx 11-14, RHA.

[28] MAULER TDP, 31 Mar 61, p. 9. MPCF, Bx 14-256, RHA.

[redacted]

price contract with GD/P. The original schedule called for delivery of the breadboard model in July 1961 and four engineering models in November 1961 and January, March, and May 1962. The program proceeded with no sign of abnormal difficulty until July 1961, when the ARGMA Test & Evaluation Laboratory installed the breadboard unit in an Army van for closed-loop tests over measured courses. From that point on, technical problems and delays abounded, as the road tests were repeatedly interrupted to correct deficiencies in key elements of the unit. As a result, the breadboard acceptance program was not completed until April 1962, and delivery of the engineering models (now reduced to three) was rescheduled for June, July, and August 1962.[29] AOMC then learned in mid-April that the Belock Instrument Corporation was on the verge of bankruptcy and had requested financial relief under ASPR 17-204.2. This led to another postponement in engineering model deliveries: two in August and one in September 1962.[30] As a result of continuing problems and delays, GD/P and MICOM later decided to drop the Belock STRAP unit in favor of a simpler device.[31]

Acquisition Radar and Infrared (IR) Scanner

([redacted]) The MAULER's primary target detection system, developed by the Raytheon Company, was a pulse doppler, stacked-beam, track-while-scan acquisition radar, which provided inertially stabilized

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[29](1) MAULER Prog Repts, Jul - Dec 1961. (2) DF, Chf, MAULER Br, SAM Sys Div, R&DD, to Chf, MAULER Br, Low-Alt AD Wpn Sys Div, Indus Dir, 26 Apr 62, subj: Belock Instrument Corp. MPCF, Bx 13-649, RHA.

[30](1) Ltr, DCG,GM, AOMC, to CofOrd, 8 May 62, subj: MAULER Monthly Prog Rept for Apr 1962. (2) AOMC Rept, Anal of Belock Instrument Corp Req for Relief, 6 Jun 62, atchd to Ltr, CG, AOMC, to CofOrd, n.d., subj: Belock Instrument Corp Req for Relief Under Sec 17 of ASPR. Both in MPCF, Bx 13-649, RHA.

[31]*See* below, pp. 183-84.

data on all air vehicles through 360 degrees in azimuth, from horizon to about 70 degrees in elevation. It was designed to detect all types of low-altitude targets from helicopters to ballistic missiles of the HONEST JOHN and LITTLEJOHN type, the latter having a radar cross section of 0.1^2 meter. Its detection range was about 19.5 kilometers (km). The infrared acquisition (IRA) unit mounted at the rear of the acquisition radar head was a passive surveillance system designed to provide continuous monitoring of the area of interest without disclosing the position or even the existence of the MAULER fire unit.[32]

(U) The Raytheon Company completed the design and fabrication of the acquisition radar breadboard subsystems and began laboratory tests in late 1961, with system tests scheduled for early 1962. Development of the IR scanner breadboard was considerably behind the acquisition radar, the contract with the Canadian Commercial Corporation not being signed until October 1961. To increase performance of the acquisition system, the original C-band was changed to L-band, and the radar head was changed to a flat-array design as indicated earlier in this chapter. One of the main weaknesses in the system was its vulnerability to side lobe jamming.[33]

Computer System

(U) To meet its performance requirements, the MAULER system would have to be capable of acquiring a target, achieving lock-on, launching a missile, and accomplishing intercept, all within a span of a few seconds. It was therefore essential that the system

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[32](1) MAULER TDP, 31 Mar 61, p. 14. MPCF, Bx 14-256, RHA. (2) ARGMA Hist Sum, 1 Jan - 30 Jun 61, p. 81.

[33](1) *Ibid.*, p. 82. (2) ARGMA Hist Sum, 1 Jul - 11 Dec 61, p. 38. (3) TT 083, CofOrd to CG, AOMC, 23 May 61, & reply thereto, Ltr, ARGMA Comdr to CofOrd, 3 Jul 61, subj: MAULER and the ECM Environment. MPCF, Bx 13-649, RHA.

[redacted]

be able to complete the threat assessment and engagement process rapidly and automatically with a minimum of participation on the part of the operator. For this purpose, the fire control system used a chain of three computers: the target data processor, the track evaluation computer, and the launch order computer.

[redacted] The target data processor served as the link between the target acquisition system and the track evaluation computer. From the acquisition radar it received data on target azimuth, elevation, range, and range rate; encoded the information in a message table for each target; then stored the total message in a buffer storage unit for transfer, upon command, to the track evaluation computer for further processing and assignment. The Raytheon Company subcontracted development of this special-purpose digital data processor to the Burroughs Corporation.

([redacted] The track evaluation computer, also developed by the Burroughs Corporation, served as the computing link between the T-I radar and the launch order computer. A binary digital computer with a non-destructive memory capacity of 2,048, 17-bit words, it received target messages from the target data processor; assembled the information into reasonable coherent target tracks; evaluated these tracks according to the relative seriousness of the threat; provided updated coordinates of the highest priority target to the launch order computer; and automatically initiated engagement orders unless overriden by the operator, who could manually counter the selection at any time. The track evaluation computer could display up to 240 target reports, or about as many as would be visible to the acquisition radar during any three scans. From these, it selected the eight most threatening targets and assigned the greatest immediate threat to the T-I radar and launch order computer for engagement.

([redacted] The launch order computer, developed by GD/P, was an analog system which served as the link between the acquisition-

[redacted]

designation system and the T-I and launcher complex. Its primary function was to perform lead angle computations and to provide position order inputs to the launcher-drive system. When the T-I radar locked on a designated target, the launcher order computer would automatically direct the launcher to the correct lead angle, or launch elevation, select and prepare the missile to be fired, and provide the firing impulse.[34]

Tracker-Illuminator (T-I) Radar

(C) The ultimate effectiveness of the MAULER air defense system would be measured in large part by the performance of the T-I radar and missile seeker head in the last critical phase of the firing sequence. Developed by the Raytheon Company, this radar set was a Frequency-Modulated/Continuous Wave (FM/CW) system which provided guidance intelligence for the missile by illuminating the designated target and transmitting a rear channel reference signal to the missile's CW semiactive homing system. It received rough coordinates of the selected target from the track evaluation computer; automatically acquired, locked onto, and tracked the target; and fed refined target coordinate and range rate data to the launch order computer for positioning the launcher and missile.[35] The T-I radar performance requirements called for a detection and lock-on capability of 20 km against a 0.1^2 meter target; a detection probability of 85 percent; a tracking accuracy within 2.0 degrees of the target position; and subclutter visibility of at least 70 decibels (db).[36]

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[34](1) MAULER TDP, 31 Mar 61, pp. 12-13. MPCF, Bx 14-256, RHA. (2) ARGMA Hist Sum, 1 Jan - 30 Jun 61, pp. 82-84.

[35](1) Ibid., p. 84. (2) MAULER TDP, 31 Mar 61, p. 12. MPCF, Bx 14-256, RHA.

[36]GD/P Rept, Mar 1962, subj: Detm of Optimum Design of the T-I Radar Ant & Msl Cntnr Rack, p. 2. MPCF, Bx 13-649, RHA.

([redacted]) The MAULER designers pressed the state of the art to the limit in many technical areas, but one of the most hostile conditions they faced concerned the design of a T-I radar that would meet the performance requirements of the MAULER system and still be small enough to fit the limited stowage space at the side of the launcher rack. The Ad Hoc Group on Low Altitude Air Defense had recognized the magnitude of this problem in its study report of July 1956. Moreover, it will be recalled that the feasibility of the proposed Convair/Raytheon radar system had been seriously questioned by members of the MAULER evaluation committees, who warned that the achievement of a fully effective missile-radar system would definitely present the greatest challenge. They could not have been more correct, for the radar developer was plagued by technical difficulties and design problems throughout the program.

([redacted]) Raytheon began laboratory tests of the first T-I breadboard model in February 1961. It then shipped the second model to GD/P for missile compatibility tests, and supplied dummy models to WSMR for use in the LBS test program. Based on the design concept originally proposed in 1958-59 and retained during the preliminary design studies in 1960, these early breadboard models consisted of a 15-inch parabolic receiving antenna mounted above a 30-inch parabolic transmitting antenna and attached to the side of the missile-launcher rack assembly. (See illustrations on page 113.)

([redacted]) One of the first problems revealed in the early laboratory tests concerned the 30-inch transmitting antenna, which would not fit in the stowage space at the side of the launcher and still meet the height limits for air transport. Since the antenna size could not be reduced without degrading system performance, its removal for air transport appeared to be a logical solution. But then another more serious problem developed that would not be so easily solved. It involved spillover from the transmitting antenna to the receiving antenna and to the missile seeker, caused by side-lobe radiation and reflections from nearby clutter. Since the spillover level directly determined the allowable noise in the T-I transmitter, it was essential that the transmitter be isolated as much as possible from the missile.

([redacted]) To reduce the side-lobe values and to eliminate mechanical interference, Raytheon inverted the receiver and transmitter antennae[37] and initiated studies to improve the design by using tunnels on the antenna dish. It also initiated a study, in mid-1961, to determine the feasibility of replacing the parabolic transmitting antenna with a flat, phased-array design similar to that adopted for the acquisition radar. The results of these studies, together with continuing design and performance problems, later led to a major redesign of both the T-I radar and missile-launcher rack assembly.[38]

Missile-Launcher Design

([redacted]) In contrast to the original sandwich-type missile-launcher rack arrangement (two rows of six rounds each), the engineering breadboard evolved during 1961 consisted of a stacked arrangement (three rows of four rounds each). Mounted atop the turret assembly, the launcher rack could be elevated and trained throughout a 360-degree field of fire, and was designed to accommodate the expected range of vehicular motion inherent in shoot-on-the-move action. The forward plane of the open end of the rack was slanted back from bottom to top to facilitate canister loading.

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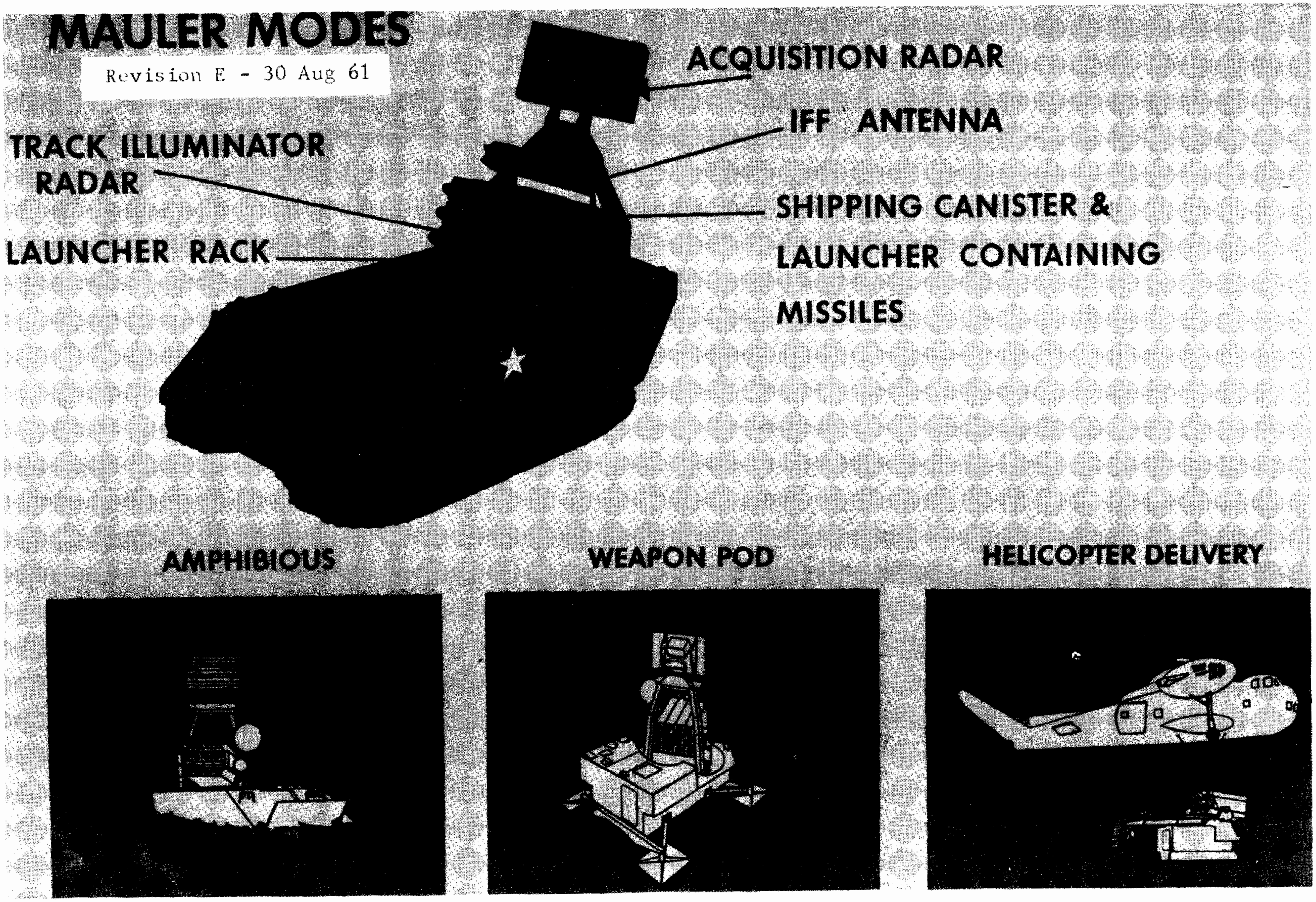
[37]The 15-inch receiver was mounted below rather than above the 30-inch transmitter, as shown in the accompanying illustration.

[38](1) MAULER TDP, 31 Mar 61, p. 12. MPCF, Bx 14-256, RHA. (2) ARGMA Hist Sum, 1 Jan - 30 Jun 61, pp. 84-85. (3) MAULER Prog Rept, May 1961, p. 2. (4) ARGMA Hist Sum, 1 Jul - 11 Dec 61, pp. 38-39. (5) <u>Also see</u> MAULER Prog Repts, Jun - Dec 1961.


MAULER MODES
Revision E - 30 Aug 61
ACQUISITION RADAR
IFF ANTENNA
TRACK ILLUMINATOR RADAR
SHIPPING CANISTER & LAUNCHER CONTAINING MISSILES
LAUNCHER RACK
AMPHIBIOUS
WEAPON POD
HELICOPTER DELIVERY

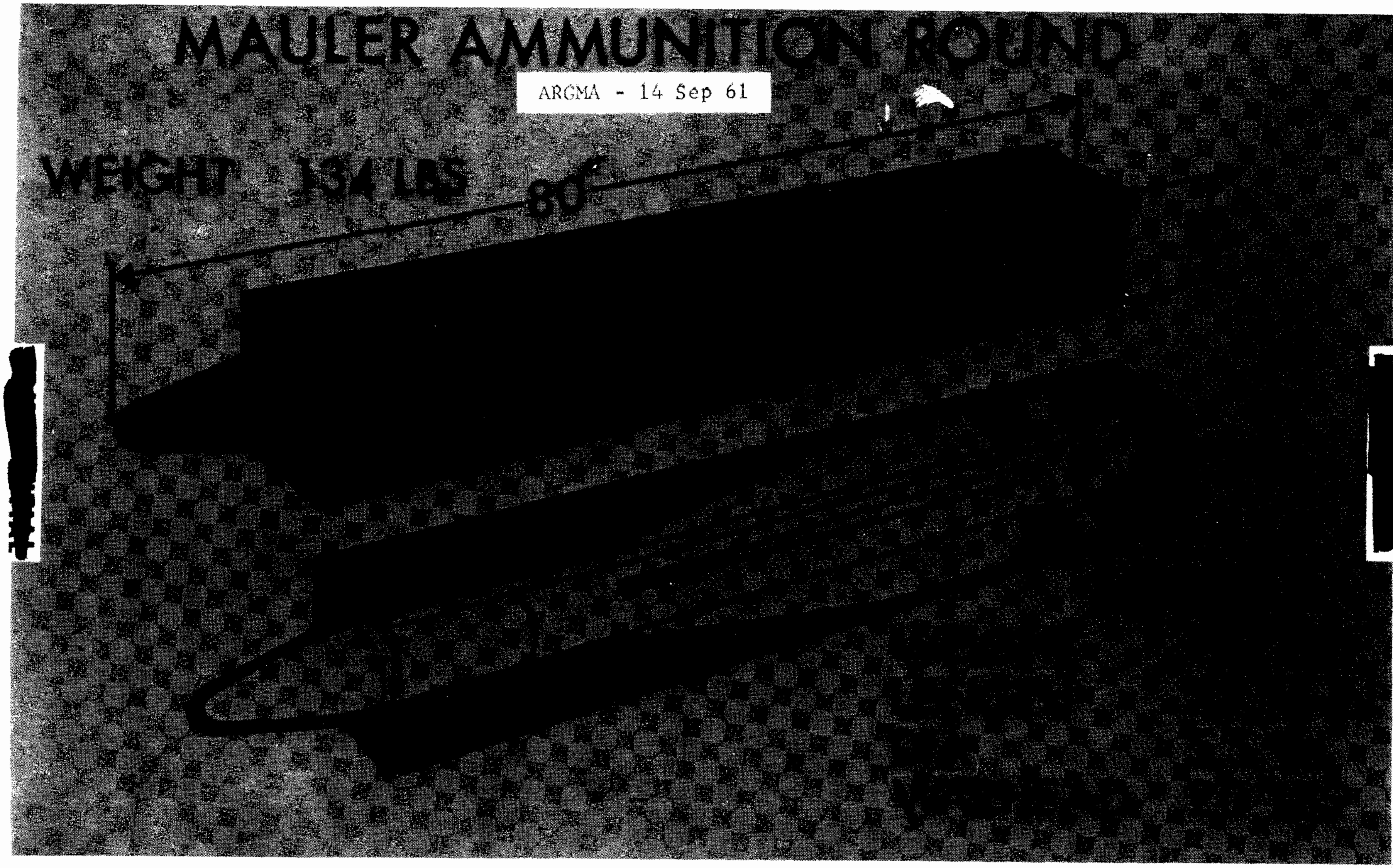
[redacted]

U [redacted] The MAULER ammunition round, embracing the missile and its canister, could be carried and loaded into the rack assembly by two men. The foam-lined canister served the dual role of launching tube and shipping container, and also protected adjacent missiles from the rocket blast. Before firing, explosive bolts ejected the nose cover, and blast cutouts on the rear of the canister relieved the rack structure of most of the blast reaction. After firing, the disposable canister could be easily removed from the rack and replaced with a new ammunition round.

U [redacted] The dart-shaped MAULER missile was propelled by a single-stage rocket motor and guided by a semiactive CW homing system which locked onto target-reflected radar energy. Once locked onto the target, the missile could be fired automatically or at the will of the operator. Two or three missiles could be launched at one target in less than 2-second intervals. Structurally, the missile was comprised of five sections: the radome and electronic sections, making up the guidance and fuzing system; and the warhead, rocket motor, and control sections.

U [redacted] The missile seeker head, located in the radome section, locked onto the target before launch and flew a proportional navigation course to the target using semiactive homing. It was designed to lock onto a 0.1^2 meter target at ranges up to 17.8 km. Upon loss of homing signal, the missile would automatically switch to home-on-jam mode; and upon return of signal would switch again to semiactive homing. The electronics section contained the radar seeker, a semiactive, X-band, homing receiver using narrow-band, doppler speedgate tracking; the autopilot, embracing the steering and roll rate control system; the electronic power supply; and the warhead proximity fuze and safety and arming device which was equipped with an impact and self-destruct device.

U [redacted] The blast-fragmentation XM-51 warhead section was carried in the missile's mid-section next to the rocket motor. Developed


MAULER AMMUNITION ROUND
ARGMA - 14 Sep 61
WEIGHT 134 LBS
80"

[redacted]

by Picatinny Arsenal, it weighed about 20 pounds including metal parts and was 8.712 inches long with a 5.35-inch diameter.

([redacted]) The propulsion system, taking up most of the missile's 77.16-inch length, consisted of a high performance, solid-propellant rocket motor with a slotted tube grain configuration. It was designed to develop a thrust of about 8,350 pounds, sufficient to bring the missile to a maximum velocity of Mach 3.2.[39] The Grand Central Rocket Company[40] began development of the rocket motor in June 1960 as a subcontractor to Convair (GD/P).[41]

([redacted]) The necessary in-flight maneuverability for the MAULER was provided by two pairs of diametrically opposite tail fins which controlled the missile in pitch, yaw, and roll. The tail fins, all independently controlled, were driven by a hot gas servo system powered by solid propellant gas generators.[42]

([redacted]) One of the most serious problems encountered in the development of missile components concerned the rocket motor. The program at the Lockheed Propulsion Company progressed on schedule and without abnormal difficulty until late March 1961, when the first two experimental rocket motor cases failed because of a propellant liner bonding problem. Lockheed immediately began laboratory tests of a new butyl rubber inhibitor material to solve the problem, with the aim of meeting a late June delivery date for the first launch test vehicle rocket motor. However, the results

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[39](1) MAULER TDP, 31 Mar 61, pp. 8, 12, 15-16. MPCF, Bx 14-256, RHA. (2) ARGMA Hist Sum, 1 Jan - 30 Jun 61, pp. 87, 89. (3) TIR 2-3-7A1, OCO, Jan 1962, subj: Dev of GM Warhead Sec for MAULER. RSIC.

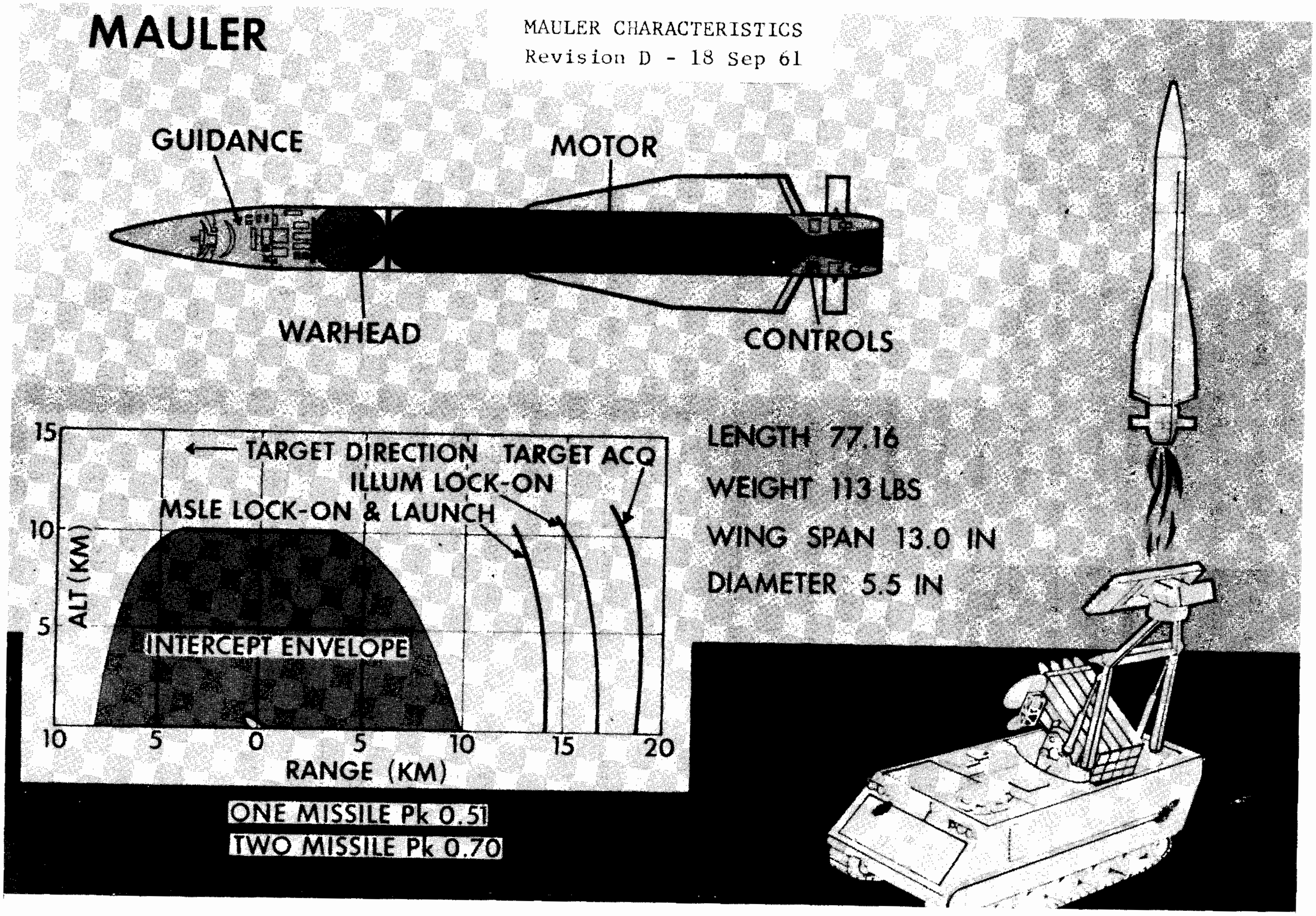
[40]Later renamed, and hereinafter cited as, the Lockheed Propulsion Company.

[41]For details relating to technical requirements, contractor selection, and original delivery schedules, see above, pp. 72-74.

[42]Design Info Bulletin (DIB) No. 4B, GD/P, 22 Jun 61, subj: MAULER Hot Gas Con Sys. MPCF, Bx 13-649, RHA.

[redacted]

MAULER CHARACTERISTICS
Revision D - 18 Sep 61



[redacted]

of three static tests in June 1961 indicated motor failure shortly after ignition because of a propellant liner separation. Lockheed then prepared a new design, using a butyl rubber inhibitor system in conjunction with a PL-1 liner and plastisol GCR-1003A propellant. Static tests of four experimental motors with the new design, in August, indicated that the problem had been solved. Following a series of seven successful static firings, Lockheed cast the first flight test motor and shipped it to WSMR in September.[43]

([redacted]) Yet another problem then developed with respect to ballistic performance, the initial motor configuration falling about 10 percent short of the required total thrust. Pending completion of a development program to increase motor performance, Lockheed, GD/P, and ARGMA agreed to a deviation in the specifications. Under this agreement, the total impulse, thrust, and operating temperature requirements for the initial experimental motors were modified to correspond with the current state of the art.[44] The improved high-performance motor reached the flight test stage in mid-1962 and is discussed in the next chapter.

Launch Test Vehicle (LTV) Program

([redacted] The LTV firing program got underway at the WSMR Small Missile Range in late September 1961, after a delay of some 6 months. The general objectives of these tests were to obtain in-flight aerodynamic, aeroelastic, dynamic, and thermodynamic data using the MAULER missile airframe and low-performance rocket motor; to evaluate the ejection operation of the front and rear canister covers; and to obtain launch blast environmental data as related to the safety of personnel in and near the weapon pod. For the

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[43] (1) ARGMA Hist Sum, 1 Jul - 11 Dec 61, pp. 41-42. (2) Also see MAULER Prog Repts, Apr - Sep 61.

[44] (1) ARGMA Diary, 1 Jul - 11 Dec 61, p. 116. (2) MAULER Prog Rept, Oct 1961, p. 4.

[redacted]

first firing, on 28 September, the D-2 pod was removed from the XM-546 vehicle and placed on the launch pad. Rounds LTV-2 and -3 were fired from the pod/vehicle combination on 27 October and 5 December, respectively. The low-performance rocket motor for these LTV rounds used the thick-wall (0.080-inch) case design with undetachable (spot-welded) steel wings. (The fourth and final missile in the LTV series was reserved for later use in proof testing the improved high-performance rocket motor and the aluminum wing configuration.)

([redacted]) The results of the three LTV firings disclosed a number of problem areas requiring design changes and refinements in both the missile and ground equipment. Except for a slight erosion of the nozzle liner on LTV-2, the interim rocket motor functioned properly and was released in mid-December 1961 for use in the initial control test vehicle firings. In all three tests, the missile zero-lift or skin friction drag was from 20 to 30 percent greater than predicted, because the method of paint application was unsuitable for the flight environment. Severe wing vibrations presented another potentially serious problem, the source of which was not immediately determined. Performance of the telemetry system was sufficient to collect the major portion of the required flight data; however, coverage was incomplete.

([redacted]) Problems relating to the blast effects on the canister and the exposed surfaces of adjacent equipment were very similar to those revealed in the LBS firings. Operation of the front cover ejection mechanism and the frangible (fiberglass) rear canister cover was found to be satisfactory, but structural failure of the double-wall aluminum canister continued to present a problem. The expansion or bulging of the canister walls noted in the first two firings was considerably reduced by the use of an improved foam bonding, but the canister still failed to meet reliability requirements. A study of the post-firing blast data showed that none of the conditions evident in the canister could result in failure of a singly fired missile; however, expansion of the canister walls could adversely affect performance of a salvo of missiles fired from adjacent canisters. To correct this condition, GD/P continued its search for a more rigid foam material to strengthen the canister's crown section. The launch blast data further demonstrated the need for better thermal protection on exposed surfaces of the pod and vehicle, and pointed up a potentially serious dispersion problem resulting from the severe blast load on the T-I radar. In the area of personnel safety, the noise levels and toxic content of gas samples were not considered excessive.[45]

(U) The design refinements resulting from the LTV firings and the ensuing Control Test Vehicle (CTV) program would be applied to the Guidance Test Vehicle (GTV) for final R&D tests. An early analysis of data requirements for the CTV and GTV programs had indicated that existing range facilities at WSMR would be adequate to support both phases. However, a range survey in the summer of 1961 disclosed that the existing facilities would not be adequate to support the test program beyond the CTV phase. In November, the Commanding General of WSMR advised ARGMA that new range facilities costing about $288,750[46] would be required for the GTV firings which were tentatively scheduled to begin in early July 1962.[47]

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[45](1) GD/P Rept CR-830-166-001, 24 Aug 62, subj: LTV Sum, pp. 1-5. MPCF, Bx 14-424, RHA. (2) MAULER Prog Rept, Dec 1961, pp. 3, 6. (3) Also see App. II.

[46]The proposed program included $210,326 for construction of specialized facilities (i.e., blockhouse, launching pad, radar tower, and utilities), and $78,424 for the modification of three existing support buildings. Funds for GTV instrumentation hardware ($411,000) had already been received and procurement was in progress.

[47]Ltr, ARGMA Comdr to CG, WSMR, 3 Nov 61, subj: MAULER Data Rqrmts for GTV, & 1st Ind thereto, CG, WSMR, to ARGMA Comdr, 17 Nov 61; atchd as incl to Ltr, Chf, MAULER Br, TSPO, R&DO, ARGMA, to GD/P, 28 Nov 61, n.s. MPCF, Bx 13-649, RHA.

[redacted]

To maintain that schedule, AOMC informed the Chief of Ordnance that authority to proceed with construction of test facilities would be required no later than 8 December 1961.[48] The urgency of this message, however, was overshadowed by the FY 1962 funding wrangle which culminated in another program stretchout and delayed the finalization of construction contracts to April 1962.[49]

[48] TT, CG, AOMC, to CofOrd, n.d., atchd as incl to SS ORDXR-A-4-61, 9 Nov 61, subj: MAULER Dev Test Facs, WSMR. MPCF, Bx 13-649, RHA.

[49] Ltr, Chf, R&D Div, OCO, to CG, AOMC, 23 Mar 62, subj: DOD Proj 92A Rept, & incl thereto. File same.

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CHAPTER VI

[redacted] FISCAL ANEMIA AND PROGRAM STRETCHOUT (U)

(U) Back in the spring of 1959—when the MAULER was yet a mere gleam in Convair's eye—MG J. H. Hinrichs, the Chief of Ordnance, had given his peers in the Pentagon a prophetic piece of advice that bears repeating. In a progress report on implementation of the Corps' assigned R&D projects, he wrote:

> As a result of inadequate funding, we have frittered away over a period of time considerable sums of money on some development programs with very small returns. The Plato project is an example of this, and there are others. I have advised the C/R&D that I believe the initiation or continuation of any development project at a funding level less than that necessary for efficient prosecution of the project is not worthwhile, and that, if necessary, we should do fewer things in a more complete manner.
>
> Funding controls, in most instances, the quality as well as the rate of progress. We cannot expect limited funds to fund unlimited programs regardless of how promising. I shall continue to make recommendations on the continuation, suspension, or termination of projects not only on the technical merits of each, but on the funding prospects. That these recommendations are not always approved is recognized as a fact of life. However, in many instances, disapproval poses a real problem of finding funds to pursue the selected course of action. . . .[1]

Three years later, nothing could be added and nothing subtracted from his words, for such was the dilemma of the MAULER project in 1962-63. The lessons of the ill-fated PLATO project[2] notwithstanding, the MAULER was headed straight down the same path to oblivion for many of the same reasons.

(U) Throughout the 1962-63 period, the MAULER program was

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[1] Memo for LTG Carter B. Magruder, DCSLOG, DA, 29 May 59, subj: Ord Objectives.

[2] See Ruth Jarrell & Mary T. Cagle, History of the PLATO Antimissile Missile System - 1952-1960 (ARGMA, 23 Jun 61).

characterized by continued fiscal anemia, painful stretchout, and escalation in RDTE cost; a multiplicity of unsolved technical problems and growing criticism of the contractor's performance; a lack of firm and timely guidance on requirements for support equipment; agonizing program reviews and reappraisals; and finally, a complete redirection of the effort to a "kill or cure" operation in late 1963. From a standpoint of adverse influence on the overall program, no one of these situations can be divorced from the other, for they all had an interrelated tendency to cause delay, frustration, and confusion, and ultimately to undermine confidence in the contractor's ability to develop an acceptable MAULER system within reasonable time and cost. Indeed, the magnitude of the problems yet to be solved in May 1963 prompted one well-informed congressional source to assert: "There is no certainty today that this advanced weapon actually can be built."[3] At that time, the Army Readiness Date had slipped 34 months—from July 1964 to May 1967—and the total estimated RDTE program cost had climbed from $77 to $323.9 million, some $120.39 million of which had been obligated during the FY 1960-63 period.[4]

(U) While the lack of technical progress during the 1962-63 period was basically the fault of the prime contractor, top-level Government officials materially contributed to the dilemma and must therefore share the responsibility for the outcome. The urgent need for an early MAULER capability had long since been recognized, and that need became even more critical with the termination of the VIGILANTE program and the retirement of the M42 DUSTER. In apparent recognition of this need, DOD accorded the MAULER top development priority and on several occasions

[3] William E. Howard, "Technical Troubles Hit Mauler Missile," Huntsville Times, May 5, 1963.

[4] (1) MAULER Chart AMCPM-MAM M-3942, 24 Apr 64. MPCF, Bx 13-410, RHA. (2) Add to MAULER TDP, 10 Dec 65, p. 10.

expressed a desire to speed up the delivery date. In practice, however, the officials holding the purse strings simply were not willing to pay the price of an efficient conventionally phased program, let alone that of an accelerated development effort. Instead, they subjected the MAULER program to a piecemeal, "stop-start" funding philosophy which not only had a profound impact on the rate and quality of technical progress, but also contributed to the schedule slippages and the steady rise in RDTE costs.

(U) It will be recalled that the MAULER program had suffered a 1-year stretchout near the end of FY 1961, when the 4-year, $108-million program was supplanted by the 5-year, $109.3-million program with a new readiness date of July 1965. The RDTE funding requirement based on the revised plan had been placed at $28.4 million in FY 1962 and $26.5 million in FY 1963. These funding estimates, however, did not include key items of ground support and ancillary equipment, the technical requirements for which had neither been developed by the user nor approved by OCRD.[5] General Hinrichs reminded OCRD, in May 1961, that the full cost of the MAULER program could not be estimated until receipt of firm guidance on support vehicles and equipment, and further, that prompt action would be required in order to meet the delivery schedule for the complete weapon system. In addition to the need for firm direction on items of equipment not organic to the fire mission of the system, he urged that an early decision be made on the specific IFF system to be used in the MAULER.[6]

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[5] See above, pp. 114-17.

[6] (1) DF, Cmt 1, 00/61S-2360, CofOrd to CRD, DA, 10 May 61, subj: IFF & Other Equip for MAULER. MPCF, Bx 13-649, RHA. (2) As noted earlier, decisions relating to IFF equipment had been delayed by an Ordnance-Signal Corps funding dispute. This controversy was finally settled in July 1961; however, since IFF equipment was a tri-service item, the specific system to be used in the MAULER had to await a final JCS decision which was not forthcoming until late 1962. See above, pp. 75-81.

Fiscal Year 1962

[redacted]The FY 1962 funding exercise started out with a monumental paper study aimed at speeding the MAULER's service availability, but ended with another program stretchout. During the first quarter, the Secretary of Defense queried the Army on the possibility of accelerating the program. Indicating that the project appeared to be substantially underfunded, he requested a report on the adequacy of funding for the current program, together with a complete program package for an accelerated development-production effort.[7]

[redacted] In early October 1961, LTG Arthur G. Trudeau, the Army Chief of R&D, furnished the Army Staff two plans, one outlining the full scope of funding requirements for the current 5-year program and the other an accelerated program. The current program—calling for an initial operational capability by July 1965 and totaling $630.1 million in RDTE and PEMA funds—provided only for the fire unit and missile plus very limited maintenance equipment. The total cost of the planned 5-year program (incorporating all essential items required to equip, train, operate, and support 14 battalions) was estimated at $1,088.3 million. Under this program, the first battalion would be activated in September 1965, and the last of the 14 battalions in July 1967. Under the proposed $1,197.8-million accelerated program, the first MAULER battalion would be activated 8 months earlier (January 1965) and the last of the 14 battalions 18 months earlier (January 1966).[8]

[redacted] To improve the chances of approval by the Secretary of Defense, Dr. Finn J. Larsen, ASA (R&D), requested that the proposed plans be reexamined "to determine if it would be feasible to provide

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[7] Memo for CofS, DA, fr ASA (R&D), 19 Sep 61, subj: Rev of MAULER Proj. MPCF, Bx 13-649, RHA.

[8] SS CRD-C2 33144, thru CofS & ASA (R&D), to SA, 9 Oct 61, subj: Rev of MAULER Proj, & incls thereto. MPCF, Bx 13-649, RHA.

a more austere program." He felt that the proposals included requirements for certain features which were desirable but not entirely necessary for effective operations, and that the funding needs could be substantially reduced by a "more simplified concept" of operation.[9]

([redacted]) Following an exhaustive study of all aspects of the project, in mid-November, the MAULER Materiel Coordination Group (MCG) came up with a 6 percent reduction in total program costs, the planned 5-year program being reduced to $1,030.5 million and the accelerated program to $1,130.8 million. The following table shows the FY 1962-63 funding status of the existing MAULER program and the funding requirements for the planned and accelerated programs (in millions of dollars).

	Currently Funded 5-Year Program[*]	Plnd 5-Yr Program	Accelerated Program
FY 1962			
RDTE..............	$ 28.5	$ 58.2	$ 84.9
PEMA..............	.7[**]	.9	4.0
OMA[***]............	0.0	3.5	3.5
FY 1962 Total.....	29.2	62.6	92.4
FY 1963			
RDTE..............	27.3[**]	75.5	85.3
PEMA..............	92.9[**]	126.8	199.7
OMA...............	0.0	0.0	2.5
FY 1963 Total.....	120.2	202.3	287.5
Total to Completion:	($ 630.1)	($ 1,030.5)	($ 1,130.8)

[*] As of Project 44 Report, dated 15 August 1961.
[**] Guidance in DOD Memorandum, subj: Review of Program Packages, dated 22 Sep 61, deleted $ .7 million in FY 62 PEMA and $92.9 million in FY 63 PEMA, and increased FY 63 RDTE to $50 million.
[***] Operations and Maintenance, Army.

Both of the programs included funds for Multisystem Test Equipment (MTE); and this, together with other items of support equipment not

[9] Memo for CofS, 26 Oct 61, subj: MAULER Proj. MPCF, Bx 13-649, RHA.

previously considered in the cost analysis, accounted for most of the difference in cost between the existing and planned 5-year programs. The increase in cost of the accelerated program resulted from such factors as multiple shift operation, increased tooling for higher production rates, dual sources of some critical items, increased number of components and subassemblies in the R&D phase, and an increased level of effort to assure adherence to schedules.[10]

([redacted]) In forwarding these program packages to the Secretary of Defense, the Secretary of the Army emphasized the urgent need for the MAULER, adding that until "this weapon system is operational, forward combat elements of the field army will be virtually defenseless against attack by short range tactical missiles and rockets and by high speed aircraft operating at very low altitudes." With regard to the two program plans, he stated:

> The accelerated program is technically feasible if sufficient funds are provided. Although it involves inherent risk, I believe the requirement for the capability it will provide justifies both the increased cost and the added risk. The Army cannot furnish the increased funds required in FY 1962 and FY 1963 from within FY 1962 resources and the FY 1963 program guidance; therefore, it is necessary to ask your assistance.
>
> It is requested that you approve the accelerated MAULER program; provide . . . $56,408,000 from FY 1962 OSD Emergency Funds to support the accelerated program; and amend your FY 1963 budget guidance to increase RDT&E funds for MAULER from $50,000,000 to $71,466,000 and for MTE from $1,333,000 to $13,780,000 and to authorize FY 1963 PEMA funds in the amounts of $190,107,000 for MAULER and $9,600,000 for MTE.[11]

(U) In view of the Defense Secretary's expressed concern that the project was substantially underfunded—a fact borne out by the above studies—and his desire to speed up the MAULER's service

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[10] SS CRD-C2 35007, CRD thru CofS & ASA (R&D), to SA, 13 Nov 61, subj: Rev of MAULER Proj, & incls thereto. MPCF, Bx 13-649, RHA.

[11] Memo for SECDEF, n.d., subj: Rev of MAULER Proj, atchd as Incl 5 to SS CRD-C2 35007, 13 Nov 61. File same.

availability, it appeared that the program's long-standing economic difficulties would at last be solved. Unfortunately, this was not the case, and another year ended with the program near complete collapse. In December 1961, the Secretary of Defense rejected both the planned and accelerated programs and decided to fund the MAULER at the RDTE levels provided in the guidance memorandum of 22 September 1961—i.e., $28.5 million in FY 1962 and $50 million in FY 1963, with no PEMA funds in either year. Although available funds for contractor and in-house effort were virtually exhausted, AOMC was directed not to make any reductions in the level of effort at that time because of the approaching Christmas season.

(U) The Missile Command informed OCO, on 18 December, that the funding situation was reaching a critical point and that $29 million in emergency FY 1962 funds would be required by early January if a total collapse of the program was to be averted. It then learned, on 2 January 1962, that the Secretary of Defense had rejected the request for emergency funds. Instead, OCO supplemented the FY 1962 RDTE program by the paltry sum of $6.9 million, increasing the total for that year to $35.352 million. The MAULER project staff determined that by using the revised FY 1962 RDTE program and shortening the contract period from 1 October to 9 July 1962, additional FY 1963 funds could be added at that time and the program could meet the revised readiness date of May 1966.[12]

(U) Along with the 10-month slippage in the service availability date, the estimated cost of the total RDTE program increased from $109.3 to $249.5 million. As noted above, most of this cost increase was attributed to the addition of support equipment not considered in previous estimates. Other contributing factors were

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[12](1) TT ORDXR-RHB-862, CG, AOMC, to CofOrd, 18 Dec 61, atchd as incl to SS ORDXR-R-1035, 15 Dec 61, subj: MAULER Program. MPCF, Bx 13-649, RHA. (2) TT, CofOrd to CG, AOMC, 2 Jan 62. Same Files, Bx 14-256. (3) MFR, Lewis L. Gober, Act MAULER PM, 17 Sep 62, subj: MAULER Program Hist. Same Files, Bx 13-410.

the lack of adequate and timely funding for a balanced program and the unorthodox contracting procedures under which the program operated; increases in material and labor costs; and requirements for additional test hardware and construction of new test facilities at White Sands.[13] The RDTE funds actually received and obligated during FY 1962 amounted to $35,763,478, increasing the total MAULER investment to $70,546,737 for the FY 1960-62 period.[14]

([redacted]) During the second meeting of the MAULER MCG, held at the Pentagon in late February 1962, revised target dates for the project were tentatively established as follows: October 1962 - first GTV firing; January 1963 - start system demonstration with the first Engineering Model Fire Unit (EMFU); August 1965 - delivery of first industrial fire unit; and May 1966 - OSRD and organization of the first MAULER battalion. At the same time, the Deputy Chief of Staff for Military Operations confirmed the requirement for a total of 16 (instead of 14) U. S. Army MAULER battalions, each with 4 batteries of 6 fire units.[15]

Fiscal Year 1963

([redacted]) The FY 1963 funding exercise was essentially a repeat performance of the previous years. The additional funds needed to maintain the revised schedule did not materialize, again forcing the MAULER Project Manager to resort to unorthodox contracting procedures based on a fixed funding level ($49.9 million) rather

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[13] (1) Ibid. (2) Anal of MAULER RDTE Cost Trends, 29 Mar 62. MPCF, Bx 11-14, RHA. Also see above, pp. 151-52.

[14] Of the $70.5 million, $63.7 million was allocated to the GD/P R&D contract (ORD-1951); $1.2 million to seven other contractors (including three new FY 1962 contracts for the IRA unit, MTE, and target missile formation control equipment); and the remaining $5.6 million to AOMC and supporting Government agencies. Add to MAULER TDP, 10 Dec 65, pp. 11-12.

[15] Ltr, DCG,GM, AOMC, to CofOrd, 8 Mar 62, subj: MAULER Monthly Prog Rept for Feb 1962. MPCF, Bx 13-649, RHA.

than a fully satisfying, balanced program. The fiscal problem was further complicated by major changes in system design to overcome technical problems. At the end of the first quarter, it appeared that the May 1966 readiness date could be met in spite of the funding shortage.[16] However, a later study of the impact of the design changes on the total program indicated an immediate need for $5.1 million in additional FY 1963 funds and an additional $20 million in FY 1964. Based on this reevaluation, Colonel Dennis, on 14 November 1962, sent AMC a formal request for supplemental program authority, advising that the additional FY 1963 funds were required by December to avert a 6-month slippage. He followed this up with a presentation to General Besson on 15 November.[17]

([redacted] In December 1962, OCRD advised General Besson that no additional FY 1963 funds would be provided and it was not contemplated that the Army could supplement the 1964 program beyond that already approved by OSD. In the light of this decision and the continued problems and delays being encountered by GD/P, Colonel Dennis had no alternative but to adjust the overall program with an attendant 6-month slippage (from May to November 1966) and a further escalation in the total RDTE cost to $323 million. In February 1963, the MAULER MCG recommended that the 6-month slippage be accepted, that full endorsement be given the $323 million RDTE program, and that system development proceed with full support of the DA Staff and major commands.[18] The RDTE funds received and

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[16] MFR, Lewis L. Gober, Act MAULER PM, 17 Sep 62, subj: MAULER Program Hist. MPCF, Bx 13-410, RHA.

[17] (1) Ltr, COL Norman T. Dennis, MAULER PM, to CG, AMC, 14 Nov 62, subj: MAULER RDTE Program. (2) MFR, LTC William C. F. Mullen, 15 Nov 62, subj: MAULER Briefing to General Besson on 15 Nov 62. MPCF, Bx 13-410, RHA.

[18] (1) MFR, COL N. T. Dennis, 21 Jan 63, subj: Trip Rept, 6-13 Jan 63, & incls thereto. MPCF, Bx 13-410, RHA. (2) Ltr, COL N. T. Dennis to LTG F. S. Besson, Jr., CG, AMC, 14 Dec 62, n.s. (3) MAULER PM$_2$P, 31 Dec 62, p. 19. (4) Hist Rept, MAULER Proj Ofc, 1 Jan - 30 Jun 63, pp. 2, 6.

obligated during FY 1963 came to $49,843,250, increasing the total investment to $120,389,987 for the FY 1960-63 period.[19]

Adjustment of Production Plans

([redacted]) The readjustment of the FY 1963 RDTE program of necessity affected the MAULER procurement and production plans. The PEMA program change proposal of May 1963 entailed a cost of $1.008 billion, in contrast to the approved figure of $750.3 million. It called for the procurement of MAULER equipment and missiles for 16 U. S. Army battalions, plus maintenance floats and other non-tactical items. The MAULER weapon system would replace the obsolete M42 DUSTER which had already been phased out of the active army except for two batteries deployed in the Panama Canal Zone. Since it would not replace any other weapon until introduction of the Army Air Defense System for the 1970's (AADS-70),[20] there would be no immediate accrual of savings to offset its cost. However, the MAULER in conjunction with the AADS-70 would replace the NIKE HERCULES and HAWK weapon systems, thereby improving the Army's air defense capability with a substantial reduction in overall cost.[21]

(U) Meanwhile, the Army General Staff deferred approval of the Determination & Findings (D&F) for award of the Advance Production Engineering (APE) contract until completion of the program review conducted by the Nichols Committee.[22] Pursuant to the findings of that committee and authority contained in the D&F signed by the

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[19] Add to MAULER TDP, 10 Dec 65, pp. 11-12.

[20] By direction of the Secretary of Defense, 15 October 1964, the AADS-70 was renamed the SAM-D (Surface-to-Air Missile Development), with concurrent redirection of the effort. See MICOM Hist Sum, FY 1965, p. 120.

[21] MAULER PCP 6.41.21.06.1-2, atchd as incl to DF, MAULER PM to CG, MICOM, 6 May 63, subj: MAULER PCP.

[22] For findings of the Nichols Committee, see below, pp. 174-81.

ASA (Installations & Logistics) on 25 June 1963, the Los Angeles Procurement District (LAPD) awarded GD/P a $3.636-million APE contract covering the cost of engineering manhours and services during the transition of the weapon system from R&D to production. This contract was to have remained in effect until 1 April 1964; however, the redirection of the MAULER R&D program led to its termination on 5 December 1963 after an expenditure of $1,017,351.[23]

([redacted]) Concurrently with processing the D&F for the APE contract, the Missile Command, in February 1963, requested approval of a D&F covering the negotiation of contracts with GD/P and others for continuation and completion of the MAULER R&D effort on an incrementally funded basis at a total estimated cost of $170,022,750. The proposed procurements during the 5-year period, 1 July 1963 through 30 June 1968, embraced evaluation testing of major and subassembly hardware, flight test firings, and fabrication of some 131 missiles, 7 fire units, and necessary ancillary equipment, together with any required product improvement effort. Approval of this blanket D&F would enable the Project Manager to make maximum use of incentive contracting; facilitate breakout procurement with potential savings in management fee areas; and considerably reduce administrative workload requirements incident to yearly contracting.[24]

(U) The ASA (R&D), in late May 1963, approved the D&F on a modified 1-year basis and authorized the negotiation of an agreement for completion of the effort under GD/P's basic contract (ORD-1951). The effort to negotiate this agreement on a cost-plus-

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[23] (1) TT AMCPM-MAP-180, CG, MICOM, to CO, LAPD, 27 Jun 63, atchd to SS AMCPM-MAP-15, Dep PM, 27 Jun 63, subj: Req for Apprl of Awd, MAULER APE Svcs Contr. (2) Hist Repts, MAULER Proj Ofc, 1 Jan - 30 Jun 63, p. 3; 1 Jul 63 - 30 Jun 64, p. 2.

[24] Ltr, CG, MICOM, to CG, AMC, 11 Feb 63, subj: Xmitl of D&F, MAULER, & incl thereto, atchd to SS AMCPM-MAP-3, MAULER PM, 11 Feb 63, subj: D&F, MAULER. MPCF, Bx 14-256, RHA.

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incentive-fee basis, however, was hampered by a lack of adequate program authority. Of the $75.716 million RDTE program for FY 1964, only $37.7 million was released for obligation and the remaining $38.016 million was deferred. The Project Manager, on 11 July 1963, awarded GD/P a 60-day letter order contract for $15 million. With the release, in September, of $21 million of the deferred funds, the letter contract was extended to 120 days at a total cost of $28,117,000. It was further extended by an additional 30 days on 7 November 1963 at no increase in cost, but was never definitized. With the redirection of the MAULER program, in December, the letter contract was purposely allowed to expire, resulting in the withdrawal of $5,028,114 from the contract amount.[25]

(U) In the meantime, two more adjustments in the program added another $31 million to the total RDTE cost. The first occurred in July 1963 as the result of an earlier decision by the House Appropriations Committee to defer initiation of the PEMA program from FY 1964 to 1965. Two months later, the Army Chief of Staff deleted PEMA hardware funds from the FY 1965 budget, thereby shifting the first industrial buy to 1966. The program adjustments resulting from these decisions increased the total estimated RDTE cost from $323 to $354 million, and extended the readiness date to November 1968. The MAULER hardware, previously planned to be bought with RDTE funds under a production contract, would have to be bought on the R&D prototype line at higher prices. Moreover, increased documentation costs would be incurred by RDTE pending availability of PEMA dollars. Also contributing to the dollar increase were the additional costs incurred in development of the IRA unit; revised cost estimates on target missiles; firmer estimates on cost

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[25](1) Memo for SA, fr Dr. Harold Brown, DDRE, 9 Sep 63, subj: Apprl of Army FY 64 RDTE Program Element MAULER. MPCF, Bx 13-410, RHA. (2) MICOM Hist Sum, FY 1964, p. 55. (3) MAULER PM$_2$P, 30 Jun 63, p. 8. Same Files, Bx 13-422. (4) Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, p. 2.

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of engineer-service test hardware; and firmer, more detailed bids for the remaining R&D effort by GD/P.[26]

(U) The achievement of a MAULER air defense capability by July 1964 at an estimated RDTE cost of $77 million thus proved to be a perplexingly elusive and impractical goal. While the MAULER weapon system was considered to be within the state of the art, its technical feasibility was yet to be demonstrated after 4 years of development effort and an expenditure of some $147 million. As pointed out in the foregoing narrative, the lack of adequate and timely financial support materially contributed both to the schedule slippages and to the steady rise in development costs. It now remains to examine the technical problems and delays that beset the development contractor and the program reviews and reappraisals that led to the redirection of the effort in December 1963.

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[26](1) Ibid., p. 4. (2) MAULER Chart AMCPM-MAM M-3942, 24 Apr 64. MPCF, Bx 13-410, RHA.

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CHAPTER VII

[redacted]) ENGINEERING MODEL AND R&D PROTOTYPE (U)

(U) In the early months of CY 1962, the MAULER weapon pod and vehicle passed from the breadboard to the engineering model stage, with flight and laboratory tests continuing in support of the R&D prototype design. The contractor had made significant progress in defining real and potential problem areas during the 30-round LBS firing program in 1960-61 and the 3 LTV firings with the interim rocket motor in late 1961. Laboratory tests of radar breadboards had also disclosed several serious problems requiring design changes. The validity of the design refinements would be established in a progressive series of laboratory and R&D flight tests, the latter including six Control Test Vehicle (CTV) firings and several special test firings. Based on the results of these proof tests, the 24-round Guidance Test Vehicle (GTV) firing program would begin at WSMR in October 1962, followed by the system demonstration with the first Engineering Model Fire Unit (EMFU) in January 1963, and the Design Characteristics Review in February 1963 preparatory to the R&D design release to industrial.

(U) Such was the MAULER plan in early 1962 immediately following the rejection of the Army's bid for an accelerated program. In the wake of growing development costs and skepticism surrounding the technical feasibility of the system, members of the MAULER MCG and other officials in the Pentagon began to follow more closely the progress made in the program and to question the propriety of solutions to existing problems. Throughout the 1962-63 period, there were frequent meetings, briefings, and presentations on the program, both at the various contractors' plants and in Washington. Such close scrutiny may have been desirable and necessary to protect the interests of the Government, but it had a distractive effect on

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the prime contractor's effort. Moreover, the frequent visits and discussions with the subcontractors had a definite tendency to undercut GD/P's position and responsibilities as prime contractor.

(U) Whether because of the Government's aggressive supervision or in spite of it, the MAULER program was destined to proceed under the momentum of what some wry humorist has labeled "Murphy's Laws."[1] Beyond the backdrop of sporadic funding and constant program adjustments, the development of the engineering model weapon system floundered in a maze of complex electronic and packaging problems that clearly skirted the periphery of existing technology.

Weapon Pod Redesign

[redacted] As a result of the radar power spillover and stowage problems disclosed in laboratory tests of breadboard equipment, it became increasingly evident that further design changes would be necessary to meet the system performance and dimensional requirements. In its search for solutions to these and other related problems, GD/P investigated a variety of configurations aimed at achieving the design goals with a minimum of operational compromises and within the projected budget and schedule. The first approach to the stowage problem entailed a reduction in the size of the transmitter radar antenna dish from 30 to about 21 inches; however, the study results showed that this would probably degrade system performance, and further, that the redesign effort would require more than a year with no guarantee of success. The design engineers then studied various alternate configurations involving repackaging the missile container rack and T-I radar system. They

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[1] The fundamental principles of which are these: (1) if something <u>can</u> go wrong, it will—at the worst possible moment, in the worst possible place; (2) when left to themselves, things seem to go from bad to worse; (3) nature always sides with the hidden flaw; and (4) whenever things seem to be going better, you've overlooked something!

[redacted]

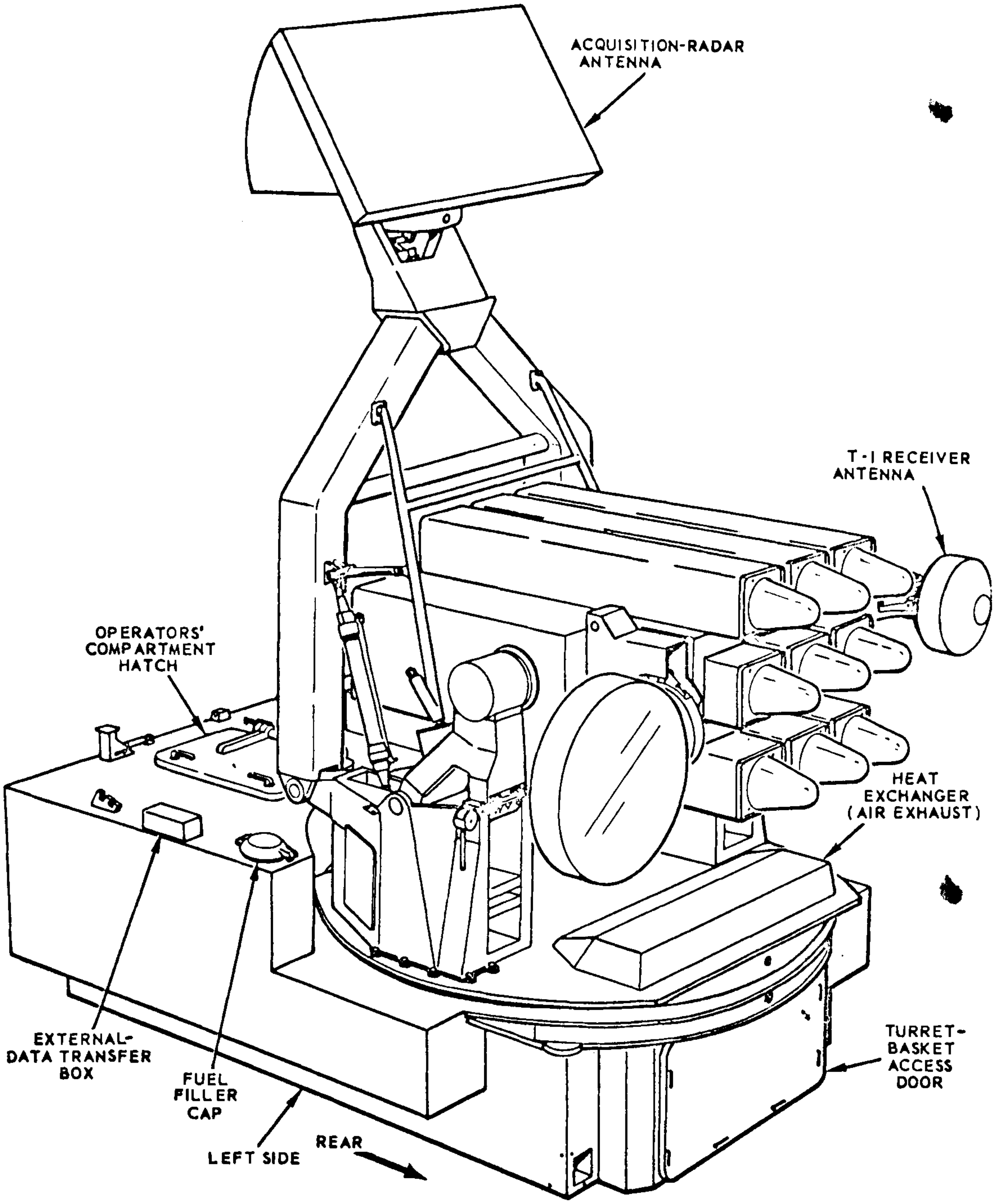
concluded that the most feasible solution was to change the missile rack to a 3-by-3-foot design with 9 instead of 12 missiles, and to split the T-I radar with the receiver dish placed on one corner of the rack and the transmitter on the other.

([redacted] This compromise design had certain built-in disadvantages, the most important being a degradation of system effectiveness resulting from the 25-percent reduction in missile load. In addition, the servo design required for the split T-I radar would make the system more complex and increase costs, and the vehicle would require minor modification. On the positive side, however, the proposed configuration would supposedly provide definite advantages. Aside from solving the stowage problem, the design engineers claimed that the split T-I radar configuration would assure more efficient operation by reducing the effect of power spillover; minimize the missile exhaust blast effects on the antenna dishes; and effect a more even distribution of weight, thereby reducing structural requirements on the missile container rack which supported the antennae. In addition, the removal of 3 missiles from the rack assembly would provide room to mount the radio frequency power package adjacent to the antennae (instead of deep within the fire unit), as well as space for the missile sequencer, the use of which would reduce wiring to the missiles by 25 percent.[2]

[redacted]) The new weapon pod configuration was adopted for the MAULER R&D prototype system in May 1962 (see illustration). Along with the changes just described, it was found necessary to reduce the number of beams in the acquisition radar from 3 to 2 and increase the power from 900 to 1,200 watts, concurrently with changes in dimensions. It was chiefly as a result of these design changes that the Army Missile Command, in November 1962, registered a requirement

[2] GD/P Rept, Mar 1962, subj: Detm of Optimum Design of the T-I Radar Ant & Msl Cntnr Rack, MAULER, pp. 1-3, 5, 9-11. MPCF, Bx 13-649, RHA.

[redacted]



(U) R&D Prototype Weapon Pod - 1962-63

[redacted]

for $5.1 million in additional FY 1963 RDTE funds.[3]

Control Test Vehicle (CTV) Program

([redacted]) The 6-round CTV firing program, along with the fourth Launch Test Vehicle (LTV) and other special firings, took place at the WSMR Small Missile Range over a period of some 10 months beginning on 15 December 1961. The primary purpose of the CTV firings was to evaluate dynamic response of the missile airframe and performance of the missile control system during a series of programmed maneuvers. Major changes from the LTV missile included the addition of an autopilot with a maneuver timer and a hot gas tail control system. Other items evaluated were a safety and arming device, a self-destruct system, three different configurations of the rocket motor, two makes of thermal batteries, and two types each of canisters, wings, tails, and breakaway connectors. All six CTV rounds were fired from the D-2 weapon pod (without the vehicle). They were originally scheduled for completion by 31 May 1962, but the design changes necessary to correct performance deficiencies resulted in a 5-month delay.[4]

([redacted]) After the second CTV firing on 28 February 1962, the program was temporarily suspended because of malfunctions in the control system.[5] On 8 June 1962, while CTV-3 was undergoing modification and laboratory test, GD/P test fired the fourth LTV

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[3](1) Ltr, DCG,GM, AOMC, to CofOrd, 8 May 62, subj: MAULER Monthly Prog Rept for Apr 1962. MPCF, Bx 13-649, RHA. (2) MFR, COL N. T. Dennis, 21 Jan 63, subj: Trip Rept - 6-13 Jan 63, & incl thereto, MAULER Presn, 10 Jan 63. Same Files, Bx 13-410, RHA.

[4](1) GD/P Rept CR-830-152-003, Feb 1962, subj: MAULER Wpn Sys Dev Test Program Plng Docu, pp. 81-82. (2) GD/P Rept CR-830-168-001, 15 Feb 63, subj: CTV Sum, p. 1. Both in MPCF, Bx 14-424, RHA.

[5](1) Ltr, DCG,GM, AOMC, to CofOrd, 8 Mar 62, subj: MAULER Monthly Prog Rept for Feb 1962. (2) Ltr, same to same, 8 May 62, subj: MAULER Monthly Prog Rept for Apr 1962. Both in MPCF, Bx 13-649, RHA.

round to evaluate the high-performance rocket motor[6] and detachable aluminum wings. Motor performance was satisfactory, but the test results indicated a recurrence of aerodynamic problems experienced in the first three LTV firings; viz., excessive zero-lift drag, and severe wing vibrations.[7] Malfunction of the control system again occurred in the CTV-3 firing on 21 June 1962. Satisfactory roll control was attained for the first time on round CTV-4, fired 17 July 1962. But CTV-5 (the first to be equipped with the GTV-type motor and wings), fired on 23 August 1962, suffered severe vibrations and resultant missile breakup. The firings were again suspended for modification of the airframe, delaying the last flight test to 12 October 1962. Round CTV-6 also experienced severe vibrations but with no damage to the missile.[8]

([redacted]) Another continuing problem encountered in the CTV program concerned the bulging of the firing canister and malfunction of the rear cover. The first five CTV rounds were fired from the aluminum, foam-lined, double-wall canister evolved from the LBS and LTV programs. The improved Beech honeycomb-wall canister being developed for the Guidance Test Vehicle (GTV) program was successfully tested in a special LBS (ZUNI rocket) firing on 18 May 1962, but suffered total structural failure in the CTV-6 firing. The blast and pressure of the high-performance rocket motor caused the complete disintegration of the canister and the rear cover failed to

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[6]It will be recalled that the MAULER rocket motor released for initial flight test in LTV rounds was of the low-performance design (<u>see</u> above pp. 147, 149). This interim motor was also used in round CTV-1, but rounds CTV-2 thru -4 used an improved LTV motor configuration with an 8 percent increase in propellant. The high-performance GTV motor with an additional pound of propellant was introduced in rounds CTV-5 and -6.

[7](1) Ltr, DCG,GM, AOMC, to CofOrd, 6 Jul 62, subj: MAULER Monthly Prog Rept for Jun 1962. MPCF, Bx 13-649, RHA. (2) <u>Also see</u> App. II.

[8]<u>See</u> App. III.

fragment properly. Pending redesign of the Beech canister, the initial GTV rounds would have to be fired from the double-wall canister with no rear covers.[9]

(U) In late October 1962, members of the GD/P test crew moved from the Small Missile Range to the newly constructed MAULER test facility for initiation of the GTV firing program. In preparation for the first flight test, they conducted two special firings (TTV-2 and TTV-3) to evaluate camera instrumentation, and carried out pre-firing performance and compatibility tests on breadboard models of the T-I radar, launch order computer, and weapon control console. A complete performance evaluation of the breadboard system, however, could not be made without the GTV-1 missile which was still undergoing acceptance tests at the GD/P laboratory.[10]

Acceptance Test of the Guidance Test Vehicle

([redacted]) Laboratory acceptance test of the first Guidance Test Vehicle (GTV)[11] had begun early in August 1962 and continued on schedule until the airframe problem developed in the CTV-5 firing on 23 August. Because of the resultant delay in firing round CTV-6 and the time required to complete the data analysis and make the necessary modifications in the GTV-1 airframe, the initiation of the flight test program had been rescheduled for 2 December 1962. But then the electronic engineers encountered a series of technical problems that prevented satisfactory missile performance and thus

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[9] (1) DF, SAM Sys Div, R&DD, to MAULER-REDEYE Proj Ofc, 4 Jun 62, subj: MAULER Monthly Prog Rept - May 1962. MPCF, Bx 13-649, RHA. (2) Also see App. III.

[10] (1) GD/P TM-830-33, 27 Nov 62, subj: Firing Test Rept of MAULER TTV-2. MPCF, Bx 14-424, RHA. (2) Hist Rept, MAULER Proj Ofc, 1 Jul - 31 Dec 62, p. 4. (3) GTV-1 Msl Hist, 17 Jun 63. MPCF, Bx 13-422, RHA.

[11] Including functional tests of individual assemblies, compatibility tests, closed-loop roll tests, vibration and structural tests, hot battery tests, and complete missile system tests.

delayed the release of GTV-1 for shipment to White Sands. These difficulties were primarily concerned with performance deficiencies in the seeker head, electrical interference between various electronic components when packaged together in a very small space, and unacceptable noise levels in the missile video spectrum. At first, it appeared that the problems would be solved in time for shipment by mid-December 1962, but that date was slipped to mid-January, thence to 6 March 1963, when the GTV-1 missile was finally shipped.[12]

The Nichols Committee Report

(U) In January 1963, Dr. Finn J. Larsen, ASA (R&D), and MG William J. Ely, Deputy Commanding General of AMC, visited the GD/P plant where they received a detailed presentation on the technical status of the program and the schedule readjustment then being made because of the FY 1963 funding shortage.[13] Thirty days later, on 12 February, LTG Dwight E. Beach, the Army Chief of R&D, paid the plant a visit and came away deeply perturbed about the continuing technical difficulties and schedule slippages. In a letter to General Besson, he declared that the MAULER appeared to be "starting on the same road that REDEYE had traveled," adding that such prospects "would be disastrous for our air defense program." Referring specifically to the technical difficulties then being experienced in the missile acceptance tests, he suggested that it would be extremely worthwhile to have a briefing by technical experts on MAULER, with emphasis on their opinion as to whether or not the problems could be "easily solved." On the basis of that briefing and the upcoming MAULER MCG report, he said, a decision would be made concerning a more detailed review by experts on the Army Scientific Advisory Panel (ASAP).[14]

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[12]GTV-1 Msl Hist, 17 Jun 63. MPCF, Bx 13-422, RHA.

[13]MAULER Presn at GD/P, 10 Jan 63. MPCF, Bx 13-410, RHA.

[14]Ltr, CRD, DA, to CG, AMC, 14 Feb 63, subj: MAULER Presn. MPCF, Bx 13-410, RHA.

(U) On 5 March 1963, the MAULER Project Manager gave General Beach and Dr. Larsen a comprehensive presentation on the background history and current status of the development program. With respect to the electronic problems that had delayed the GTV firing program, he reported that the contractor had isolated and eliminated the noise sources in the system and was preparing to ship the GTV-1 missile to WSMR, where it would undergo further pre-firing checks over the next 2 weeks in preparation for the first flight test. While noting that there were a great many other problems yet to be solved, he emphasized that such difficulties were not uncommon at this stage of development and expressed confidence in the ability of the contractor to arrive at satisfactory solutions. In this connection, he pointed out that the lack of adequate and timely funding since the inception of the project had greatly impaired the contractor's ability to carry out his responsibilities, as well as the Project Manager's ability to conduct an orderly and dynamic program.

(U) Anent the recent criticism of the REDEYE and MAULER programs, the Project Manager explained that General Dynamics had made a number of personnel and organizational improvements, and that both programs for the next several months were sound. In this view, he "strongly recommended that we take the spotlight off this contractor for the next few months." Both the rank and file personnel and their supervisors, he noted, "have been involved in a very great many VIP visits and defensive discussions. I am seriously concerned over the in-roads on the time of these people and the deleterious effect it is having on their attention to the tasks at hand . . . ."[15]

(U) The spotlight, however, was not turned off. The next day, as the GTV-1 missile left Pomona for the trip to White Sands,

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[15] Larsen-Beach Briefing, 5 Mar 63. MPCF, Bx 13-410, RHA.

General Beach and Dr. Larsen decided to establish an Ad Hoc Group on MAULER to review the problems of electronic spillover and missile seeker noise, and to investigate the adequacy of proposed solutions.[16] The ASAP MAULER Ad Hoc Evaluation Group was chaired by MG K. D. Nichols (USA, Retired), and came to be known as the Nichols Committee. Aside from a secretary and two technical observers (one each from the Raytheon Company and the United Kingdom), it consisted of four members:

Dr. William S. Pickering, Director, Jet Propulsion Laboratory
Dr. Andrew Longacre, Stanford University
Dr. Joseph M. Pettit, Stanford University
Dr. William H. Saunders, Harry Diamond Laboratories

(U) The Nichols Committee submitted its final report on 16 April 1963, following a 3-day meeting at GD/P, 10-12 April. As far as revealing anything new about the program or its problems, the exercise was a waste of time. In fact, the report simply restated in very brief form what the MAULER Project Manager had already reported in his detailed presentation on 5 March 1963. As General Ely put it: "The report and subsequent discussions with General Nichols don't give us much that we can get our teeth in, at this time. They highlight some areas that were already of concern, and suggest that we <u>expedite</u> the Test Vehicle firings and then reappraise."[17]

([redacted]) One of the salient points made in the committee's report was that the spillover and missile seeker noise problems "are made more difficult by the fact that contractor efforts at solution are directed toward . . . 'desired' rather than 'required' military

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[16]Draft Dir, Ad Hoc Gp on MAULER, CRD, DA, 6 Mar 63. MPCF, Bx 13-410, RHA.

[17]Ltr, DCG, AMC, to MG Francis G. McMorrow, CG, MICOM, 6 May 63, n.s., & incl thereto, Memo, thru CRD, for ASA (R&D), fr MG K. D. Nichols, 16 Apr 63, subj: Rept of the ASAP MAULER Ad Hoc Eval Gp. (The latter document hereinafter cited as the Nichols Com Rept.) MPCF, Bx 13-410, RHA.

characteristics." The committee members considered these problems to be serious and some of the proposed solutions "probably beyond what can be accomplished within schedules." However, until sufficient data became available from experimental test firings, it would not be possible to assess the major problem areas, to review the obtainable performance, or to restate compatible Army requirements. In consonance with the suggestions made by the MAULER MCG at its February meeting, they recommended that the Army reevaluate the program after the sixth GTV firing, or before, if unusual difficulties or delays develop.[18]

([redacted]) Although the committee's review was primarily focused on the spillover and noise problems, a cursory examination of other aspects of the program left it with the "definite impression" that there were other serious problem areas. The three prime examples cited were: the helicopter as a target, problems associated with rocket blast after launching, and increasing complexities of the system. Specific conclusions reached by the committee were:

> a. The Group questions the likelyhood [sic] of meeting the "desired" rather than "required" characteristics within the time frame as outlined by the present schedule.
>
> b. The contractor should emphasize and accelerate the acquisition of sufficient data for the empirical appraisal of both problem areas. Where practicable within the current schedule, work in other aspects of the program should be more completely coordinated with the progress or lack of progress in these problem areas to avoid uneconomical expenditure of funds.
>
> c. A redefinition of design criteria for meeting Army requirements should be made consistent with what can be attained technically within the defined program schedules. The Group considers that this may result in design criteria that will meet military characteristics somewhere between those presently listed as "desired" and those listed as "required" (The specification of $.1m^2$ as typifying a ballistic missile target may have to be reviewed).[19]

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[18]Nichols Com Rept, 16 Apr 63, p. 1. MPCF, Bx 13-410, RHA.

[19]Ibid., pp. 2-3.

([redacted]) As noted before, the Nichols committee report revealed nothing about the MAULER program that was not already common knowledge. Hence, the report, in and of itself, evoked little reaction within the AMC/MICOM complex, other than an agreeable nod and a promise to implement its conclusions and recommendations. However, in briefing members of the Army General Staff, on 19 April, General Nichols injected some rather derogatory remarks and observations not supported by anything said in the formal report. He refused to assess the technical competence of the contractor on the grounds that this was not possible after only 3 days' contact, and also declined comment on project management, per se, in that this exceeded the scope of the Group's task. Yet he went on to cast aspersions on both:

—GD/P tends to "put off hard things until last and do the easy things first." They should be required to do the hard things first. The Project Manager is the man to do this and he should be at the plant instead of at Huntsville.

—The Army is not completely "on top of the program" -- specifically concerned that the Project Manager did not attend the Ad Hoc Group evaluations.

—The contractor "with bright ideas" has a tendency to "add on things." . . . The Army has a tendency to "stick in too many complexities - this means dollars for the contractor - he'll always say yes because he'd love to try."

Summing up the appraisal of the program, General Nichols reiterated his belief that ultimately "the Army will come through with a fine weapon," adding that the program "should not be killed - nor was it 100% in order - somewhere in between."[20]

([redacted]) During a subsequent briefing for Dr. John McLucas, Deputy Director for Tactical Warfare Program, ODDRE, on 29 April, General Nichols and members of the Army General Staff presented the findings

[20] MFR, COL Milford W. Wood, Chf, AD Div, OCRD, 26 Apr 63, subj: Rept of the ASAP MAULER Ad Hoc Eval Gp [re Briefing for ASA(R&D) & CRD, 19 Apr 63]. MPCF, Bx 13-410, RHA.

of the program review and answered pertinent questions relating to the Group's recommendations and the planned reappraisal. General Nichols emphasized that the Army's basic assumption was to stick to the time scale; that some of the performance characteristics, though ultimately attainable, might not be realistic with the established time frame; and that the program was approaching a testing period and "the Army should wait until reappraisal can be made based on testing." General Beach stated that the Army was in complete agreement with the Group's recommendations and planned to conduct the recommended reappraisal by December 1963. Asked what would be done "if by December the program cannot be appraised because it's no further along than now," General Beach replied, "if we're not any further along in December than now, we'll kill the program."[21]

([redacted]) In the light of the observations made by General Nichols and the obvious skepticism about the program in OCRD and OSD, General Ely urged that MICOM redouble its efforts in the area of contract supervision and make maximum use of its in-house engineering skills to expedite solutions to known problem areas.[22] The Missile Command's response to all this was one of guarded optimism as to the ultimate success of the program and outright disagreement with the allegations made by General Nichols. As General McMorrow saw it, "a very wide variety of interpretations" could be placed on the oral comment and the formal conclusions and recommendations of

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[21](1) MFR, COL Milford W. Wood, Chf, AD Div, OCRD, 9 May 63, subj: Rept of the ASAP MAULER Ad Hoc Eval Gp [re Briefing for Dr. McLucas, 29 Apr 63]. MPCF, Bx 13-410, RHA. (2) Though not brought out in the resume of the discussion, GD/P had run into further difficulties at WSMR, and the first GTV missile had not been fired at the time of the briefing. It had been planned to complete the pre-firing checkout tests in time for the GTV-1 firing on 3 April; however, that date had been moved back to 24 April, thence to 2 May. (The GTV-1 missile was finally fired on 27 June 1963.)

[22]Ltr, DCG, AMC, to MG Francis G. McMorrow, CG, MICOM, 6 May 63, n.s. MPCF, Bx 13-410, RHA.

the Ad Hoc Evaluation Group. He had no argument with the formal report, but soundly disputed the allegations made during the Army Staff briefing.

(C) Defending the existing development plan as logical and realistic, General McMorrow pointed out that specific difficult tasks were delayed only when the accomplishment of other tasks took precedence as a mandatory prerequisite. Furthermore, the program had been and would continue to be examined with frequent reviews to determine the appropriate starting dates for the various elements of the system to insure their phased development and production by the readiness date. In this connection, he noted that the Project Manager had been forced to incorporate some delays because his request for additional FY 1963 RDTE funds had been denied. "It would be unfortunate - and undoubtedly the subject of future criticism - if a successful MAULER missile and fire unit maintained its schedule and the user was faced with an incomplete weapon system on the Army Readiness Date."

([redacted]) Anent the charge that the contractor had a tendency to "add on things," General McMorrow reminded AMC that "while it may be an unpalatable thought in Army Staff, it must be recalled that Army Staff has increased the requirements on the contractor to a tremendous degree since inception of the contract." Referring specifically to the decrease in the prescribed radar cross section from 1.0 to 0.1^2 meter and to the belated inclusion of ancillary equipment,[23] he expressed the opinion that these added requirements were "responsible for approximately 75% of the increase in cost and complexity of the MAULER System," the balance being attributed to overly optimistic early estimates and to inflation. On the other hand, he said the Missile Command was also becoming concerned about

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[23] Namely, the battery command post, support and second echelon maintenance vehicles, transport dolly, missile test set and MAULER peculiar MTE, operator trainer, and Type II handling trainer.

the contractor's internal management structure[24] and would continue to watch this closely.

> . . . Since the challenge by Army Staff, people seem to be more free to point out deficiencies and certainly the continuous slippage of GTV-1 is not reflecting creditably in that direction. . . . Of course, if we become convinced that a change is necessary, the consequences will be severe. An upheaval within the company or a termination for convenience can only insure further delays.[25]

<u>Postponement of the Design Characteristics Review</u>

(U) Meanwhile, the Design Characteristics Review (DCR) had been postponed from February to April, thence to August 1963. The latter postponement had occurred in early March 1963 because of prevailing uncertainties as to the precise design of the R&D prototype and production equipment. These uncertainties stemmed from the recent technical problems, program readjustments and reoriented efforts, delayed technical guidance on certain essential elements of the system, and other circumstances beyond the control of the MAULER Project Office.[26]

[redacted] One item of long-standing concern had to do with equipment for adequate aircraft identification, without which the effectiveness of MAULER would be so seriously impaired that its contribution to air defense of the forward area would be negligible. The development of electronic IFF equipment, it will be recalled, had been delayed first by the Ordnance-Signal Corps funding dispute that was finally settled in mid-1961, and then by a protracted JCS debate

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[24]The Project Manager had so noted this in his 5 March MAULER presentation for General Beach and Dr. Larsen, and had outlined some of the improvements recently made in both personnel and organizational structure.

[25]Ltr, MG Francis J. McMorrow, CG, MICOM, to MG W. J. Ely, DCG, AMC, 17 May 63, n.s. MPCF, Bx 13-410, RHA.

[26]DF, Cmt 1, LTC Willis H. Clark, Dir, Sys Engrg Div, MAULER Proj Ofc, to Colonel Dennis, 7 Mar 63, subj: Recmn to Postpone DCR. MPCF, Bx 11-14, RHA.

[redacted]

over the selection of a specific system for tri-service use. The decision in favor of the Mark XII IFF system was not forthcoming until October 1962, and it was early 1963 before the Hazeltine Corporation began work on the program definition phase.[27] In the absence of an adequate IFF device suitable for installation in all aircraft, CONARC, in late October 1962, had proposed a Qualitative Materiel Requirement (QMR) for a mobile Battery Command Post (BCP) to provide friendly aircraft protection and the facilities necessary for supervision and coordination of MAULER fire units within a firing battery. The QMR was approved and published in December 1962 as a revision of the MAULER MC's, and the Project Office completed preliminary studies leading to the selection of a development contractor in early 1963.[28] However, because of the leadtime required for the bidders conference, evaluation of proposals, etc., it would be mid-July at the earliest before the BCP design concept could be established and a well-defined contract placed in force.[29]

(U) Also contributing to the postponement of the DCR were the recent technical difficulties and proposed design changes in the IRA unit being developed by DeHavilland Aircraft, and the continuing lack of Special Development Requirements (SDR's) for some key items of support equipment. An SDR had finally been received for the operator trainer and Type II handling trainer, and the design of these items was in progress at GD/P. For the rest of the ancillary items, however, MICOM had received neither SDR's, MC's, nor QMR, repeated requests for the same notwithstanding. The main holdup here was the lack of unanimity among the users as to the precise requirements. Although development costs for the equipment

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[27] <u>See</u> above, pp. 75-81.

[28] (1) AMCTCM 358, 13 Dec 62, subj: MAULER BCP - Estb of QMR. RSIC. (2) MAULER BCP TR MA-4-63, 1 Apr 63. MPCF, Bx 11-14, RHA.

[29] DF, Cmt 1, LTC Willis H. Clark, Dir, Sys Engrg Div, MAULER Proj Ofc, to Colonel Dennis, 7 Mar 63, subj: Recmn to Postpone DCR. MPCF, Bx 11-14, RHA.

[redacted]

had been included in the total program estimates, the design specifications could not be established and development initiated until receipt of specific guidance from higher headquarters.[30]

(U) As a result of continuing program delays, technical problems, and design changes in key components, the DCR date of August 1963 was further extended to mid-January 1964.[31] The circumstances prompting this action were primarily concerned with difficulties in the GTV firing program, the details of which will be discussed later. Also contributing to the postponement were design problems in the R&D prototype vehicle and weapon pod, and further delays in establishing firm requirements for ancillary equipment.

(U) To alleviate the overloaded and badly distributed gross weight on the vehicle suspension, the Food Machinery and Chemical Corporation recommended, in May 1963, that the prototype XM-546 vehicle be modified to incorporate a sixth pair of roadwheels. As a result of this change—later concurred in by the Army Tank-Automotive Center (ATAC), MICOM, and GD/P—the reducible weight of the vehicle exceeded the 13,000-pound limitation for transport by C123B aircraft, requiring another waiver of the MAULER MC's.[32]

(U) Another change associated with the weapon pod came in September 1963, when the Army Missile Command and the prime contractor decided to drop the Belock STRAP unit in favor of a simpler device. At that time, only one engineering model STRAP unit had been delivered. Belock's subcontract for development and fabrication of the remaining two models was terminated. The alternate unit was expected to degrade the land navigation system, but not

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[30] Ibid.

[31] Ltr, XO, MAULER Proj Ofc, to CG, USATECOM, 13 Aug 63, subj: DCR. MPCF, Bx 11-14, RHA.

[32] (1) TT 14812, CG, ATAC, to CG, MICOM, 31 May 63. MPCF, Bx 14-256, RHA. (2) Hist Rept, MAULER Proj Ofc, 1 Jan - 30 Jun 63, p. 9.

to an unacceptable degree.[33]

(U) Progress in establishing firm requirements for ancillary equipment fell far below that anticipated in the March 1963 projection. The BCP development contract was awarded to the Hughes Aircraft Company on 13 August 1963.[34] Specific guidance for development of the support vehicle and transport dolly finally reached MICOM in late July 1963; but the Combat Developments Command withheld the technical description for the second echelon maintenance vehicle and contact team vehicle pending approval of the maintenance support plan and definition of the MTE concept.[35]

([redacted]) Yet another factor contributing to the delayed DCR concerned the belated decision to change the seeker head design. In the face of growing concern over the missile sensitivity problem, GD/P's engineers stepped up their in-house studies of the phased-array seeker head as a possible replacement for the rotating parabola antenna seeker. Based on the results of studies completed in late May 1963, they concluded that the adoption of the phased-array seeker was definitely in the best interests of the program. The evaluation indicated that this technique would provide a number

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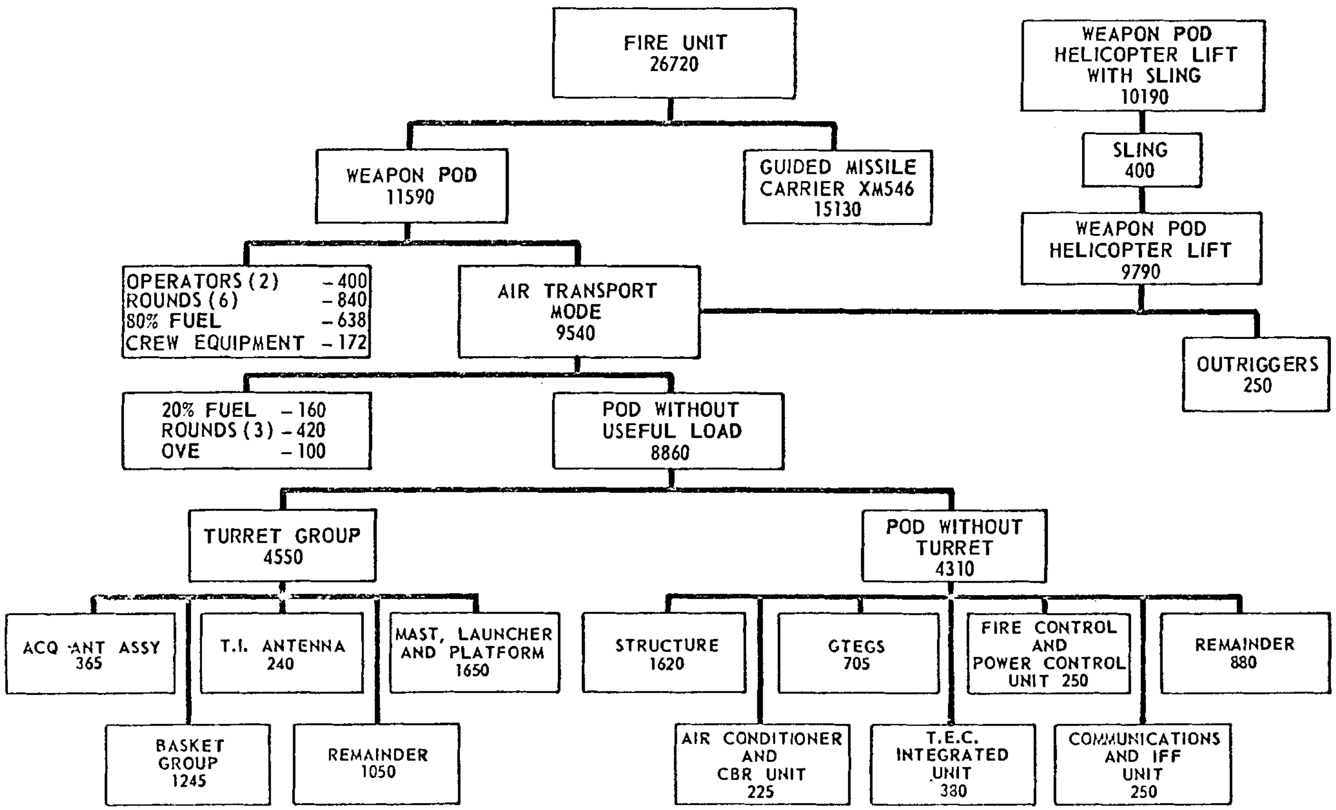
[33](1) Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, p. 21. (2) For details relating to early development problems and delays, see above, pp. 137-38.

[34]It covered the design or program definition phase to be completed in October 1963, and development, fabrication, and test of the breadboard model to be completed in August 1964, at a total cost of $374,192. (1) Ltr, CO, LAPD, to CG, MICOM, 15 Jul 63, subj: Ppsd Proc of MAULER BCP fr Hughes Aircraft Co. (2) DF, Chmn, Tech Eval Com, to Chmn, Source Selection Bd, 5 Aug 63, subj: Selection of Contr for BCP. (3) Ltr, Dep MAULER PM to Hughes Aircraft Co., 4 Sep 63, n.s. All in MPCF, Bx 11-14, RHA. (4) The Phase I design study was later extended through January 1964, and the schedule for completion of Phase II was amended accordingly. Ltr, GD/P to CG, MICOM, 1 Nov 63, subj: BCP Task. File same.

[35]Ltr, CG, USACDC, Ft Belvoir, Va., to CG, AMC, 21 Jun 63, subj: MAULER Vehs Dev Guidance, & 1st Ind, CG, AMC, to CG, MICOM, 17 Jul 63. MPCF, Bx 11-14, RHA.

R & D WEIGHT

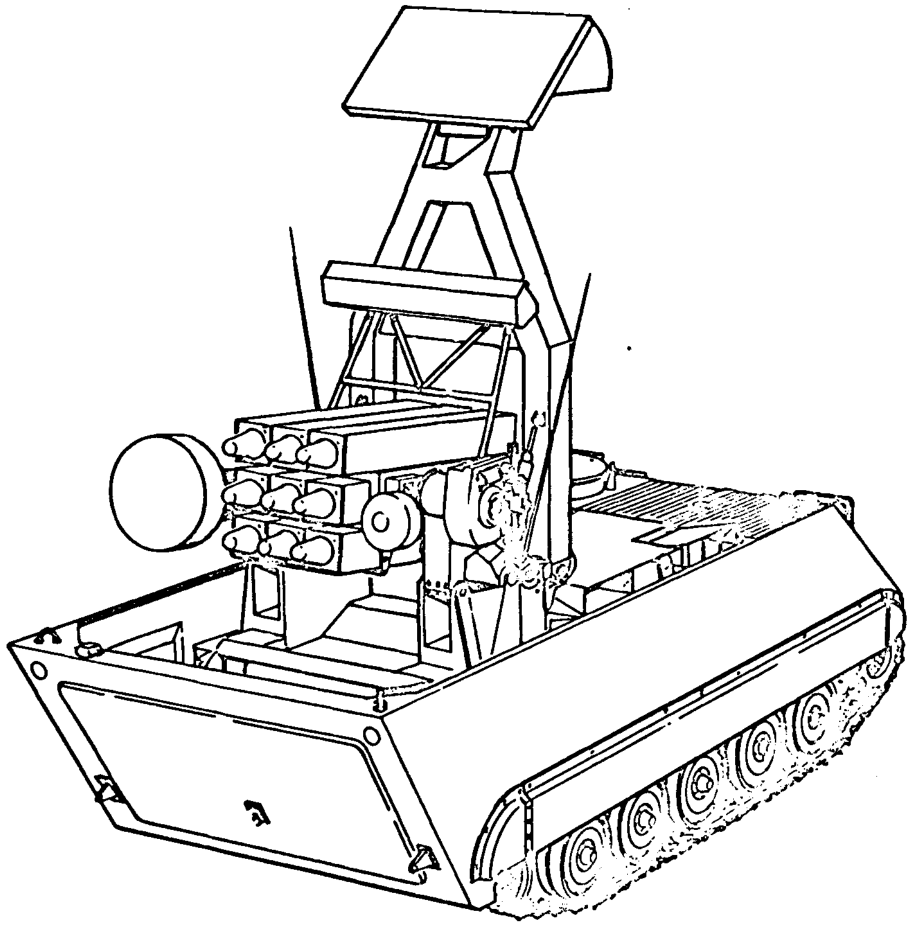


M-F6-170 4/5/63

MAULER

R&D PROTOTYPE

FIRE UNIT OPERATING MODE



M-C6-22 3/2/63

[redacted]

of performance advantages over the spinning dish, including improved reliability, lower noise and susceptibility to spillover, increased sensitivity, and reduced reaction time.[36] An independent MICOM analysis of both techniques, completed in early June, confirmed that greater capabilities for the MAULER could be obtained with the phased-array design. The Project Manager, on 7 June 1963, therefore concurred in the proposed design change, subject to assurance from the contractor that it could be effected within present schedules and RDTE funding. To preclude interference with the GTV firing program, the spinning dish design would be used in the first 20 test rounds. Flight tests with the phased-array seeker would begin with round GTV-21 in April 1964.[37]

Consideration of a Backup Program

([redacted]) In view of the eleventh-hour design changes, difficulties, and delays being encountered in the MAULER and REDEYE programs, Dr. Larsen directed that definitive proposals be prepared for a backup program as an alternate solution to the forward area air defense problem. Among the "quick fix" approaches suggested for consideration during a meeting at the Pentagon in early June 1963 were a modification of the HAWK into a more mobile system to fulfill a portion of the MAULER mission; the adaption of existing air-to-air missiles, such as the FALCON and SIDEWINDER, to the air defense role; and a backup MAULER program with another contractor based

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[36] Ltr, W. J. Morrow, Dir, Army Wpn Sys Mgt, GD/P, to COL N. T. Dennis, 31 May 63, subj: MAULER Prototype Seeker Head. MPCF, Bx 11-14, RHA.

[37] (1) Ltr, COL N. T. Dennis, MAULER PM, to CG, AMC, 7 Jun 63, subj: Ch in Seeker Design for the MAULER Msl, & incl thereto, Staff Study. MPCF, Bx 13-410, RHA. (2) Ltr, COL N. T. Dennis to W. J. Morrow, GD/P, 7 Jun 63, n.s. Same Files, Bx 11-14. (3) As a result of later problems with the phased-array seeker, the Project Manager, in May 1964, appointed a committee to reconsider the design change. DF, MAULER PM to Chf Scientist, 14 May 64, subj: Com on MAULER Seeker Head. Same Files, Bx 13-410.

[redacted]

[redacted]

on reduced military requirements.[38] Regardless of the alternate or backup action taken, AMC was to continue the MAULER and REDEYE development efforts with high priority.[39]

([redacted] On the basis of a cursory time and cost study of the "quick fix" solutions, MICOM concluded that the suggested HAWK and FALCON-SIDEWINDER concepts offered a high probability of success within the prescribed 18-month time frame, but that no benefit would accrue from a backup MAULER system with reduced capabilities. Another contractor would require at least 2 years to determine his hardware shortcomings and problems, and it was not very likely that solutions to problems such as those encountered by GD/P could be accurately predicted during a study program alone. It was the considered opinion of the Command that the "problems presently being encountered . . . in the MAULER System will be solved resulting in a highly effective weapon system for the Army."[40]

MAULER Reliability Briefing

([redacted] In the meantime, Government officials from the OSD on down focused their attention on the MAULER test site and the frantic efforts of the GD/P task force to get GTV-1 off the ground. Upon receipt of the missile early in March 1963, the test crew had begun the mandatory pre-firing checkout exercises preparatory to

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[38]The reductions proposed in MAULER requirements were in areas where GD/P was having the greatest difficulty; i.e., give up the single-vehicle fire unit concept and shoot-on-the-move requirement; eliminate the requirement for IR passive detection; ease the weight limitations and altitude requirements; increase the target radar cross section; relax the diesel power requirement; and accept an increase in warm-up time from 3 to 5 minutes. (The latter change had been suggested during the December 1960 ECR, but was disapproved by CONARC. See above, pp. 109-111.)

[39](1) MFR, Chf, Dev Div, Dir, R&D, AMC, 4 Jun 63, subj: Interim and Backup Sys for MAULER & REDEYE. (2) Ltr, Chf, Msl Br, Dev Div, Dir, R&D, AMC, to CG, MICOM, 5 Jun 63, subj: Fld Army AD.

[40]TT AMSMI-RFC-34, CG, MICOM, to CG, AMC, 7 Jun 63.

[redacted]

the first flight test.[41] Throughout the ensuing 3 months, their efforts to checkout and fire the GTV-1 missile were thwarted by continued technical difficulties similar to those experienced in the laboratory—i.e., low missile sensitivity owing to internally and externally generated noise; inability of the T-I radar to track through the launch blast environment; and incompatibilities among the various breadboard system components. By 17 June, the latter two problems were thought to be solved, but the noise problem had not been sufficiently alleviated to permit the flight test.[42]

[redacted] On 25 June, as the GTV-1 missile rested in its canister at the proving ground, Colonel Dennis faced the painfully difficult task of explaining the reasons for continued program slippages and technical problems, as part of the Army's reclama of the recent Congressional decision to defer the initial MAULER production buy to FY 1965. The final countdown was about to begin and the firing of the first Guidance Test Vehicle was expected momentarily. But it was far too late for promises of success to influence the decision at hand. Not only were the MAULER PEMA funds slashed from the 1964 budget, but the OSD withheld half of the RDTE funds for that year[43] pending the program reappraisal to be conducted later in 1963.

(U) Up to that time, Colonel Dennis had defended GD/P against Army Staff criticism with respect to the lack of progress in the MAULER and REDEYE programs. But now his patience had clearly run

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[41]The checkout exercises embraced missile/T-I/weapon control console compatibility tests; missile acceptance tests to determine the state of firing readiness; blast acoustic effects tests to insure that the T-I radar was capable of tracking a target in the expected launch blast environment; dress rehearsals of the GTV-1 firing operation; and conduct of T-I to missile RF power spillover tests.

[42]GTV-1 Msl Hist, 17 Jun 63. MPCF, Bx 13-422, RHA.

[43]See above, p. 164.

out. In a private talk with Mr. W. J. Morrow—one of the top-level GD/P officials attending the DOD briefing—he took the company to task for its complacent attitude toward the problems and slippages in both programs. Describing the company's reputation at WSMR as "one of the poorest of the various contractors operating there," he emphasized that more firm control of the test program was imperative, and warned that increased pressure from MICOM and higher headquarters could be expected unless "technical progress improves."[44]

Initiation of Guidance Test Vehicle Firings [redacted]

[redacted] The Guidance Test Vehicle (GTV) program finally got underway with the firing of the first round on 27 June 1963—some 8 months behind schedule.[45] To the extent that the rocket motor got the missile out of its canister, the test was a dramatic success. But as far as operation of the guidance system was concerned, it was a miserable failure. After some 3 months of intensive missile checkout tests and dress rehearsals, the GD/P test crew had been able to achieve a missile/target lock-on in the launch environment. But immediately upon launch, the seeker lost lock because of power spillover, flame modulation, and internal missile noise.

[redacted] According to the original design concept, the missile was to have been equipped with a reacquisition capability; i.e., upon loss of homing signal, the missile seeker would automatically switch to home-on-jam operation and upon return of signal automatically switch again to semiactive homing.[46] However, the missile had not been equipped with reacquisition circuitry and, having lost the homing signal, it simply failed to guide. The decision not to

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[44] MFR, COL N. T. Dennis, 26 Jun 63, subj: Trip Rept, Washington, D. C., 24-25 Jun 63. MPCF, Bx 13-410, RHA.

[45] Hist Rept, MAULER Proj Ofc, 1 Jan - 30 Jun 63, p. 5.

[46] <u>See</u> above, p. 145.

provide the missile with the reacquisition capability was based on the quick reaction time required to attack close-in or short-range targets. For longer range targets, the reaction time would be greater and reacquisition after launch therefore appropriate; but the split-second reaction time for very close targets made reacquisition after launch impractical and circuitry for that purpose had been omitted. Yet another significant deviation concerned the speed of outgoing targets that could be intercepted by MAULER. Here, GD/P requested and was granted a target speed deviation from 1,200 to 720 knots. Laboratory tests had shown that for outgoing targets traveling at speeds in excess of 720 knots, the T-I radar had difficulty in distinguishing between the missile and the target.[47]

([redacted] With only 5 months left before the program reappraisal, it behooved GD/P to conduct the subsequent firings on schedule and to see that they produced tangible evidence of progress toward solutions to problems still plaguing the system. The revised schedule called for delivery of the GTV-2 missile to WSMR for flight test evaluation in July 1963. However, laboratory checkout of the missile was delayed by difficulties similar to those experienced in GTV-1. Mr. W. J. Morrow, the MAULER Project Manager at GD/P, promised delivery by 12 August 1963,[48] but continuing noise problems forced another slippage to late August,[49] and another month would be required to complete on-site checkout tests and dress rehearsals.

[redacted] Meanwhile, a slippage also occurred in delivery of the

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[47](1) MAULER Briefing to MG F. H. Britton, Dir, R&D, AMC, 8 Oct 63. (2) DF, COL N. T. Dennis to CG, AMC, 15 Oct 63, subj: MAULER GTV-2 and 3. Both in MPCF, Bx 13-410, RHA.

[48]Ltr 7-813-02561, W. J. Morrow, GD/P, to CG, MICOM, 30 Jul 63, subj: GTV-2 Dlvry for Fld Tests. MPCF, Bx 11-14, RHA.

[49]Ltr 7-813-02684, same to same, 9 Aug 63, subj: GTV-2 Dlvry Scd. File same.

first Engineering Model Fire Unit (EMFU-1). In early August, Mr. Morrow notified MICOM that the delivery of EMFU-1 for systems tests had been changed from 31 July to 14 October 1963, because of problems in two general areas. First, the austere nature of the MAULER funding program had precluded the procurement of spare parts to support the integration and test programs; and secondly, the basic technical problems inherent in the integration of many complicated subsystems into a functioning system required more time to solve than anticipated. Typical of the latter difficulties were the instability of the radar, launch order computer, and launcher servo loop; slipring assembly failures during checkout; and incompatibility of the target simulator and radar systems. These problems were exceedingly difficult to diagnose and often required redesign and subsequent manufacture and test of components. Frequently, the failures were of such a nature that spare parts were needed, and having none, the laboratory either had to use existing repair parts in stock or cannibalize another fire unit. Very often, the needed part had to be ordered and testing held up until its receipt and installation. Because of the total impact of the two problem areas, mid-October was the earliest delivery date possible for EMFU-1, and 24 December 1963 for EMFU-2.[50]

([redacted] In early September 1963, as GD/P's 120-day letter contract was about to expire, Dr. Harold Brown, DDRE, agreed to release $21.2 million of the deferred FY 1964 RDTE program, enough to carry the MAULER effort through February 1964. The remaining $16.816 million programmed for the MAULER would continue in a deferred status pending the AMC reappraisal of the weapon system and a firm program based on the evaluation of test firings.[51]

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[50](1) Ltr 7-813-02603, W. J. Morrow to CG, MICOM, 2 Aug 63, subj: Dlvry of MAULER EMFU-1. (2) Ltr 7-813-02713, same to same, 13 Aug 63, subj: same. Both in MPCF, Bx 11-14, RHA.

[51]Memo for SA, fr DDRE, 9 Sep 63, subj: Apprl of Army FY 64 RDTE Program Element MAULER. MPCF, Bx 13-410, RHA.

[redacted] With the second GTV missile yet to be fired on 3 October 1963, it was obvious that the program reappraisal would have to be conducted without the benefit of the six firings suggested by the Nichols Committee. The Commanding General of MICOM depicted the precarious status of the MAULER project at that particular point when he told the Acting Director of R&D, AMC: "This program is in trouble technically and financially. It will most likely cost more than currently estimated and also requires more time than now programmed. . . . MAULER is fine, if the technical requirements can be met; but as of now we are in trouble. . . ."[52]

[redacted] The results of the GTV-2 firing on 9 October 1963 confirmed that the MAULER was indeed in very deep trouble. As in the previous firing, the seeker lost lock at launch and, having no reacquisition circuitry, was unable to regain target lock-on. The contractor then decided to equip subsequent GTV rounds with circuitry for an in-flight reacquisition capability, thereby degrading the system's ability to attack very close targets.[53]

[redacted] In mid-October 1963, while GD/P proceeded with the modification and bench test of the GTV-3 missile, COL Erwin M. Graham, Chief of the Missile Branch, R&D Division, AMC, recommended that immediate action be taken to appoint a committee for reappraisal of the MAULER program. Although the Nichols Committee had suggested that the reappraisal be made after the sixth firing, he pointed out that serious doubts had arisen at all management levels as to the feasibility of the existing design concept and the contractor's ability to evaluate and solve the technical problems. Moreover, the funds then available to the Project Manager would be exhausted on 29 February 1964, and no further release would be made until

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[52] Journal Entry, CG, MICOM, 4 Oct 63, subj: Rev of FY 65 RDTE Program.

[53] DF, COL N. T. Dennis, MAULER PM, to CG, AMC, 15 Oct 63, subj: MAULER GTV-2 and 3. MPCF, Bx 13-410, RHA.

after completion of the reappraisal. This dictated that the re-appraisal effort be completed no later than mid-January 1964.[54]

Program Reorientation

([redacted]) In view of the unsatisfactory performance of the first two GTV's and the multiplicity of problems and delays being encountered in the checkout of EMFU-1, the MAULER Project Manager, in a series of briefings during October and November 1963, recommended that the development program be redirected to one of feasibility validation. While the plans for the proposed Feasibility Validation Program (FVP) were being processed through the Army General Staff, General Besson appointed BG Charles W. Eifler, then Deputy Commanding General for Land Combat Systems at MICOM, as the chairman of a technical committee to conduct a reappraisal of the MAULER program. This committee, established in mid-November 1963 and known as the Eifler Committee, was charged with evaluating the engineering concept, identifying the problem areas, and determining whether the successful development of MAULER could be adequately assured within reasonable time and cost.[55]

(U) The formal plans for the FVP were not officially approved and published until receipt of the final reappraisal report in early 1964. However, the level of effort at GD/P was cut back early in December 1963 in order to stay within available program authority. The cost-plus-incentive-fee letter order supplement to the R&D contract (ORD-1951), issued in July 1963, was purposely allowed to expire and the FVP effort was initiated on 8 December

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[54] DF, Chf, Msl Br, R&D Div, AMC, thru Chf, Dev Div, to CG, AMC, 14 Oct 63, subj: MAULER Reappraisal. MPCF, Bx 13-410, RHA.

[55] (1) Memo for PM, MAULER, fr COL James L. Lewis, Sp Asst for Proj Mgt, AMC, 15 Nov 63, subj: Conf of CG, AMC, with Chmn, Com for Reappraisal of MAULER Program. MPCF, Bx 13-410, RHA. (2) MAULER TDP, 31 Mar 64, pp. v - vi. Same files, Bx 13-422.

under a new 120-day letter order contract for $10.620 million.[56] This decreased the level of effort from $6 million to $2.6 million per month and reduced the number of contractor personnel assigned to MAULER by nearly 50 percent—from 2,900 to 1,407.[57]

(U) At that time, the fabrication of the engineering model hardware had been completed and design of the R&D prototype system was about 50 percent complete. GD/P completed the integration and acceptance testing of EMFU-1 and delivered the unit, on 26 October 1963, to the Chino, California, test facility. Following component checkout and dynamic tracking tests employing a GTV missile, EMFU-1 would be shipped to WSMR for flight tests in late June 1964.[58]

([redacted] Although the GTV firing schedule was officially cancelled with the redirection of the development program, General Besson granted General Eifler authority to reschedule the firings as needed in the performance of his weapon system reappraisal. The GD/P test crew attempted to fire GTV-3 at WSMR on 19 December 1963, but the firing was aborted because of a malfunction in the hot gas generator mechanism. The firing of GTV-3 was postponed pending an evaluation of the best use for the missile based on the FVP test program recommended by the Eifler Committee.[59]

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[56] (1) MICOM Hist Sum, FY 1964, p. 55. (2) The total value of the GD/P R&D contract ORD-1951 through the date of expiration was $130,085,146. The new CPFF letter order was later definitized under Contract DA-04-495-AMC-345(Z) in the amount of $34,692,525 for the period 8 December 1963 through 28 February 1965. Add to MAULER TDP, 10 Dec 65, p. 12.

[57] MFR, COL N. T. Dennis, MAULER PM, 15 Jan 64, subj: Trip Rept, 17-20 Dec 63 [re Briefing to Dr. Brown, DDRE, 20 Dec 63]. MPCF, Bx 13-410, RHA.

[58] (1) MAULER PM_2P, 30 Jun 64, p. 3. MPCF, Bx 13-422, RHA. (2) Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, p. 15.

[59] (1) Ibid., pp. 15-16. (2) Memo for PM, MAULER, fr COL James L. Lewis, Sp Asst for Proj Mgt, AMC, 15 Nov 63, subj: Conf of CG, AMC, with Chmn, Com for Reappraisal of MAULER Program. MPCF, Bx 13-410, RHA.

The Eifler Committee Reappraisal Report

(U) Since the FVP plan initially proposed by MICOM and AMC was generally compatible with the interim findings of the Eifler Committee, the development effort at GD/P was reoriented on that basis pending approval of the formal reappraisal report. Official DOD sanction of the proposed reoriented program came during a conference in Dr. Harold Brown's office on 20 December 1963, at which time General Eifler reviewed the findings of his Committee. The formal reappraisal report was published in two volumes, the first on 20 December and the second on 27 January 1964.

([redacted]) The Eifler Committee concluded that the MAULER concept was technically within the state of technology and that the system could be expected to engage successfully tactical jet and piston aircraft at slightly reduced range from that defined in the threat. Additional modification would be required to engage helicopters traveling at radial speeds of less than 90 knots and the system had only marginal capability for effective engagement of short range rockets (HONEST JOHN type) and missiles. The Committee concluded that the "shoot-on-the-move" requirement should be dropped as impractical. It was further determined that the packaging requirements to place the entire system on a single vehicle were so severe that reliability could be seriously degraded on the battlefield. The Committee recommended that consideration be given to repackaging the concept on two vehicles instead. In addition, considerable work was required to eliminate serious performance deficiencies in the missile and the Engineering Model Fire Unit (EMFU). Pending solutions to the technical problems revealed in the first two guided flight tests and the laboratory checkout of EMFU-1, the Committee recommended that further hardware work be deferred on the vehicle, turbine and primary power system, the Battery Command Post, support and test equipment, and IFF equipment. It also recommended that further hardware work cease on the R&D prototype model of the target evaluation computer, but that the development of program tapes be continued since these were necessary for [redacted] proper checkout of the EMFU.

([redacted]) The Eifler Committee found that progress was being made in the isolation of performance and compatibility problems in EMFU-1 at the Chino Test Facility, but noted that adequate tracking tests were yet to be conducted. It emphasized that the equipment should not be moved to WSMR for missile launching until proper and reliable performance had been demonstrated in ground and target tests. Since components for the R&D prototype acquisition and T-I radars were about 90 percent complete, General Eifler recommended that the fabrication of one each be completed. With respect to the infrared acquisition unit being developed by DeHavilland, he felt that it offered an attractive potential for passive surveillance on the battlefield and recommended that component work be continued toward solution of basic problems, such as background rejection.

([redacted]) Based on an evaluation of the missile design, the Committee concluded that significant modifications would be needed to meet minimum performance requirements. Those requiring the highest priority attention were the installation of acquisition circuitry for seeker lock at launch and a change in the present open loop autopilot to one providing aerodynamic control loop rate stability, or rate-gyro feedback. To solve these and other electronic problems in the minimum of time, General Eifler asserted that the use of proven technology would be mandatory. In this connection, he advised against the use of the phased-array seeker or any other substantially new device for the feasibility validation program, but suggested that ground and captive tests of the phased-array seeker be continued for possible future use. Before resuming fully guided flight tests, performance of the missile and its components was to be satisfactorily demonstrated in a progressive series of ground tests, simulator tests, and captive flight tests.[60]

([redacted]) Dr. Brown's reaction to the Eifler Committee's recommendations was that "the overall approach outlined was good but may be about two years too late." Satisfied that the system was technically feasible, he approved the reoriented program and the proposed test plan for the feasibility validation effort.[61]

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[60] (1) MFR, COL N. T. Dennis, 15 Jan 64, subj: Trip Rept, 17-20 Dec 63, & Incl 3 thereto, Eifler Com Reappraisal Rept, 18 Dec 63. MPCF, Bx 13-410, RHA. (2) Info furnished by MG Charles W. Eifler, CG, MICOM, 19 Dec 68.

[61] MFR, Chf, AD Div, OCRD, 23 Dec 63, subj: Reoriented MAULER Program. MPCF, Bx 13-410, RHA.

CHAPTER VIII

([redacted] FEASIBILITY VALIDATION PROGRAM AND ALLIED STUDIES (U)

(U) The provisions of the Eifler Committee Reappraisal Report were formally implemented early in 1964, pursuant to instructions issued by the Commanding General of AMC.[1] COL Bernard R. Luczak, who succeeded COL Norman T. Dennis as MAULER Project Manager on 12 February 1964,[2] made the necessary revisions in the test plan and technical requirements for the Feasibility Validation Program (FVP), effected the deferment of work in those areas specified in the reappraisal report, and amended the scope and direction of work under existing development contracts.

(U) Concurrently with the FVP effort, several allied studies were conducted for later use by higher headquarters in making a final decision on the future course of the MAULER project and the forward area air defense program. These included trade-off and configuration studies to determine the attainable characteristics and growth potential of the MAULER R&D prototype,[3] conducted by a MICOM-GD/P team; and a cost effectiveness study by the Combat Developments Command (CDC). The primary objectives of the latter study were to evaluate the cost effectiveness of MAULER (based on the MICOM configuration study) and other forward area air defense weapons, and to determine the most desirable alternatives to meet the threat during the 1970-75 period.

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[1] Ltr, CG, AMC, thru CG, MICOM, to MAULER PM, 2 Mar 64, subj: Impln of the Findings of the Eifler Com. MPCF, Bx 13-410, RHA.

[2] MICOM GO 14, 11 Feb 64.

[3] The 9-missile design with split T-I radar antennae.

Program Plans and Objectives

(U) The overall objectives of the reoriented program was to validate the feasibility of the MAULER principles and techniques as a self-contained air defense system, using engineering model hardware. Specific objectives of the program were (1) to demonstrate by test that the EMFU could acquire, designate, and track airborne targets; (2) to demonstrate by test that the missile could guide to the vicinity of the target; (3) to determine by test and analysis that the miss distance, fuze, and warhead would ultimately provide the required target kill effectiveness; and (4) to determine by evaluation, analysis, and demonstration that a tactical weapon could be fielded in an acceptable time frame with an adequate level of effectiveness.[4]

(U) The basic program plan called for completion of the design validation and test activities by 31 May 1965. The RDTE cost of the total FVP effort was estimated at $55 million, bringing the cumulative cost to $202 million for the FY 1960-65 period ($147 million had been obligated at the time of the program reorientation in late 1963). The total estimated RDTE cost for completion of the program—assuming successful recovery and resumption of full development—was $411.4 million.[5] The originally planned FVP effort was completed on schedule with an underrun of $4,960,263. Pending a final decision as to the MAULER's future, the test and engineering activities were extended through 30 September 1965, as shown in the accompanying charts.[6]

(U) The $10.62 million, 120-day letter contract awarded to GD/P on 8 December 1963 was extended to 145 days on 9 March 1964.

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[4]Add to MAULER TDP, 10 Dec 65, pp. 1-2.

[5]Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, p. 5.

[6]MAULER PM_2P, 30 Jun 65, p. 21. MPCF, Bx 13-422, RHA.

CHART 7

MAULER

(U) FEASIBILITY VALIDATION PROGRAM
PLANNED AND ACTUAL SCHEDULE
10 December 1965

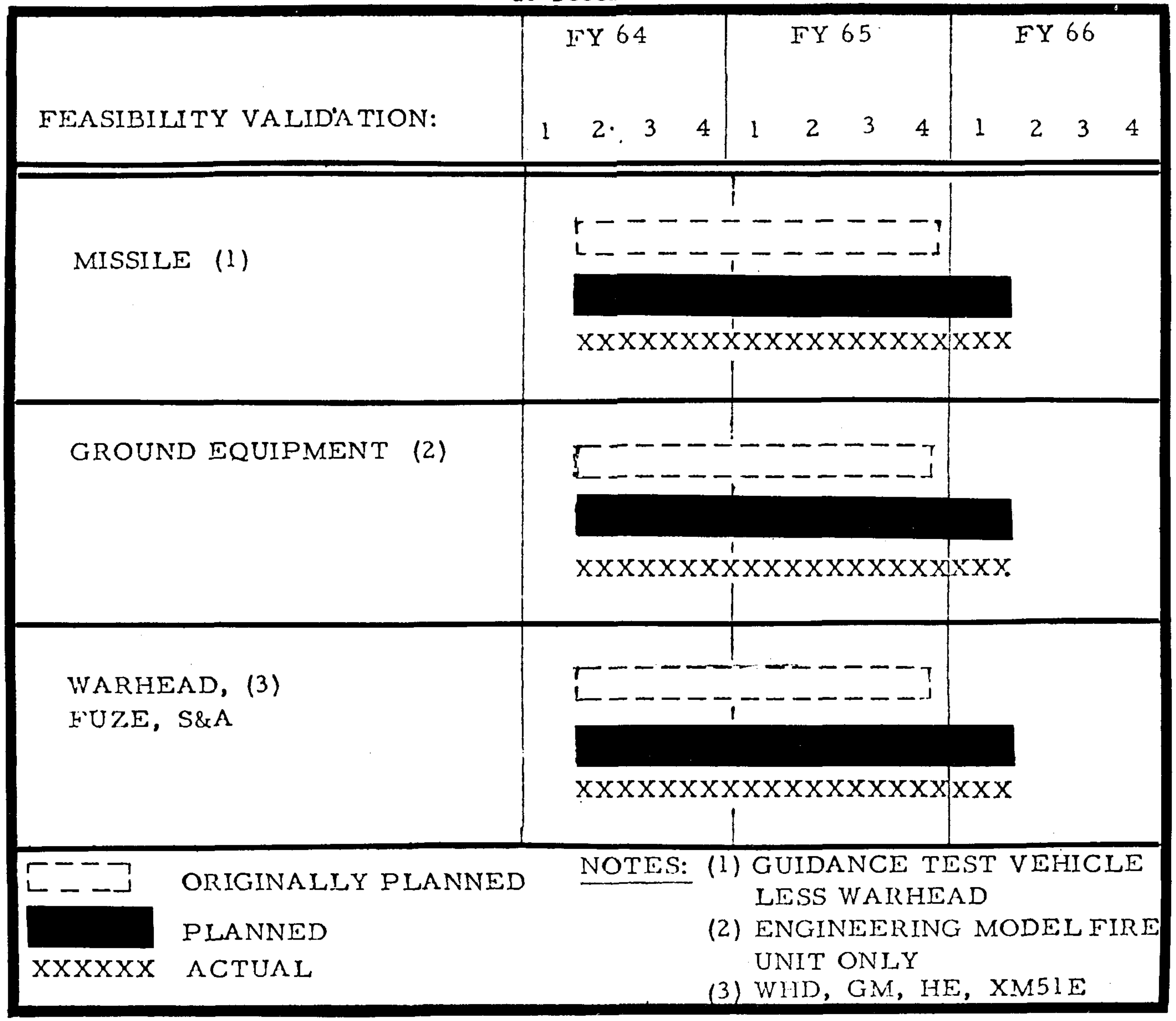
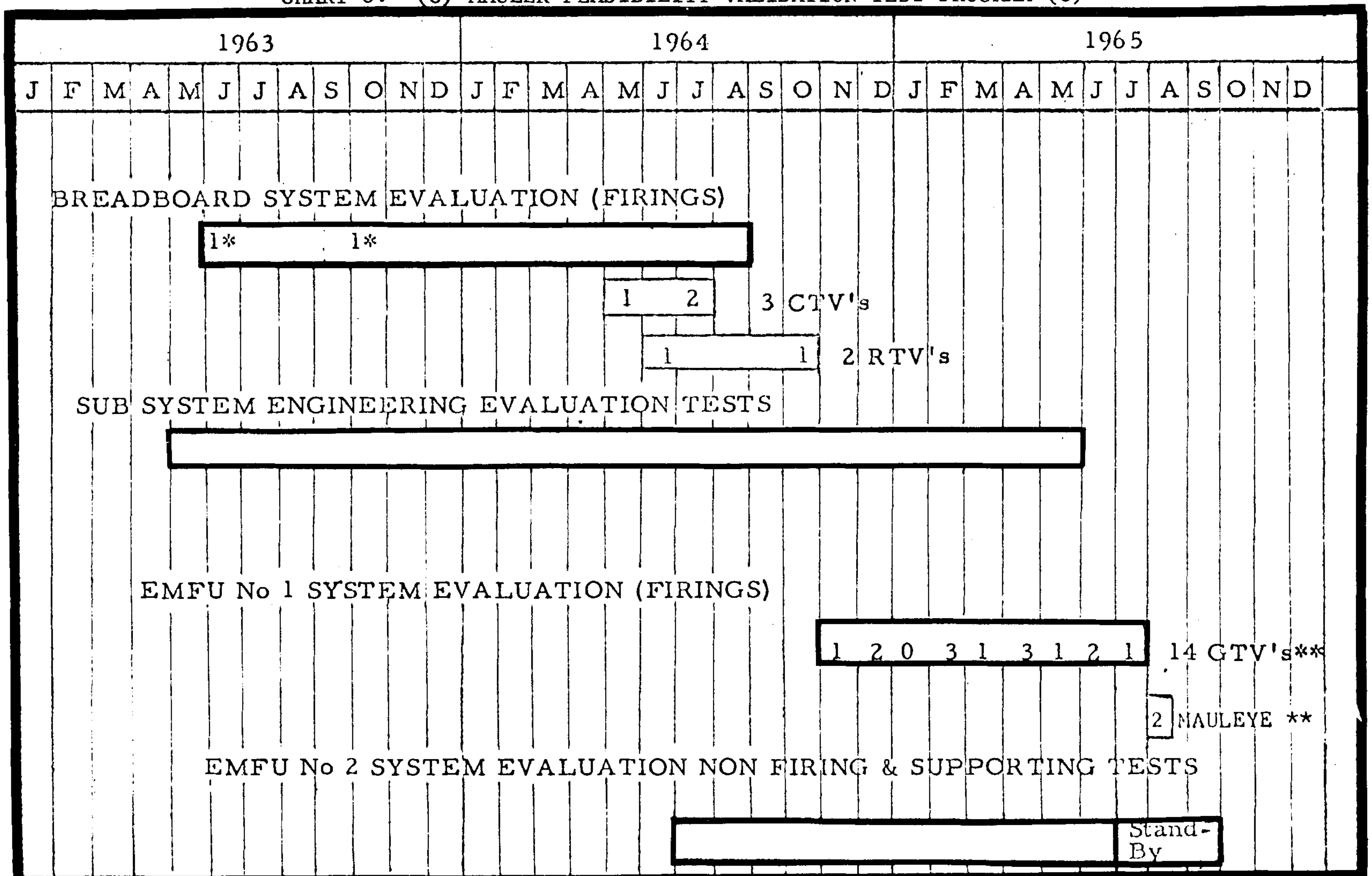


CHART 8. (C) MAULER FEASIBILITY VALIDATION TEST PROGRAM (U)



* TWO GTV's FIRED PRIOR TO FEASIBILITY VALIDATION PROGRAM

** THREE GTV's & TWO MAULEYE TEST MISSILES FIRED DURING FEASIBILITY VALIDATION EXTENSION

10 December 65

It was then definitized on 30 April as a CPFF contract in the total amount of $34,692,525, including a fixed fee of $1,932,822 (5.9 percent).[7] Subsequent modifications amounting to $11,733,457 resulted in a total contract value of $46,425,982 for the FY 1964-65 period. Included in this amount was $3,685,661 for an extension of the FVP effort from 1 June to 30 September 1965.[8]

(U) Pursuant to recommendations of the Eifler Committee, the BCP development contract with the Hughes Aircraft Company was allowed to expire at the end of the program definition phase in January 1964,[9] and the original IRA development contract with the Canadian Commercial Corporation was replaced on 7 February 1964 by a new 60-day letter contract for the design validation effort. The latter contract was definitized on 8 April in the amount of $849,900. A change order issued on 24 June redirected work under the contract toward the spatial discrimination technique for reduction of background clutter.[10] Subsequent modifications amounting to $358,537 resulted in a total contract value of $1,208,437 for the FY 1964-65 period, $283,085 of which was to cover the FVP extension through the first quarter of FY 1966. This represented the U. S. portion of the 50-50 development sharing agreement between the American and Canadian Governments. A separate contract in an equal amount was executed directly between the Canadian Government and DeHavilland Aircraft, Ltd.[11]

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[7] (1) Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, p. 5. (2) SS AMCPM-MAP-10, MAULER PM, 14 Apr 64, subj: Req for Apprl of Awd, MAULER Wpn Sys FVP, Contr DA-04-495-AMC-345(Z), & incl thereto, 1st Ind, CG, MICOM, to CG, AMC, 14 Apr 64, on Ltr, CO, LAPD, thru CG, MICOM, to CG, AMC, 10 Apr 64, subj: Req for Apprl of Awd.

[8] MAULER PM2P, 30 Jun 65, p. 8. MPCF, Bx 13-422, RHA.

[9] Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, p. 20. (2) Also see above, p. 184.

[10] Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, pp. 3-4.

[11] MAULER PM2P, 30 Jun 65, p. 8. MPCF, Bx 13-422, RHA.

[redacted]

Execution of the Program

(U) In contrast to the repeated failures and schedule delays experienced in the development program during the 1960-63 period, the feasibility validation effort was, as Colonel Luczak put it, a "resounding success." It was completed precisely on time, and not only within the funding objective, but with an underrun of more than four million dollars. He attributed this achievement, in the main, to careful and close management in which the new PERT/Cost technique was used.[12]

([redacted]) Although the single-vehicle weapon system was considered to be within reach of existing technology, the technical difficulties encountered during the first several years of development indicated that further design engineering and evaluation would be essential before release it for production. Of prime concern were unsolved technical problems in the following areas:

1. Weight and size - fire unit and missile.
2. Miniaturization of electronic components.
3. Packaging of electronic components.
4. Acquisition and T-I radar clutter and spillover.
5. Target reacquisition and lock-on after launch.
6. System noise, acoustic (turbine generator set) and electronics.

The first three problem areas, while definitely pushing the state of the art, were considered to be within reach of solution and were not of immediate concern. The latter three deficiencies, however, prevented the weapon system from meeting the performance and reliability requirements, and it was primarily the problems in those general areas that prompted the redirection of the program.[13]

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[12] MAULER Eval Bd Briefing, 4-7 Jun 65, p. 8. MPCF, Bx 13-410, RHA.

[13] (1) MAULER TDP, 31 Mar 64, pp. v, vii. (2) MAULER PM_2P, 30 Sep 64, p. 5. Both in MPCF, Bx 13-422, RHA.

[redacted]

([redacted]) To provide effective air defense in the forward area, a weapon system such as the MAULER must be able to acquire, evaluate, designate, track, and destroy aircraft and short-range ballistic missiles in a very short time. To this end, the acquisition radar must be able to detect low-altitude high-speed targets at sufficient range to take maximum advantage of the system's missile range. The target acquisition data rate and processing must be such that rapid evaluation can take place so that appropriate target selection occurs when multiple targets exists. Evaluation must also be rapid to permit engagement of those targets which have evaded radar detection until they are very close to the weapon. Likewise, target designation must also be rapid both in decision and in execution. The target tracking and illuminating function must provide for a correlation check of the target designated and also provide reliable illumination in the difficult environment which exists when tracking targets at low level and in the presence of missile firing. The missile capability must be such that a wide spectrum of targets ranging from helicopters and liaison aircraft to ballistic missiles can be intercepted and destroyed. Here again, owing to the low altitude of the threat and the probability of short allowable time for engagement, the missile must be able to engage targets very close to the weapon.

([redacted]) These stringent weapon system requirements formed the basis for the FVP effort that began in December 1963 and continued through May 1965. The design validation of the engineering model weapon system (see illustrations) embraced a planned program of design refinements which were demonstrated in a progressive series of laboratory tests, tracking tests, captive flight tests, and finally, actual firing tests against targets of increasing engagement difficulty.[14]

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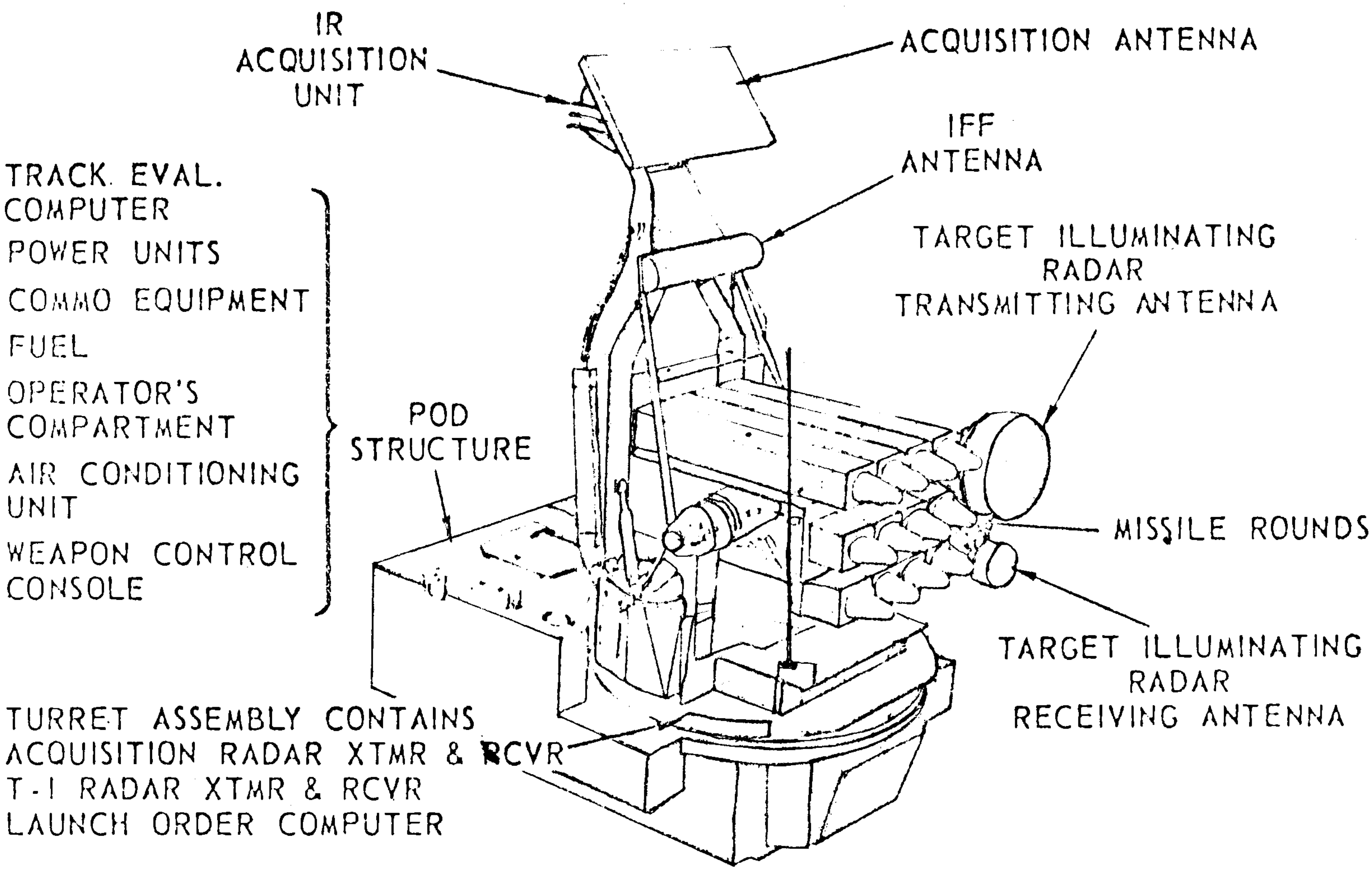
[14] GD/P Rept CR-820-453-001, 30 Jul 65, subj: MAULER FVP Final Rept - 8 Dec 63 thru 28 May 65, pp. 1.5 - 1.7, 2.1 - 2.2. RSIC.

MAULER
USAMICOM

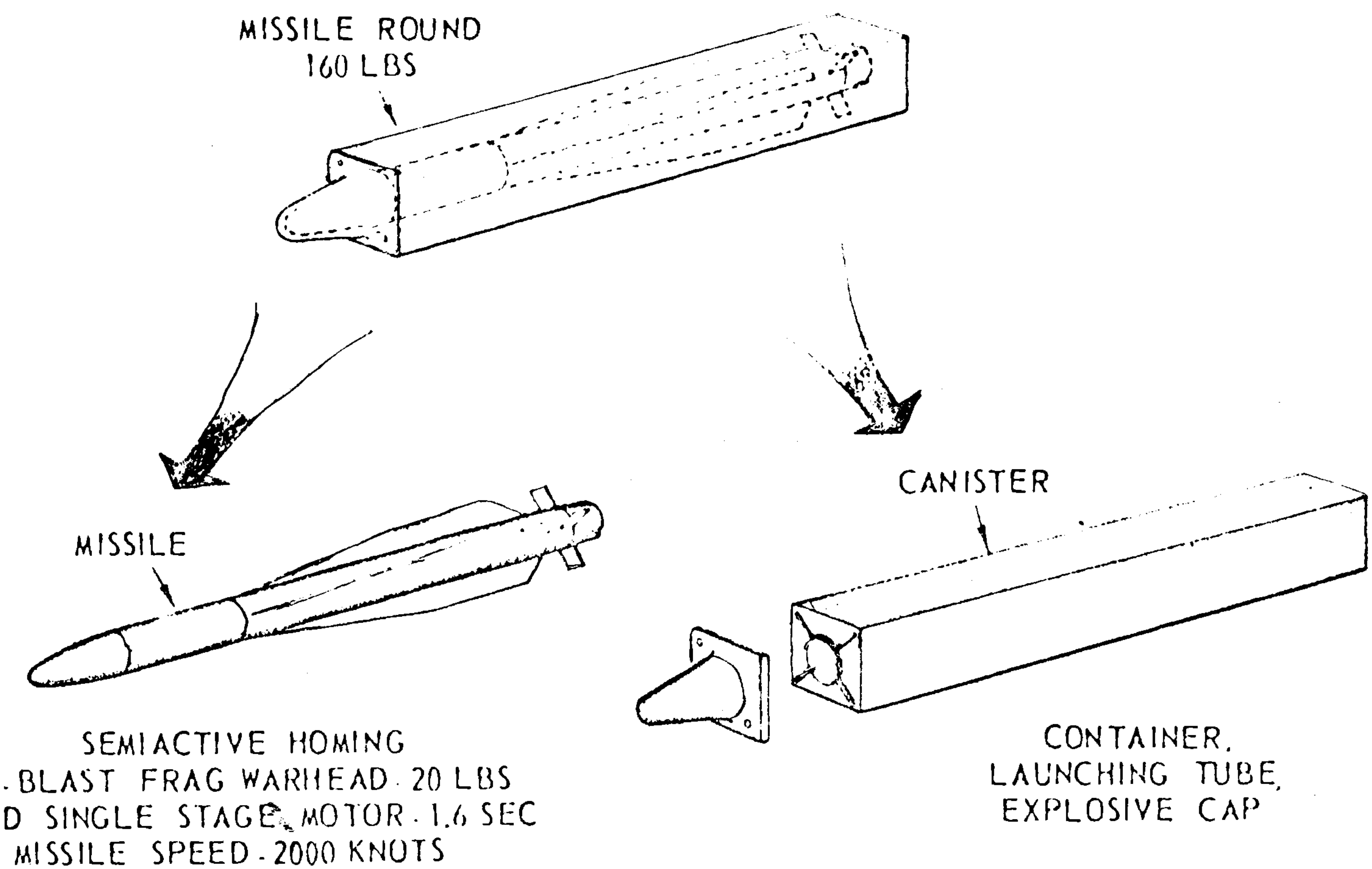
THE WEAPON POD

ENGINEERING MODEL



MAULER
U S A M I C O M

THE MISSILE



[redacted]

[redacted]

[redacted]

Test and Evaluation of the Fire Unit

(U) Very early in the program, GD/P engineers retrofitted the two engineering model fire units (EMFU-1 and EMFU-2) with several R&D model capabilities to eliminate known deficiencies in performance and reliability. As the test and evaluation effort continued, additional retrofits were introduced to correct latent deficiencies. Among these were acquisition radar data converters and high voltage power supply; on-turret hydraulic pump; azimuth servo pump; control console digital encoders; T-I radar receiver clutter notch filter; and T-I radar speedgate.[15]

(U) The EMFU-1 pod had already undergone laboratory integration and checkout tests and had been delivered to the Chino Test Facility in late October 1963 for further subsystem and system evaluation. Comprehensive tracking tests continued at Chino until 27 June 1964, when the unit was shipped to WSMR for more tracking tests and checkout with the GTV missile. (This unit was used in all of the GTV firings.)

(U) System integration and checkout test of the EMFU-2 pod was completed at the GD/P laboratory in July 1964. The unit then underwent tracking tests at Chino until mid-December 1964. At WSMR, it was used in extensive tracking tests and in compatibility tests with the XM-546 vehicle.

[redacted] In the course of the EMFU evaluations, all critical operational characteristics of the weapon pod were successfully demonstrated. On 75 percent of the recorded tracking missions, the fire unit sufficiently demonstrated the ability to acquire, evaluate, designate, perform T-I search, and lock on representative targets at ranges that would permit maximum range intercepts. From a total of 324 automatic engagements at WSMR, 305 were successful

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[15] _Ibid._, pp. 2.2 - 2.3.

[redacted]

in locking the T-I radar on the proper target. The average demonstrated fire unit performance was more than adequate to allow the system to intercept targets at a 7 km outer boundary. Against a 400-knot target, for example, the missile would have to be fired at 9 km in order to achieve a 7-km intercept. The available test data indicated that the fire unit was ready to fire the missile when the target was at about 16.5 km, thereby allowing the system more than sufficient time to intercept this class of target.[16] As an extreme test of the unit's capability, ballistic missile targets (the HONEST JOHN) were successfully acquired and tracked on two different occasions. Another significant capability demonstrated, in addition to the basic FVP objective, was the acquisition, target designation, and T-I track of a simulated target while the fire unit was on the move.[17]

(U) In February and March 1964, while the design validation of the retrofitted EMFU's was in progress, the GD/P crew at WSMR test fired one special test vehicle (STV-8) and six blast test vehicles (BTV's) with the ZUNI rocket motor from the breadboard weapon pod (Engineering Model Pod #1) used in the earlier MAULER firings. The purpose of these tests was to obtain data on the missile launch environment and to evaluate specific firing geometrics and blast effects on pod operation and performance. The test results indicated little or no damage to the pod or associated equipment; however, flame ingestion into the turbine intake caused a momentary flame-out of the turbine. An additional BTV round (BTV-7), incorporating a modification of the turbine intake, was successfully fired on 9 April 1964.[18]

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[16] MICOM Rept, 27 Jul 65, subj: Eval of the MAULER FVP as of 1 Jun 65, pp. 10, 12, 19. RSIC.

[17] (1) GD/P Rept CR-820-453-001, 30 Jul 65, op. cit., pp. 2.2 - 2.3. RSIC. (2) Add to MAULER TDP, 10 Dec 65, p. 2.

[18] Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, pp. 16-18.

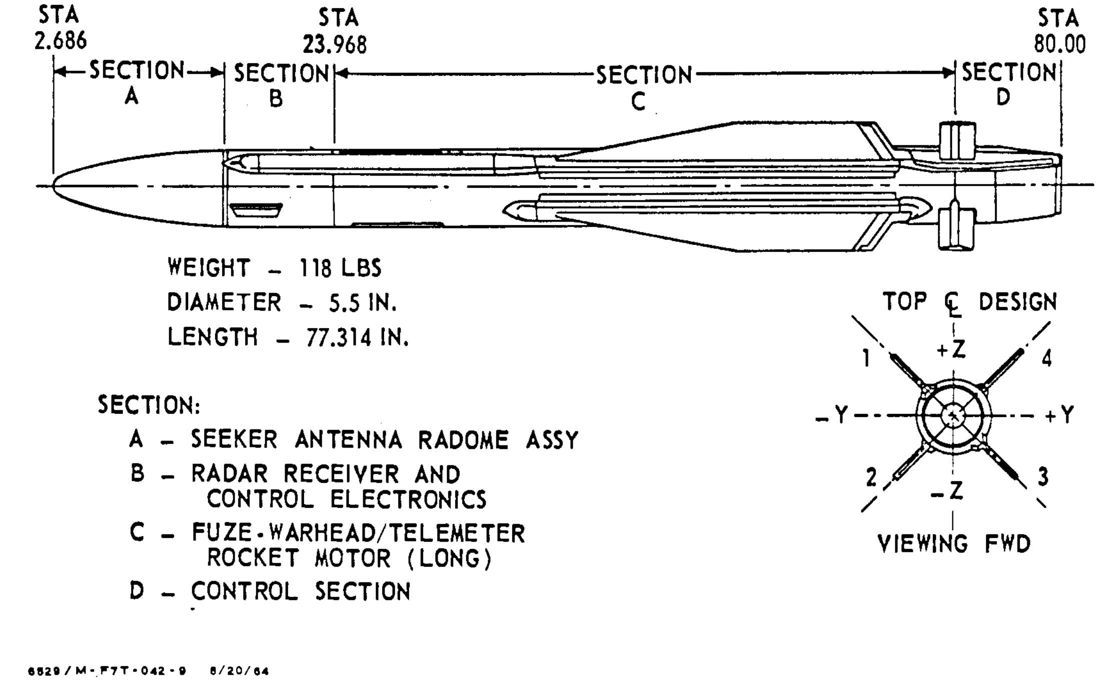
Validation of the Missile Subsystem Design

[redacted] Validation of the missile subsystem design consisted of a series of captive flight tests and test vehicle firings to prove the validity of design refinements, preparatory to the final GTV/EMFU-1 system tests. The missiles used were of two basic configurations: the short airframe (engineering model) type for the Reacquisition Test Vehicle (RTV) flights, and the long airframe type for the CTV and GTV flights. The long airframe had been designed for the R&D prototype MAULER missile, but was introduced in the CTV-8 firing because of the FVP requirements. The physical characteristics of the two configurations are shown in the accompanying illustrations.

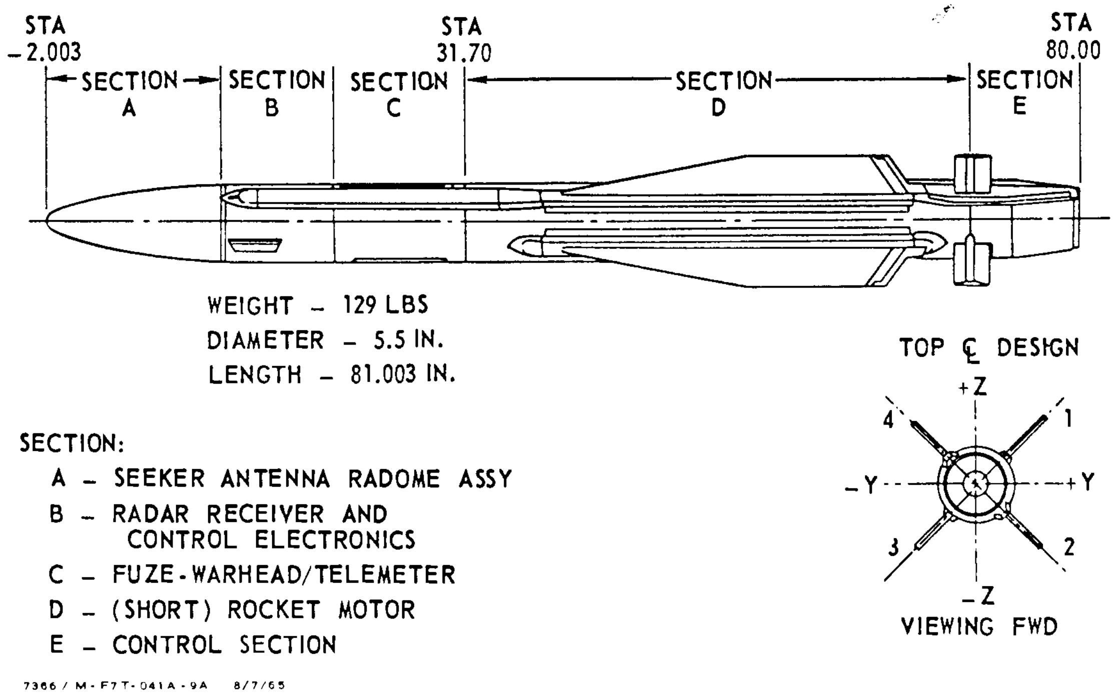
[redacted] In May and July 1964, the test crew at WSMR fired three control test vehicles, all with the MAULER rocket motor, to verify performance of the long airframe missile containing a steering autopilot modified for rate feedback stabilization. These tests began on 7 May, some 3 weeks ahead of schedule, and all three rounds were fired from the breadboard weapon pod. The first round (CTV-8) correctly executed maneuvers and exhibited satisfactory roll control and missile stability. However, the motor blast caused the complete disintegration of the canister, and the T-I radar transmitter shut down during launch apparently because of the launch blast. The blast environment of CTV-8 was duplicated in the firing of round BTV-8 on 21 May 1964, with no adverse effects on operation of the T-I transmitter. The last two CTV firings, in July, were also marred by component failures not directly connected with the gyro feedback circuitry. CTV-9 experienced a harness connector (power distribution) failure at 1.4 seconds before launch and was considered "no test." CTV-10 suffered an internal battery failure at 2.3 seconds after launch and was considered "no test" thereafter.

(U) Meanwhile, members of the GD/P crew completed a series of

[redacted]



(C) Basic RTV Missile Configuration.



(C) Basic GTV Missile Configuration.

[redacted]

captive flight tests to validate the missile in-flight reacquisition circuitry design, preparatory to the first RTV firing. In the initial phase of the captive flights, conducted during the period 25 February to 3 April 1964, they used the Navy EA3A aircraft stationed at Point Mugu, California, to gather clutter data on video tape to verify the missile flight reacquisition circuitry and determine the clutter environment in which the weapon was expected to operate. In the second phase, completed in early June, they used a Navy A3A and F-100 target aircraft. These tests indicated that the MAULER target analyzer would reacquire a target under simulated after-launch conditions.

(U) In support of the RTV evaluation tests, the crew at WSMR fired round STV-9 from the breadboard pod on 11 June 1964, to gather needed data on flame modulation and noise levels of the MAULER rocket motor. Some of the desired data was lost because of a missile battery power failure several seconds after burnout.[19]

[redacted] To meet the established performance goal, the two RTV rounds were required to achieve target lock-on within 2.0 seconds or less and maintain lock through intercept. The first round (RTV-5), fired on 25 June 1964, failed to meet the required lock-on time. Several acquisitions were made after launch, but lock-on could not be maintained because of noise on the aided track function. Changes in the aided tracking design were verified in the firing of round STV-9A on 23 September 1964, and the second RTV firing followed on 8 October. In the latter test (RTV-6), the seeker achieved lock-on at 0.5 second and performance of the target analyzer was satisfactory; however, the missile experienced four brief losses of lock owing to signal degradation during missile

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[19] (1) Ibid., pp. 17-19. (2) GD/P Rept CR-820-453-001, 30 Jul 65, op. cit., pp. 4.1, 4.69. RSIC. (3) MICOM Rept, 27 Jul 65, subj: Eval of the MAULER FVP as of 1 Jun 65, p. 74. RSIC.

roll resulting from a roll relay malfunction.[20]

Weapon System Tests

(U) Having demonstrated the validity of subsystem design refinements in the missile and fire unit, the GD/P crew began weapon system (GTV/EMFU-1) feasibility validation firings in late November 1964. The FVP test plan issued in April 1964 called for a total of 14 GTV firings; however, only 11 were required to fulfill the program objectives. The remaining three GTV missiles were retrofitted with phased-array seekers and test fired during the extended FVP effort, along with two MAULEYE missiles equipped with the REDEYE missile infrared guidance head.

[redacted] Of the 11 FVP flight tests conducted during the period 24 November 1964 to 25 May 1965, 6 were successful and 5 unsuccessful. Two of the six successful rounds (GTV-14 and -19) achieved direct hits—one against a 332-knot high-altitude target and one against a 400-knot short-range target. The other four rounds (GTV-11, -12, -15, and -16) achieved reasonable miss distances—two of them against medium-range/medium-altitude targets and two against low-altitude targets traveling at speeds ranging from 335 to 480 knots. The average miss distance for the 6 rounds was 10.5 feet.

[redacted] The five unsuccessful firings were attributed to random component failures. Two of them involved the rocket motor—in GTV-13, a malfunction in the region of the nozzle blast tube caused the disintegration of the missile aft section; in GTV-17, the motor case ruptured, causing minor damage to the fire unit. Of the remaining three unsuccessful firings, one (GTV-18) was attributed to a hold relay failure that prevented target lock-on; one (GTV-20)

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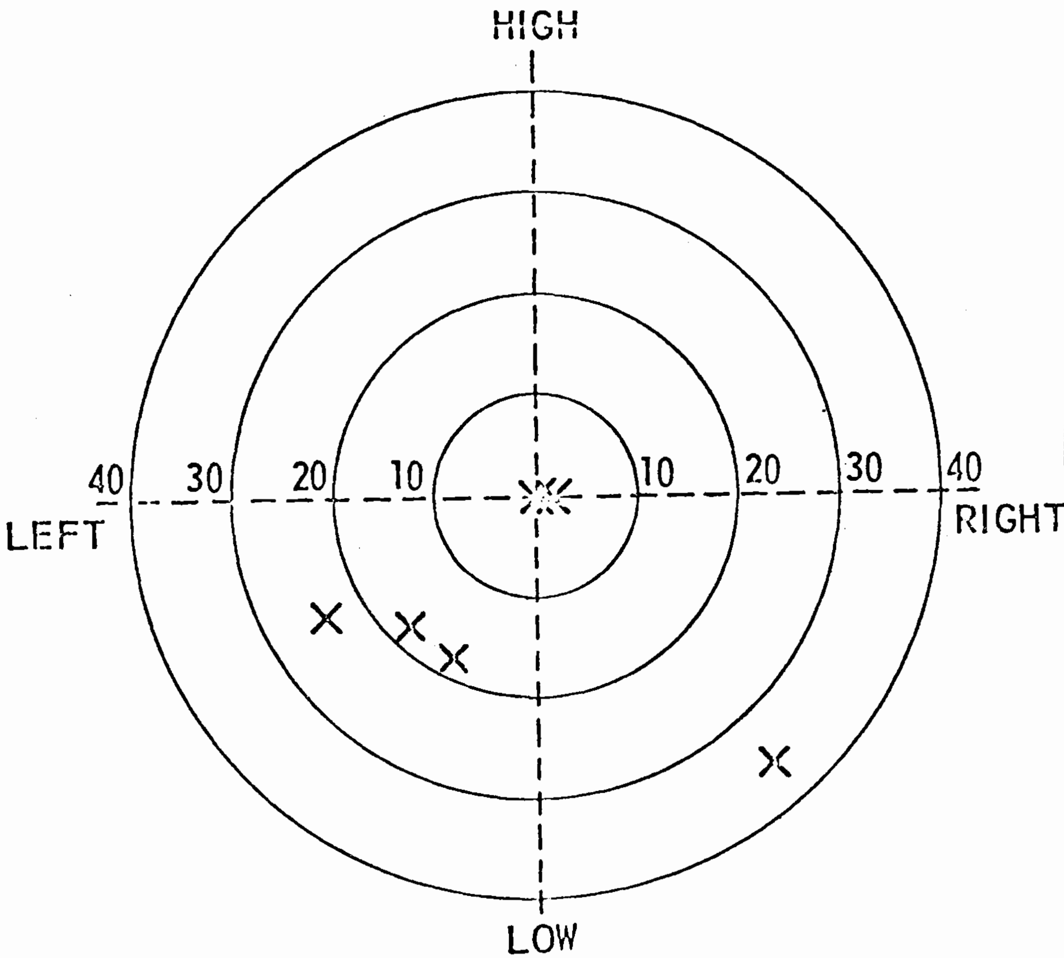
[20] (1) Ibid., pp. 76-78. (2) Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, pp. 19-20. (3) PM_2P's, 30 Sep 64, p. 32; 31 Dec 64, p. 31. MPCF, Bx 13-422, RHA.

(C) FVP FIRING RESULTS - 24 Nov 64 - 25 May 65 (U)



Miss Distance in Feet

KILL PROBABILITY		
TARGET	SALVO 1	SALVO 2
FROG IV	.36	.56
FLASHLIGHT	.46	.62
MIG-17	.52	.64
HOUND	.57	.79

TOTAL MISSILES FIRED 11

SUCCESSFUL 6

UNSUCCESSFUL 5

to missile structural failure at 1.7 seconds; and one (GTV-21) to failure of the missile to reacquire the target after launch.[21]

Supplemental Firings

([redacted]) During the period June - August 1965, while awaiting a decision on the future direction of the MAULER program, the GD/P test crew conducted three additional GTV firings to evaluate the phased-array seeker (GTV-3, -7, and -22), and two firings of the new MAULEYE missile equipped with the REDEYE infrared guidance head and the MAULER propulsion and control system.

([redacted]) Of the three supplemental GTV firings, only one was successful—GTV-22 achieved a close miss distance of 2.5 feet against a high-altitude, 375-knot target; the other two rounds failed to achieve and maintain target lock-on. Both of the MAULEYE firings were highly successful. The first round (fired against an outbound 267-knot, QF-80 target flying at 300 meters altitude and 4 km slant range) scored a direct hit with the missile flying straight up the target jet engine exhaust tube. The second round intercepted and destroyed an outbound 300-knot Q2-C target flying at 300 meters altitude and 6 km slant range.[22]

Conclusions

([redacted]) Based on a detailed analysis of the stated objectives, criteria, and results of the FVP, both MICOM and GD/P concluded that the technical feasibility of the single-vehicle MAULER concept

[21](1) MICOM Rept, 27 Jul 65, subj: Eval of the MAULER FVP as of 1 Jun 65, pp. 10-11, 86. RSIC. (2) GD/P Rept CR-820-453-001, 30 Jul 65, op. cit., p. 4.69. RSIC. (3) Also see App. IV.

[22](1) MICOM Rept, 27 Jul 65, op. cit., pp. 11, 79. RSIC. (2) GD/P Rept CR-820-453-002, 31 Aug 65, subj: MAULER FVP Add to Final Rept - 1 Jun 65 - 31 Aug 65, pp. 1.1, 4.5. RSIC.

had been successfully demonstrated and that a weapon system with a tactical effectiveness higher than that originally envisioned could be fielded in early 1970. The engineering model hardware used in the program did not and was not intended to meet all of the requirements of the tactical MAULER system. However, analysis and simulation showed that relatively few changes would be required to meet the MC's for the tactical system.

[redacted] Among the recognized problems or tasks involved in bringing the MAULER design to that of an acceptable tactical system were repackaging of subsystem hardware to reduce weight and to improve maintainability and producibility; and design refinements and improvements in electronic counter-countermeasures, system reaction time, missile sensitivity (for required performance against tactical ballistic missiles), and subclutter visibility. The latter problem area was primarily concerned with the ability of the acquisition radar to see small moving targets in the presence of severe clutter. Although the engineering model design demonstrated the required subclutter visibility, there remained a question as to whether or not the requirement as established would be sufficient. All of these problems were considered to be within reach of solution by straightforward engineering application.[23]

MAULER Trade-Off and Configuration Studies

(U) Concurrently with the decision in November 1963 to reorient the MAULER program, the Director of R&D, AMC Headquarters, directed the Project Manager to conduct trade-off and configuration studies for the purpose of defining trade-offs related to the R&D model (see photo) which would result in a higher probability of success,

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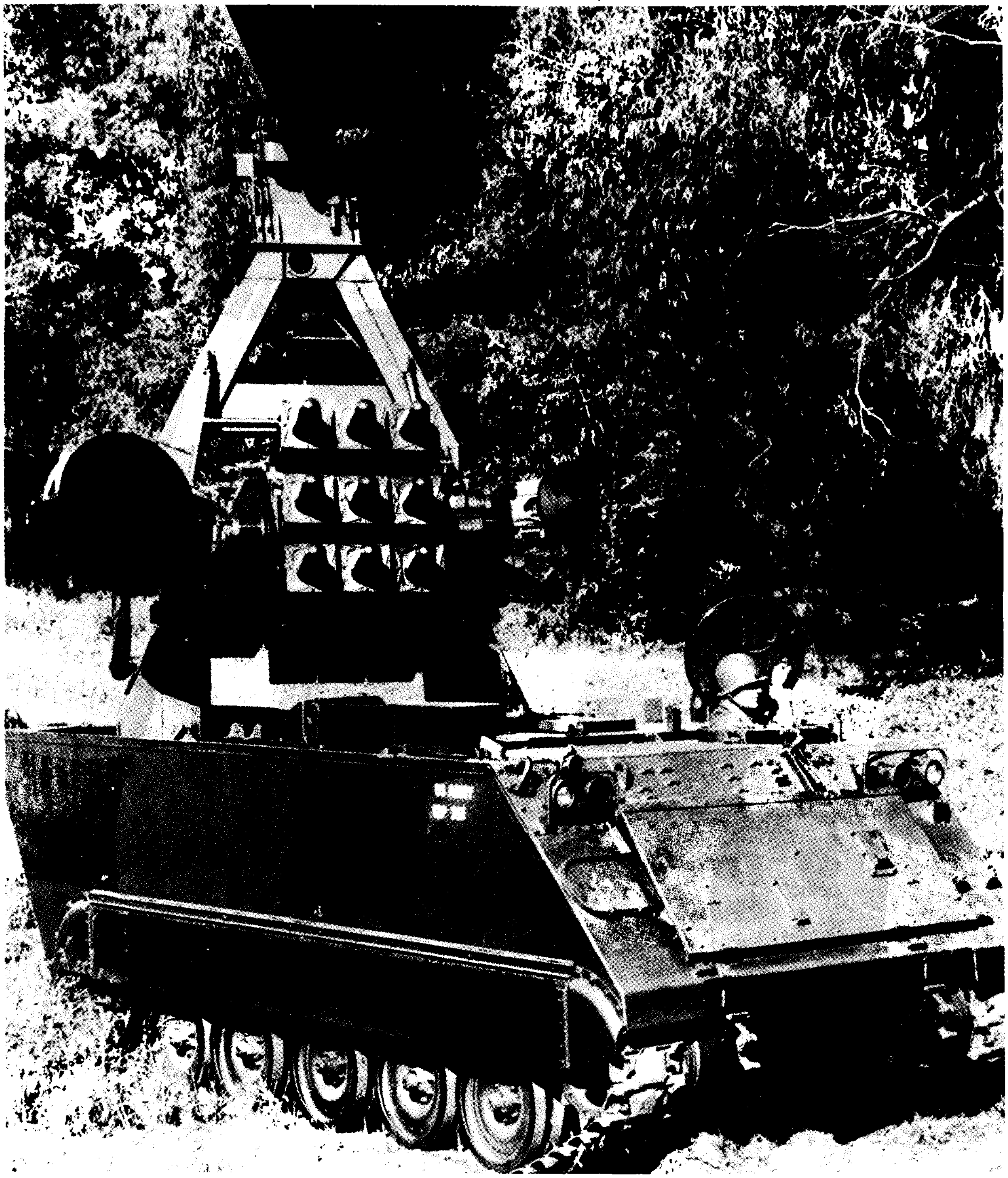
[23](1) GD/P Rept CR-820-453-001, op. cit., pp. 2.1, 2.3. RSIC. (2) MICOM Rept, 27 Jul 65, op. cit., pp. 4, 11. RSIC. (3) MAULER FVP Briefing to DA GS, 17 May 65, Part B, pp. 7-8. MPCF, Bx 13-410, RHA.



(U) MAULER R&D Model - 1964

MAULER

R&D MODEL

GENERAL CHARACTERISTICS

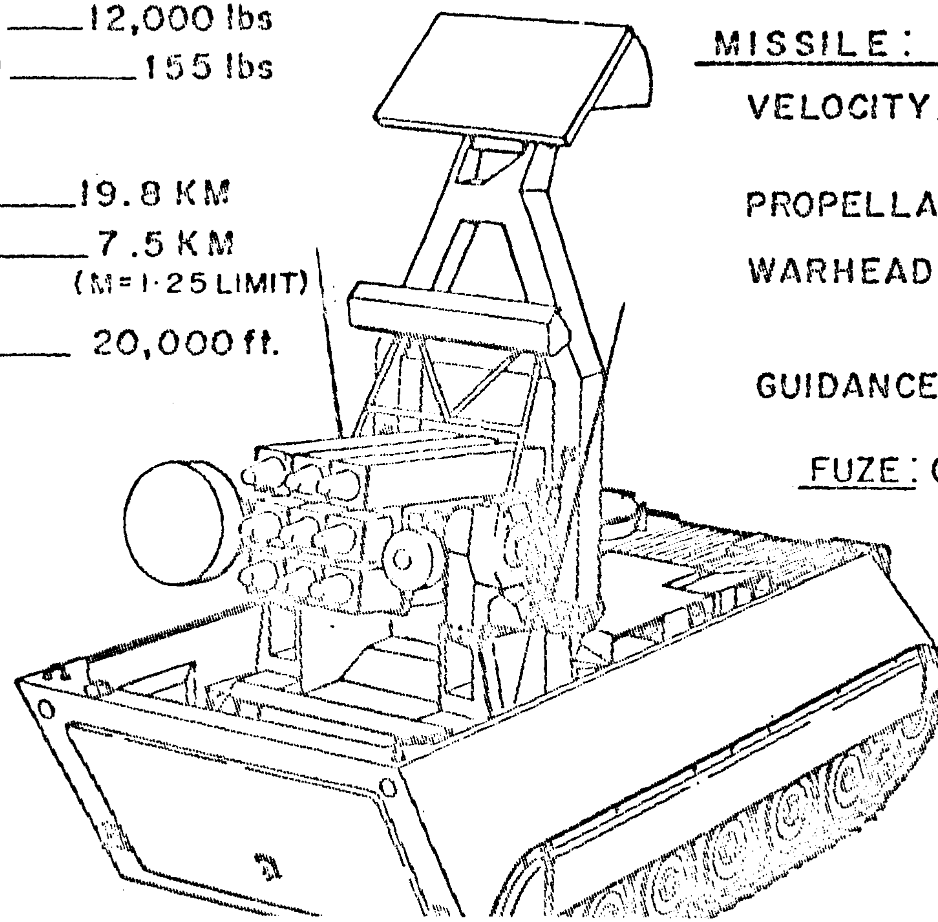
COMBAT GROSS WEIGHTS:

FIRE UNIT ______ 28,000 lbs
WEAPON POD ______ 12,000 lbs
AMMO. ROUND ______ 155 lbs

RANGE:

ACQUISITION ______ 19.8 KM
INTERCEPT ______ 7.5 KM
(M=1·25 LIMIT)

ALTITUDE: ______ 20,000 ft.



MISSILE:

VELOCITY ______ 3300 ft. per sec. AT BURN OUT
PROPELLANT ______ SOLID
WARHEAD ______ 19 lbs BLAST FRAGMENT
GUIDANCE ______ SEMI ACTIVE

FUZE: C BAND PULSE DOPPLER

PHASE II
AIR TRANSPORTABLE IN C-130 HERCULES AIRCRAFT.

M-3943
24 APRIL 64

[redacted]

improved schedules, or reduced cost. Upon completion of the trade-off study in February 1964, the Project Manager established study teams at GD/P, MICOM's R&D Directorate Laboratories, and the MAULER Project Office to determine the attainable characteristics and growth potential for various MAULER configurations, including the two-vehicle concept suggested by the Eifler Committee.[24] The MAULER Configuration Study Report forwarded to AMC on 15 June 1964 outlined five different variations of the R&D model, all based on the use of RF (Radio Frequency) missiles for target engagement. The five configurations are briefly described below.

[redacted] MAULER I. Characterized, primarily, as a system that could be fielded by December 1969, the MAULER I was based on the R&D prototype and incorporated the modifications necessary to meet that date with minimum risk. Some of its distinguishing features were a wider pod; a single beam acquisition radar; a T-I radar with acquisition mode for low altitude; an advanced computer; and the XM-551C vehicle. The MAULER I did not meet all of the original or the proposed revised MC's, but it offered considerable growth potential, required minimum new development, and represented the best overall balance.

[redacted] MAULER II. The MAULER II configuration incorporated the system improvements necessary to meet nearly all of the approved and proposed revised MC's. Its distinguishing features were a wider pod with a larger turret and basket; improved resolution in the acquisition radar by increasing to three beams and three-receiver channels; a T-I radar with electronic scan-receiver for improved reliability and electronic counter-countermeasure capability; a special purpose digital computer which included the control and computation functions of the launch order computer;

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[24] (1) Ltr, Dir, R&D, HQ AMC, to MAULER PM, 22 Nov 63, subj: MAULER Program Rqrmt Study, & incls thereto. MPCF, Bx 13-410, RHA. (2) Hist Rept, MAULER Proj Ofc, 1 Jul 63 - 30 Jun 64, pp. 7, 9-10.

[redacted]

and the XM-551C vehicle. This system could be fielded by December 1970.

([redacted]) <u>MAULER III</u>. Characterized as a system that could be fielded by December 1971, the MAULER III was designed to meet as closely as possible all of the approved MC's. Advantage would be taken of the longer development time to include more advanced concepts for overcoming problem areas inherent in the R&D model. Among these were an acquisition radar with pulsed amplifier system for improved subclutter visibility; a pulse doppler T-I radar to accomplish velocity, range-lock, and tracking signal processing on the ground rather than in the missile; a larger missile with improved kill probability; a digital data processor; and the XM-551C vehicle. Some of the disadvantages of the MAULER III were its heavier missile, reduced missile load (from nine to six), additional communications, and requirements for considerable new development, more support equipment, and more personnel.

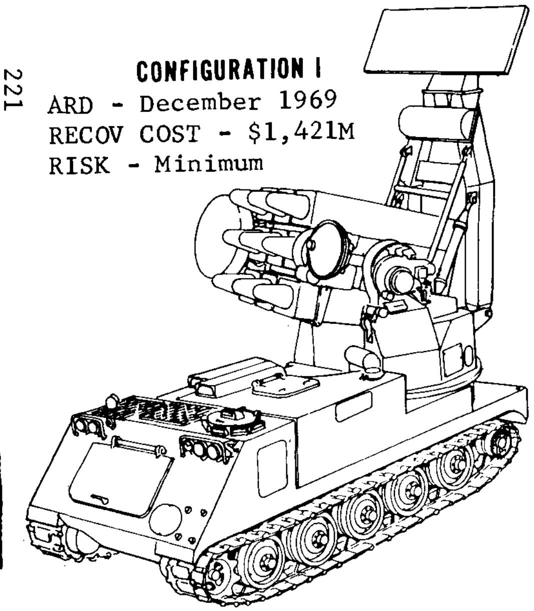
([redacted]) <u>MAULER IV</u>. This configuration was a 2-vehicle (XM-551C) concept, with the launcher moved to a second tracked vehicle. Advantage would be taken of the added space, additional development time, and design advances for solving the more serious problems in the R&D model if the single-vehicle concept should prove infeasible. Other characteristics of the MAULER IV were a single receiver acquisition radar; removal of radars from the missile blast environment; a larger missile with increased range and improved kill probability; and an increased missile load (from 9 to 12). Its major disadvantages were an increased reaction time, two vehicles, heavier missiles, and requirement for more support equipment and personnel. The MAULER IV could be fielded by December 1971.

([redacted]) <u>MAULER V</u>. The MAULER V was a minimum-cost, minimum-capability system that would be effective against the manned aircraft threat postulated for the early 1970's. It would have no acquisition radar, track evaluation computer, infrared acquisition

([redacted]) MAULER CONFIGURATION STUDY CONCEPTS - 11 JUNE 1964 (U)

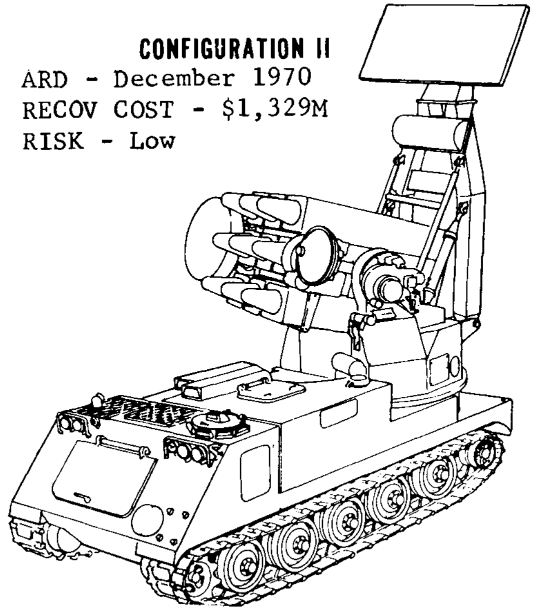
CONFIGURATION I

ARD - December 1969
RECOV COST - $1,421M
RISK - Minimum



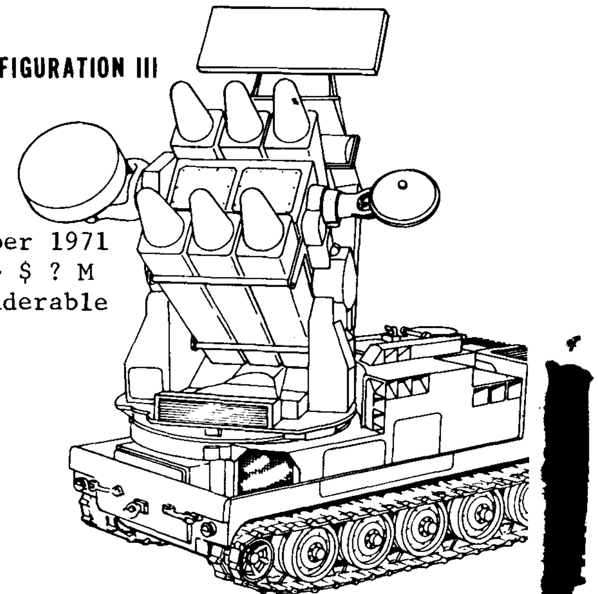
CONFIGURATION II

ARD - December 1970
RECOV COST - $1,329M
RISK - Low



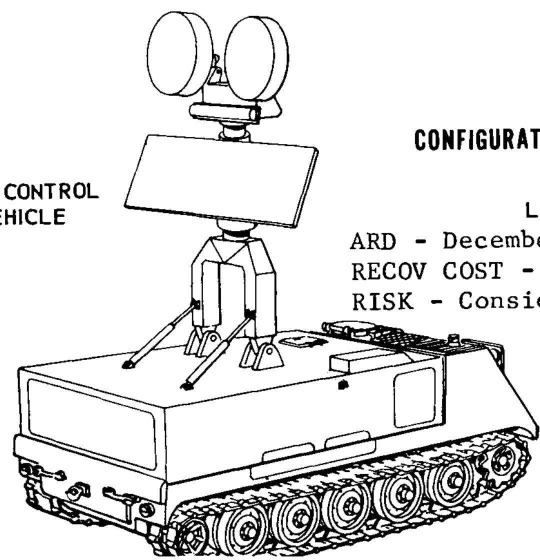
CONFIGURATION III

ARD - December 1971
RECOV COST - $? M
RISK - Considerable

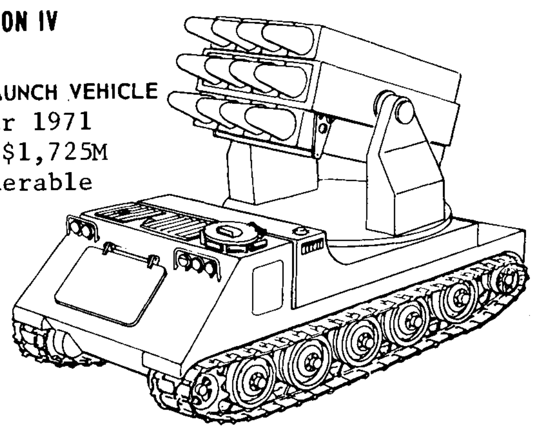


CONFIGURATION IV

FIRE CONTROL VEHICLE



LAUNCH VEHICLE



ARD - December 1971
RECOV COST - $1,725M
RISK - Considerable

CONFIGURATION V

ARD - Sep 1969
RECOV COST - $908M
RISK - Minimum

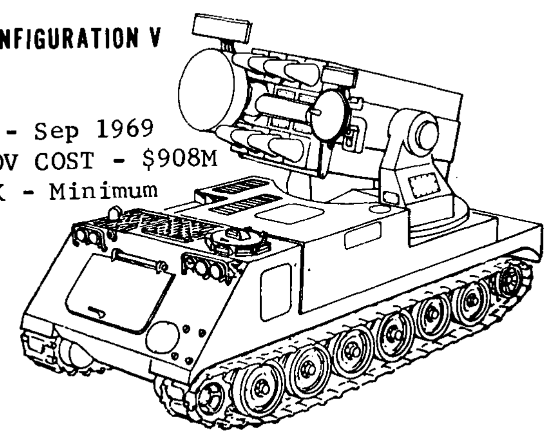


Table 1

[redacted]) COMPARISON OF MILITARY CHARACTERISTICS - MAULER CONFIGURATIONS (U)

	CONFIGURATION				
	I	II	III	IV	V
Dead Area............................	O	O			O - R
Rate of Fire.........................	R				R
Target Speed - Outgoing...............	O	O	O	O	O - R
Communications.......................	O - R*				O - R*
Missile Weight.......................			O - R	O - R	
Single Vehicle.......................				O - R	
Security.............................				O - R	
Safety...............................				O - R	
Personnel............................				O - R	
Readiness............................				O - R	R
Power Auxiliary......................					NR - R
Altitude.............................					O - R
Field of Fire........................					O - R
Land Navigation......................					NR - R*
Infrared Acquisition Unit.............					NR - R*
Tactical Ballistic Missile Capability..					R

LEGEND: O = Does Not Meet Original MC's   NR = Not Required in Original
R = Does Not Meet Revised MC's   * = Growth Possible

Note: No configuration meets the MC's in respect to maneuvering targets at maximum range, acquisition on the move, or Phase I airlift.

SOURCE: Incl [redacted]19 to Resume of ADEX Conference MAULER Briefing, 16 Jul 64, by COL B. R. Lucza[redacted]. MAULER Proj Case Files, Bx 13-410, RHA.

(IRA) unit, or navigation unit. The IRA unit, however, possibly could be added at a later date to provide a means of passive target acquisition. The console would be greatly simplified and the system would have voice communications only. Target acquisition and tracking would be provided by the T-I radar. The R&D prototype weapon pod and the XM-546E1 vehicle would be used. The MAULER V could be fielded by September 1969. Weighed against its advantages of an early service availability date, low recovery cost, low silhouette, and requirement for very little new development, were these key disadvantages: very low growth potential, reduced missile load (from nine to eight), no tactical ballistic missile capability, lack of full surveillance coverage, and provision for voice communications only.

[redacted] Based on a detailed analysis of the five system concepts, the Project Office recommended the selection of MAULER I as the best approach if the resumption of full development should be authorized upon completion of the Feasibility Validation Program (FVP).[25] During a briefing to the Air Defense Executive (ADEX) Conference, on 16 July 1964, Colonel Luczak outlined the current status of the MAULER FVP effort and the results of the configuration study. In order to meet the Army Readiness Date (ARD) of December 1969 for the MAULER I, he pointed out that a firm decision on the resumption of full development would be required by March 1965 so that the program effort could begin by June 1965. The RDTE recovery cost of the program would be about $411 million, this figure including the $202 million invested in the engineering model development and FVP during the FY 1960-65 period, plus $209 million in additional funds for the 1966-69 period. The estimated PEMA cost for advance production engineering and production during the 1966-71

[25](1) Ltr, MAULER PM to CG, AMC, 15 Jun 64, subj: MAULER Configuration Study, & incl thereto, MAULER Configuration Study Rept, 11 Jun 64. (2) Also see MAULER TDP, 1 Jul 64; and MAULER PM2P, 30 Sep 64, p. 4. All in MPCF, Bx 13-422, RHA.

period totaled $1.010 billion. The aggregate RDTE/PEMA recovery cost would thus come to $1.421 billion for the MAULER I system. The only alternative for a service capability by 1970 would be the MAULER V configuration whose total recovery cost would be about $908 million. Colonel Luczak closed the briefing with these remarks:

> ([redacted]) The FVP is proceeding on schedule. I feel it is a mistake to redirect or terminate the MAULER prior to the completion of the FVP. Any system designed to fill the forward area, low altitude, all weather system role in the 1970-1980 [period] must proceed along the same technical path as the MAULER is presently going. We can learn where the path leads and the pitfalls from the $200 million we have already put into the program.
>
> ([redacted]) The Army Missile Command . . . can field MAULER I and MAULER V prior to 1970. Our job, however, is to field what the Army wants, not what we think the Army should have. MAULER, in our opinion, will do the job. It represents a quantum jump in low altitude defense. We recognize that it is necessary to meet the changing threat. We are far enough down the pike to be reasonably confident that we can produce a MAULER as early as 1970 to meet this threat.[26]

([redacted]) As stated earlier, the five MAULER concepts derived from the configuration study were based on the use of RF missiles for target engagement and none of them fully met all of the original or proposed revised MC's. In its July 1964 report of the Phase I cost effectiveness study,[27] the Combat Developments Command (CDC) concluded that neither of the MAULER concepts would adequately satisfy the air defense requirements for the 1970's, and that there was no requirement for the weapon as then configured.[28] Pursuant

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[26] Resume of ADEX Conf MAULER Briefing, 16 Jul 64, w/incls, atchd to Ltr, COL B. R. Luczak, MAULER PM, to Comdt, USAADS, Ft Bliss, Tex, 6 Aug 64, subj: ADEX Conf - 16 Jul 64. MPCF, Bx 13-410, RHA.

[27] Which study included consideration of MAULER's I - V, plus 5 other missile systems and 12 generic gun systems.

[28] CDC Rept, Proj No. USACDC (MR-1) CAG 64-3, Jul 1964, subj: Study - Cost Effns of Fwd Area AD Wpns, Vol I, pp. 11, 38-39. RSIC.

to CDC's expressed desire for both fair-weather and all-weather systems with a reduced reaction time and multiple-target engagement capability, GD/P and MICOM in late 1964 established three new versions of the MAULER for consideration in the second phase of the cost effectiveness study. Two of these—the MAULER VI and MAULER VII—evolved from a GD/P corporate-funded study. The other configuration, known as the MAULER VIII, was a product of the MAULER Project Office.

[redacted] The MAULER VI was a minimum configuration like that of MAULER V, but with two added features to improve performance: an IRA unit for passive target detection and the facility to interchange or mix Radio Frequency (RF) missiles with infrared (IR) missiles. With the IR missile, the system would have a fair-weather capability for the simultaneous engagement of multiple targets. Like MAULER V, it would use the XM-546E1 vehicle. Significant differences in the external configuration—aside from the addition of the IRA antenna—were an increase in missile load from eight to nine and a change in the T-I radar from the split design to a composite package attached to the right side of the canister. Without the acquisition radar, the system's low silhouette and passive target detection ability would enhance its survivability in the battlefield environment. The MAULER VI could be fielded late in CY 1969.

[redacted] The MAULER VII was somewhat similar to MAULER I with changes to reduce cost where the results of the GD/P cost effectiveness study did not support the MAULER I approach. Eliminated functions included automatic threat evaluation, ability to display friendly targets at the discretion of the operator, and ability to put in no-fire sectors. This would result in an increase in the mean system reaction time from 5.8 seconds for MAULER I to 8.8 seconds for MAULER VII. The system would have no navigation or stabilization capability. Like MAULER VI, it would have the facility to interchange or mix RF and IR missiles for a multiple target handling capability, and it would use the XM-546E1 carrier. The MAULER VII could be fielded late in CY 1969.

([redacted]) The MAULER VIII—proposed by the MAULER Project Manager and later recommended as the best approach to meet the air threat in the 1970's—was a cross between the MAULER I (RF) configuration and GD/P's MAULER VII (RF-IR) system. Characterized as a weapon meeting both the approved MC's and the new requirements specified by CDC,[29] the MAULER VIII (RF-IR) incorporated some of the cost saving features of MAULER VII, such as the elimination of navigation and stabilization capabilities, use of the composite T-I radar design, and simplification of the pod and turret assemblies. It would use the XM-546E1 carrier and obtain primary power from a vehicle engine driven generator, thereby eliminating the gas turbine generator in the weapon pod. Other significant features of the system were retention of the automatic threat evaluation and minimum reaction time, and incorporation of the RF-IR missile mix or interchange capability. With these additions and simplifications, the MAULER VIII offered an all-passive mode of operation, as well as the multiple target handling capability of MAULER's VI and VII. It could be fielded late in CY 1969, assuming the resumption of full development by October 1965.[30]

([redacted]) Supposedly, the final decision on resumption of full development would be based on the outcome of the FVP, scheduled for completion in May 1965, coupled with the results of the new configuration study and Phase II of CDC's cost effectiveness study. Although meaningful results of the latter study would not be available until mid-April 1965, it was abundantly evident as early

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[29]Simultaneous multiple target engagement capability with high rate of fire (quick reaction time of 3-5 seconds), and passive and active modes (acquisition, tracking, and missile guidance).

[30]PM$_2$P's, 31 Dec 64, pp. 4a, 6a; 30 Jun 65, pp. 4-5. MPCF, Bx 13-422, RHA.

[redacted]

as November 1964 that CDC's recommendations would not be favorable to the MAULER. As a result of the unfavorable comments made in the Phase I cost effectiveness study, and similar conclusions contained in the preliminary Phase II study report, there was a sharp decline in support for the MAULER at DA and OSD levels. An indication of this came in late November 1964, when MICOM learned that the Secretary of Defense had directed a cut in MAULER FY 1966 funds from the programmed $46 million to $10 million, and that OCRD did not plan to reclama the action.[31]

([redacted]) That the MAULER project was doomed to be cancelled regardless of the outcome of the FVP effort became apparent early in 1965. In testimony before the House Committee on Armed Services, on 4 February, Secretary of Defense Robert S. McNamara stated that a final decision on the future of the program was being withheld pending completion of the current study. "Meanwhile," he said, "we are not requesting further funding at this time and tentatively plan to apply all presently available MAULER funds to other urgent air defense programs."[32] In the FY 1966 budget review, the OSD indicated that the MAULER project would be terminated upon completion of the validation program and confirmed the cut in the budget for that year to $10 million, which funds would be earmarked "for a new project which is the development of an advanced forward area air defense system as an alternative to MAULER."[33]

[redacted] Early in April 1965, after sufficient FVP firings had been conducted to demonstrate the feasibility of the single-vehicle MAULER concept, the Project Manager removed from further consideration the two-vehicle approach, as well as the larger missile designs. To eliminate the confusion resulting from the eight

[31] Ltr, CG, MICOM, to CG, AMC, 20 Nov 64, subj: Future of MAULER.

[32] Quoted in Congressional Fact Paper, AMC, 1 Apr 65, subj: The MAULER AD Wpn Sys. MPCF, Bx 13-410, RHA.

[33] Ibid.

[redacted]

[redacted]

configurations considered in the course of the study, he dropped the Roman numeral designations and narrowed the field down to three specific MAULER concepts with titles reflecting their respective capabilities. During the period of discussions and decision on the MAULER's future, the following three concepts would be considered, all of them having a passive IRA unit:

RF MAULER - An all-weather system capable of engaging targets with Radio Frequency missiles only (old MAULER I to V).

IR MAULER (IRMA) - A fair-weather system with infrared missiles only.

RF-IR MAULER - An all-weather system capable of engaging targets with either RF or IR missiles (old MAULER VI to VIII).

([redacted]) The MAULER project staff concluded that the RF-IR MAULER (VIII) with two radars and automatic operation would meet the full requirements specified in the CDC Phase I cost effectiveness study. The IR MAULER, or IRMA, was derived from the RF-IR MAULER and included only those elements absolutely essential to make it an effective weapon for the 1970 time frame.[34] It was conceived as an inexpensive, complementary fair-weather, proliferation weapon to meet the stated CDC requirement for "a simple, short-range, quick reaction, fair-weather division air defense weapon system, to be employed in fairly large numbers with an all-weather system employed in minimum numbers . . . ."[35]

([redacted]) BG Howard P. Persons, Jr., the Deputy Commanding General for Air Defense Systems, and members of the MAULER Project Office outlined the results of the FVP and configuration studies in a detailed briefing to the Army General Staff on 17 May 1965. Summing up the MICOM position, General Persons declared that the

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[34]Ltr, Lewis L. Gober, Act MAULER PM, to CG, CDC, 9 Apr 65, subj: MAULER Configurations.

[35]CDC Rept, Proj No. USACDC (MR-1) CAG 64-3, Jul 1964, op. cit., p. 38. RSIC.

[redacted]

feasibility of the MAULER system had been clearly demonstrated, adding that "we can have in MAULER a highly mobile, extremely flexible all-weather air defense system which can be fielded in a variety of configurations in an acceptable time frame." He recommended that the RF-IR MAULER be adopted as the all-weather system, and that the IRMA version be considered as the ultimate fair-weather proliferation or gap-filler weapon, if such a weapon were required.[36] Preliminary estimates for the RF-IR MAULER, based on a 16-division Army force of 20 fire units each, indicated a total funding requirement of \$896 million—\$180 million in RDTE funds (FY 1966-69) and \$716 million in PEMA funds for advance production engineering and production.[37] (The aggregate program cost, including the \$202 million obligated during the 1960-65 period, would be \$1.098 billion.)

([redacted]) Colonel Luczak pointed out that the readiness date of early 1970 was predicated on optimum funding and timely administrative decisions to permit the resumption of full development by October 1965. Referring to the declining support for the program, he asserted that "DOD has almost written off MAULER and we feel this attitude can only be changed with a strong, united, and firm Army stand that MAULER is vitally needed." He indicated that \$25 million in FY 1966 funds would be the rock bottom level for a meaningful full development start from October 1965 to July 1966, when FY 1967 funds would be available. "Stretch-out," he declared, "appears to us to be a waste of time and money. We recommend that MAULER be fielded or killed."[38]

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[36] MAULER Briefing to DA Staff, 17 May 65, Part D, p. 1. MPCF, Bx 13-410, RHA.

[37] Ibid., Part C, Slide #11.

[38] Ibid., Part C, p. 4.

[redacted]

Cost Effectiveness Study

Background

(U) The need for an appraisal of the MAULER's cost effectiveness as a tactical system became apparent in late 1963, when a series of studies pointed up the fact that the attainable MC's were marginal for satisfying the forward area air defense requirement during the post-1970 period. It will be recalled that the Army had originally planned to fulfill the need for a fully effective air defense system in the 1960's through a series of evolutionary developments, beginning with the improvement of an existing artillery gun and proceeding with the design of more sophisticated systems as technological advancements permitted. The light antiaircraft development program, begun in 1952, consisted of a progressive three-part effort: development of t[redacted]e Phase I RADUSTER as an interim replacement for the outmoded 40-mm. M42 DUSTER; followed by the Phase II VIGILANTE, a 37-mm. Gatling gun system, to be available in the early 1960's; and finally, the Phase III optimum weapon system (MAULER), which was to provide combat units of the field army with full, all-weather, low-level protection against all forms of aerial vehicles. For reasons enumerated early in this study, these goals were never achieved.

([redacted] With the cancellation of the RADUSTER early in 1958, the Army accelerated development of the VIGILANTE to fill the gap, and began feasibility studies of the MAULER concept which, together with the manportable REDEYE system, was expected to satisfy the low-altitude air defense requirements of the forward area. Development of the Phase III MAULER—delayed some 12 months for lack of funds—began in March 1960 with a scheduled readiness date of July 1964. Beginning in 1961, the VIGILANTE program was hampered by low priority and a consequent lack of funds, and this, together with the limited capabilities of the system, led to the termination

[redacted]

of the Phase II effort in July 1963.[39]

([redacted]) Meanwhile, the MAULER program had suffered a series of financial and technical reversals, with a consequent stretchout in the readiness date to November 1968 and an increase in the total RDTE cost from $77.6 to $353.9 million.[40] At the same time, the air threat that the MAULER was designed to counter had undergone progressive changes, and there was serious doubt that the weapon system, even if proved technically feasible, would be able to satisfy the full requirement in the time frame of its availability.

([redacted]) Hence, the Combat Developments Command, in February 1964, directed its Air Defense Agency to evaluate the MAULER and other forward area weapons on a cost effectiveness basis to determine the most desirable alternatives. The specific objectives of the study were to evaluate the capability of MAULER to counter the low-altitude air threat in the forward area of the field army; to compare MAULER with other methods of coping with the threat in the post-1970 period; and to determine the best interim system to fill the gap pending availability of a fully effective weapon system.[41]

Initial Study Findings

([redacted]) For purposes of the initial study, the CDC Air Defense Agency considered 10 missile systems and 12 automatic gun-type weapons which could be made available during the 1970-75 period. Aside from the five proposed RF MAULER configurations (I thru V), the missiles considered were the REDEYE; the Self-Propelled HAWK

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[39] See above, pp. 8-21, 31, 53-56.

[40] For details relating to the program stretchout and cost escalation, see Chapter VI.

[41] Ltr, CG, USACDC, Ft Belvoir, Va, to CG, USACDCCAG, Ft Leavenworth, Kan, 11 Feb 64, subj: Study Dir, Cost Effns of Fwd Area AD Wpns, & 1st Ind, CG, USACDCCAG, to CO, USACDCADA, Ft Bliss, Tex, 19 Feb 64. Reprinted in Rept, USACDC (MR-1) CAG 64-3, Jul 64, op. cit., pp. vii - xiv. RSIC.

(Division HAWK); the CHAPARRAL (modified SIDEWINDER); the ET-316 (a British fair-weather missile system); and the TADS (Tactical Air Defense System—a conceptual daylight, fair-weather weapon consisting of a visual acquisition system, a launcher, and one to four missiles, mounted on a lightweight vehicle).

([redacted]) The two leading contenders for the all-weather air defense role were the RF MAULER and Division HAWK. The study group found the MAULER to be superior to the HAWK because of its greater mobility, shorter reaction time, fewer vehicles, and smaller personnel requirement. The MAULER, however, was an exceedingly expensive system which could be justified only if it had a sufficiently long operational life on the order of 8 to 10 years. Moreover, computer runs showed that the MAULER and the Division HAWK lacked the desired effectiveness against very low altitude attack, and both systems had seriously degraded capabilities against multiple targets. The study report noted that the MAULER was designed late in the 1950 decade using the technology of that period (i.e., single function rotating radars), that mounting all of this equipment on one vehicle was posing serious development problems, and that the resulting maintenance problems were yet to be measured.

([redacted]) In view of these factors, the CDC Air Defense Agency concluded that the HAWK was the best candidate as an interim system, and that the 1970 MAULER as currently configured was not required. As an alternate approach, it suggested that a new MAULER system having a multiple target capability (perhaps against six targets), a short reaction time (3 to 5 seconds), and a small inner boundary (500 to 800 meters) would be highly effective as an all-weather, day and night, divisional weapon system. An analysis of the total forward area air defense problem indicated that the concept of a simple, short-range, quick-reaction, fair-weather division air defense system, to be employed in fairly large numbers

[redacted]

with an all-weather system employed in minimum numbers, would be sound.

(U) Since the results of the initial cost analysis were inconclusive, the Air Defense Agency recommended that a Phase II study be conducted to evaluate other configurations of the MAULER and additional weapon force levels and mixes.[42]

Final Conclusions and Recommendations

([redacted]) The scope of the Phase II cost effectiveness study, completed in April 1965, was broadened to include four objectives:

1. To evaluate the capability of field army air defense systems to provide sufficiently low altitude coverage over the division from positions behind the division rear boundary (i.e., to determine whether an all-weather air defense system must be deployed in the division to permit the division to perform its land warfare mission against expected threats).

2. Evaluate thoroughly the operational value, including vulnerability, cost, and effectiveness, of employing any all-weather systems, whether MAULER or Division HAWK, for forward area air defense.

3. To determine whether the MAULER should or should not be deployed and fielded.

4. To determine the optimum mix of air defense weapons and force level to protect the forward area of the field army.

([redacted]) The weapon systems considered were in two groups. Competitors in the all-weather group were the RF MAULER, the RF-IR MAULER (VIII), the new SAM-D, the Division HAWK, and the Advanced Division HAWK. In the fair-weather group were the IR MAULER (IRMA); the interim, improved, and advanced versions of the CHAPARRAL; the REDEYE; the TADS; the British ET-316; the M61 VULCAN 20-mm. gun; the M42 DUSTER; and the HISPANO SUIZA triple 20-mm. gun.

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[42] CDC Rept, Proj No. USACDC (MR-1) CAG 64-3, Jul 1964, subj: Study - Cost Effns of Fwd Area AD Wpns, pp. 2-3, 11-12, 31, 38-39. RSIC.

[redacted]

[redacted] In general, the findings of the Phase II study indicated that there was insufficient justification to support the development of a division-peculiar all-weather system, such as the RF-IR MAULER. This conclusion was based largely on the determination that all-weather, night, and tactical ballistic missile (TBM) protection of the division area could be provided as an additional mission by long-range Army-type air defense weapons located outside the division area and in the rear of the division area boundary. This defense could be provided down to altitudes of 1,000 feet in severe terrain and down to altitudes of 500 feet in less severe terrain. Below these altitudes there was no requirement for all-weather air defense of the division area, since enemy aircraft could not operate effectively in foul weather below those levels. Fair-weather systems would be required in the division area to combat the very low altitude threat expected during periods of fair weather, and all-arms systems would provide protection for those elements operating on the fringes of the air defense umbrella.

[redacted] The members of the study group therefore concluded that, from field army sites, a system of the SAM-D type could provide adequate protection over the forward (division) area, and that such a system should be developed as a matter of national priority. They suggested that the SAM-D system be designed with sufficient flexibility and mobility to perform this mission, and that a broad R&D effort in the field of phased-array radars would materially contribute to such a program. With respect to an interim all-weather capability pending the availability of SAM-D (6 to 8 years), they found the Division HAWK to be superior to the MAULER VIII (RF-IR MAULER), particularly in the areas of cost effectiveness, range and altitude, vulnerability, survivability in the battlefield environment, electronic countermeasure capability, antimissile capability, and potential growth.

[redacted] In the area of fair-weather defense requirements, they suggested that a QMR be written for an advanced proliferation system to provide both area and point defense protection for the forward area, the possible approaches to such a system including the Advanced CHAPARRAL and the IR MAULER. Until such time as an advanced system could be fielded, and subject to current tests and studies, they concluded that the Interim CHAPARRAL and the 20-mm. VULCAN gun, in combination, would provide the required fair-weather air defense.

([redacted]) The final recommendations of the study group were essentially as follows:

1. That development of SAM-D be pursued as a priority matter to provide the earliest possible fielding of this weapon "as a keystone of field army air defense."

2. That the HAWK Improvement Program be continued in the interest of attaining the best interim all-weather defense of the division and deeper areas, and that the decision on developing an Advanced Division HAWK be made later in light of the threat and SAM-D capabilities and availability date.

3. That the CDC submit to the Department of the Army a QMR for an advanced proliferation weapon attainable before 1975.

4. That the MAULER development program be terminated, the QMR withdrawn, and a 1-year project undertaken to evaluate its components and technology for possible future applications.[43]

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[43]CDC Rept, Proj No. USACDC (MR-1) CAG 64-3, 17 Apr 65, as revised 29 Apr 65, subj: Cost Effns of Fwd Area AD Wpns - Phase II [Study], Vol. I, pp. vii, 68-72. RSIC.

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CHAPTER IX

[redacted]) FINAL MAULER EVALUATION AND TERMINATION (U)

(U) In May 1965, the Secretary of the Army commissioned a MAULER Evaluation Board to develop recommendations pertaining to the continuation, realignment, or termination of the project. He named LTG James H. Polk, Commanding General, V Corps, as President of the Board and the following personnel as members:

MG Frank T. Mildren, Deputy Assistant Chief of Staff for Force Development

MG Austin W. Betts, Deputy Chief of Research and Development

MG Elmer J. Gibson, Assistant Deputy Chief of Staff for Logistics

MG Kenneth G. Wickham, Commanding General, Combat Service Support Group, Combat Developments Command

BG Donald V. Bennett, Director, Strategic Plans & Policy, Office, Deputy Chief of Staff for Military Operations

BG Cornelis D. W. Lang, Artillery Commander, Seventh Army

Advisors to the Board were Dr. Wilbur B. Payne, Office of the Assistant Secretary of the Army (Financial Management); Dr. William H. Saunders, Harry Diamond Laboratories; and Mr. David C. Hardison, Combat Developments Command. Observers were Mr. Willis M. Hawkins, ASA (R&D), and GEN Frank S. Besson, Jr., Commanding General of the Army Materiel Command.[1]

Evaluation Board Briefings

(U) On 4, 5, and 7 June 1965, the Evaluation Board received comprehensive presentations on all aspects of the MAULER program and competing weapon systems, the cost effectiveness study, and

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[1]Ltr, AGAM-P (M)(27 May 65), OCofS, TAG, DA, to ASA (R&D), et al., 28 May 65, subj: Estb of a MAULER Eval Bd. MPCF, Bx 13-410, RHA.

[redacted]

other studies and exercises relating to the general problem of air defense in the forward area. Colonel Luczak made three presentations on the MAULER program: the first dealing with the results of the FVP and configuration studies; the second with the IR MAULER and the requirement for a proliferation (fair weather) weapon; and the third with the recommendations of the Missile Command as to the future direction of the program. Other MAULER presentations included one by General Persons who outlined AMC's position on the findings and recommendations of the CDC cost effectiveness study, and another by GD/P representatives on the technical and operational aspects of the system.[2] On the second day of the evaluation proceedings, Colonel Luczak accompanied General Polk to WSMR for an inspection of the MAULER facilities. During the inspection, General Polk witnessed a dramatic demonstration of the MAULER EMFU-2, which successfully tracked targets while it was both stationary and on the move. General Polk then entered the weapon pod, operated it on three successful target runs, and seemed to be very impressed both with the performance of the equipment and with the complexity of the gear.[3]

[redacted] In his first presentation, on 4 June, Colonel Luczak briefed the Evaluation Board on the three principal MAULER designs derived from the configuration studies, and the physical and performance characteristics of the recommended tactical fire unit (RF-IR MAULER) as depicted in the accompanying illustrations. He then described the results of the feasibility validation program, noting that all objectives had been achieved on time with an underrun of some four million dollars, and that the flight test

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[2] With regard to the contractor presentation, Colonel Luczak later remarked that "while technically good, [they] were received in a cold atmosphere because of the level of confidence in GD/P." MFR, COL B. R. Luczak, MAULER PM, 10 Jun 65, subj: Presn to the MAULER Eval Bd. MPCF, Bx 13-410, RHA.

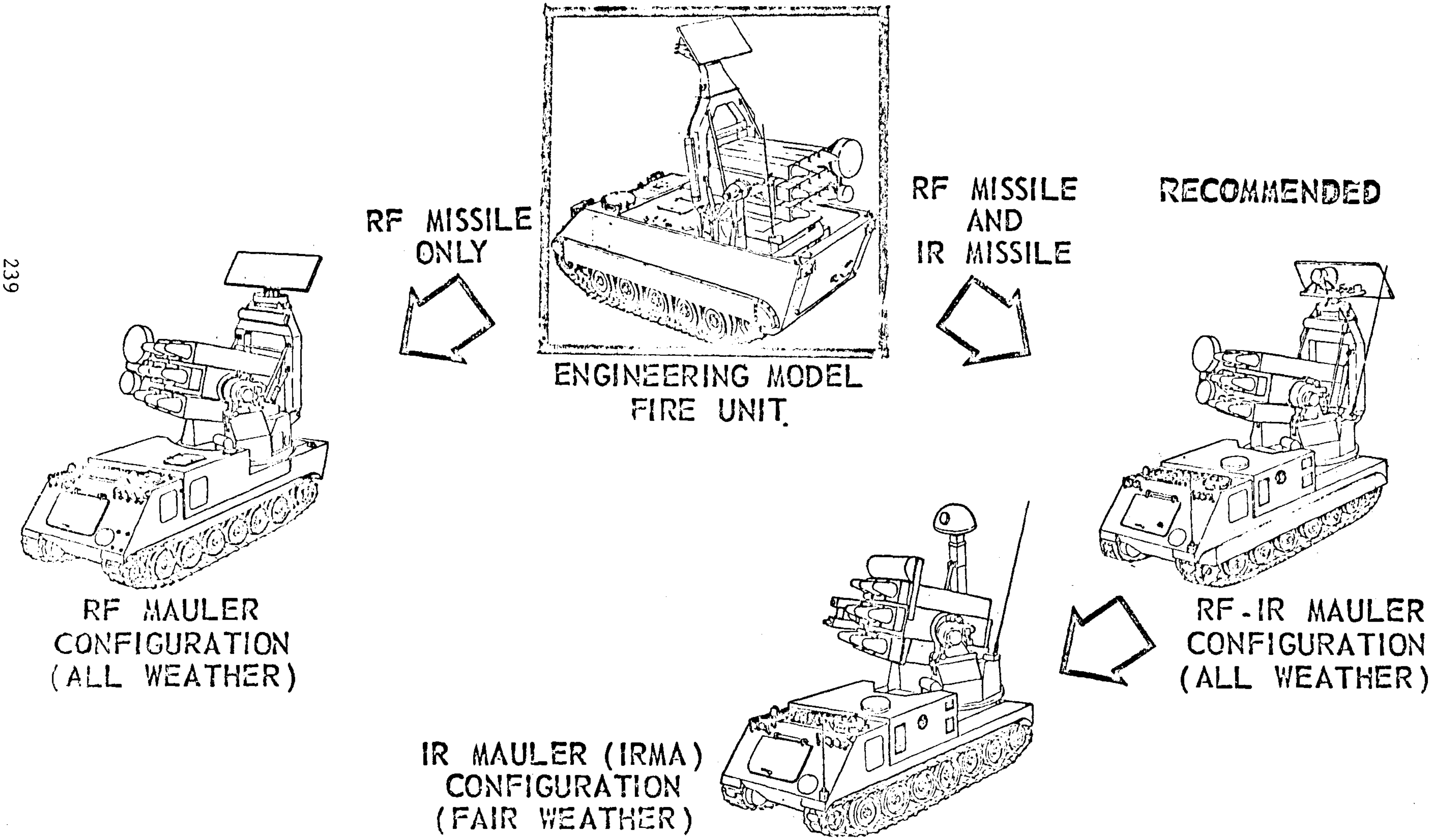
[3] (1) Ibid. (2) Hist Rept, MAULER Proj Ofc, 1 Jul 64 - 30 Jun 65, pp. 12-13.

[redacted]

MAULER
USAMICOM

FINAL

MAULER CONFIGURATIONS



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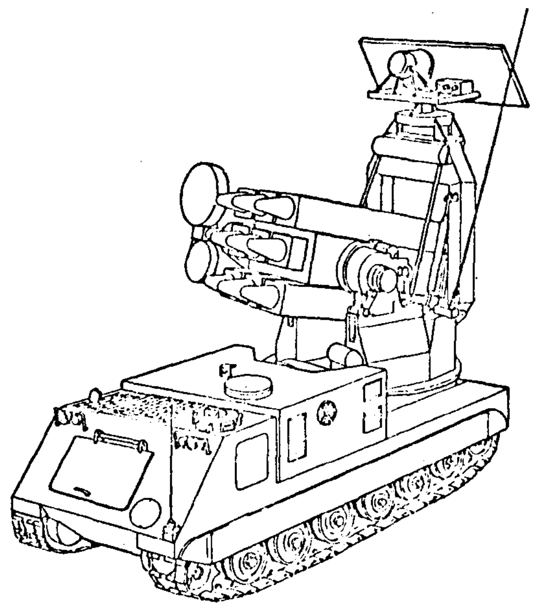
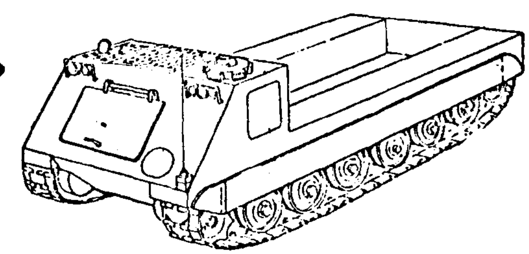
MAULER
USAMICOM

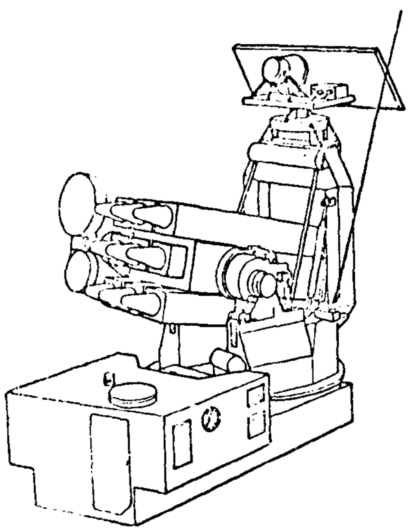
TACTICAL FIRE UNIT



MAULER FIRE UNIT
COMBAT WEIGHT = 25,400 LBS



WEIGHT 15,000 LBS



WEIGHT 10,400 LBS

7209/M-B13U-027A-9 5/30/65

firings had demonstrated the single-vehicle MAULER to be technically feasible and achievable within an acceptable time frame. While describing the basic technical problems as being well in hand, he emphasized that the MAULER design still had a long way to go in both time and money before it would be ready for production. Among the problems to be resolved in the tactical system design were these: maintainability and reliability; interface of system components; human engineering; electronic counter-countermeasures; radar and missile sensitivity (i.e., the ability to see targets of very small cross section at sufficient range to permit engagement); and radar subclutter visibility. These problems, he concluded, were considered to be solvable by straightforward engineering application.

[redacted] Colonel Luczak's next presentation, on 7 June, dealt with the MAULER's capabilities to meet the proposed requirement for a proliferation (fair weather) weapon. The conclusions reached from the analysis were (1) that the IR MAULER met the requirements for the proposed proliferation weapon; (2) that a mix containing a separate proliferation weapon was not justified because of the degradation in foul weather effectiveness for a small savings, if any, in cost; and (3) that the RF-IR MAULER would provide the most effectiveness for the least cost in the all-weather conditions.[4]

[redacted] In his final presentation, Colonel Luczak outlined three alternate courses of action: continuation of component development at a reduced level, outright termination of the program, or resumption of full development. While a limited component development effort would be one method of postponing a decision without complete termination, he told the Evaluation Board, "We in the Project are hoping you will be able to come up with a firm 'kill

[4]MAULER Eval Bd Briefing, 4-7 Jun 65. MPCF, Bx 13-410, RHA. (This document contains the script and slides used in briefings by Colonel Luczak and General Persons.)

or field' decision."

[redacted] If component development should be the Board's decision, a minimum of $12 million in FY 1966 funding would be required for a meaningful interim program, during which attention would be focused on the development of IR missile components, an improved receiver for the RF missile, and an improved transmitter for the acquisition radar to achieve better subclutter visibility. On the other hand, if the Board should decide to terminate the program, there would not be very much that could be readily salvaged from the $200 million MAULER investment. One notable exception would be the IRA unit which would have general application to other short-range surface-to-air defense systems. The only other possible exceptions would be the acquisition radar which might be used with the Advanced CHAPARRAL, and the MAULER missile which might be adapted as a Navy point defense weapon.

[redacted]) If a decision should be made to develop and field the recommended all-weather RF-IR MAULER weapon system, the total program cost for the FY 1966-71 period would be about $877 million. This estimate included a total RDTE cost of $180 million and a PEMA program of $697 million, the latter based on 16 battalions of 20 fire units each. With optimum funding and timely administrative decision, the first MAULER battalion could be completely equipped, trained, and ready for deployment by June 1970. To maintain this schedule, $45 million in FY 1966 RDTE funds would be required, together with a firm decision to permit the resumption of full development by October 1965. A minimum of $24 million would be required for a meaningful program, and if FY 1966 funding should be reduced to that level, the earliest readiness date would be December 1970. Colonel Luczak ended the briefing with this recommendation:

> In conclusion, assuming that this Board finds the requirement for an all weather short range, highly mobile air defense system for the forward area is still valid, it is recommended that the

RF/IR MAULER be approved for development, and that the resumption of full development be initiated on 1 October 1965.

([redacted]) On the last day of the Evaluation Board proceedings, BG H. P. Persons, Jr., gave a detailed presentation on AMC's position regarding the findings and recommendations of the CDC cost effectiveness study. After outlining numerous instances of contradiction and faulty judgment in the CDC study, he summed up the main points of disagreement as follows:

> From our knowledge of the terrain in most areas of the world, we cannot agree that all-weather air defense of the division area can be provided by a long-range Army type system from positions in rear of the division, even down to 500 feet. And from our assessment of aircraft attack capabilities, we do not agree that there is no requirement for all-weather defense below 500 feet.
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> * * * *
>
> . . . [Reviewing] the question of HAWK's superiority over MAULER, and using the Phase II material, we find that: (a) defense mixes containing Advanced Division HAWK [ADH] or RF MAULER are equivalent; (b) that RF-IR MAULER is superior to the RF MAULER; (c) that the RF-IR MAULER is superior to Advanced Division HAWK. Thus, we strongly disagree with this CDC conclusion, that "On a pure cost effectiveness basis, there is no clearly discernible difference between ADH and RF-IR MAULER."
>
> Finally, I have this comment on the . . . conclusion that "An advanced proliferation weapon is required for fair weather protection of the forward area." We in AMC agree with this conclusion, <u>provided</u> the CDC assumption that such weapons will be relatively <u>inexpensive</u> is correct.
>
> A proliferation weapon having the characteristics as outlined in the Phase II study is <u>unlikely to be cheap</u>; and, in fact, might closely resemble MAULER.
>
> We in AMC believe that the RF-IR MAULER VIII, in addition to its foul weather role, will meet the requirement for an <u>advanced</u> proliferation weapon.

([redacted]) On the basis of its own analysis, the Army Materiel Command concluded that the Army air and missile defense family should consist of three classes of weapons, as follows: for field army defense, HAWK and NIKE HERCULES, followed by the SAM-D; for division area defense, RF-IR MAULER; and for forward area defense, REDEYE and TADS. General Persons told the Evaluation Board: "AMC recommends this family of weapons since it provides the most effectiveness, for the least cost, within an acceptable time frame."[5]

([redacted]) There were many other presentations in the course of the Evaluation Board hearings, some of them in favor of the MAULER, some against, and some in between the two extremes. An example of the latter was the Marine Corps study which indicated that the Corps would choose the Advanced Division HAWK, but conceded that the MAULER would be superior in a Vietnam situation and that the HAWK could not survive in such an environment without extensive sandbagging. The Board hearings ended with a cost analysis presentation on four options (including the MAULER) costed out for a 10-year period.[6]

(U) The letter order establishing the MAULER Evaluation Board had directed that the findings and recommendations of the Board, together with pertinent study reports, be submitted to the Secretary of the Army. According to a source closely associated with the project, General Polk made a verbal report on the evaluation to a committee of high-level general staff officers in whose hands rested the MAULER's fate.[7] A search of MICOM sources failed to reveal a copy of the final report; however, in the light of subsequent developments, it appears that CDC's recommendations prevailed, eloquent appeals to the contrary notwithstanding.

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[5] MAULER Eval Bd Briefing, 4-7 Jun 65. MPCF, Bx 13-410, RHA.

[6] MFR, COL B. R. Luczak, 10 Jun 65, subj: Presn to the MAULER Eval Bd. File same.

[7] Intvw, Mary T. Cagle with Raymond C. Hase, Jr., Sys Engrg Div, SAM-D Proj Ofc, 13 Jun 68.

Termination of the Program

(U) The Secretary of Defense approved the termination of the MAULER development program on 19 July 1965.[8] This decision came as a surprise to no one, least of all to the Project Manager. The Defense Department's attitude toward the MAULER had been crystal clear since late 1964. Secretary McNamara, during the FY 1966 budget review, had indicated that the project would be terminated upon completion of the validation program, and that the reduced funding for that year would be used for the development of an advanced forward area air defense system as an alternative to the MAULER.[9] Still, the project staff clung to the hope that the successful demonstration of the MAULER's technical feasibility would somehow save the program. In the final analysis, however, the success of the validation program had precious little to do with the final decision. MG John G. Zierdt summed it up in an impeccable understatement when he told a member of the project team:

> . . . I am sure you share my disappointment that MAULER should have been terminated at a stage when it was achieving technical success and had demonstrated feasibility. However, in spite of vigorous and determined efforts by my Project Manager and his combined staff, the program was overtaken by what appears to the "user" to be a more timely and economical solution to a portion of the Low Altitude problem.[10]

Close-Out Actions

(U) At the behest of OCRD, the Project Manager, in early July 1965, had prepared a termination plan outlining the actions required for the close-out of contracts and disposition of residual

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[8] TT DA 7254399, DA to CG, AMC, 27 Jul 65, subj: Termination of MAULER Dev Program.

[9] <u>See</u> above, pp. 226-27.

[10] Ltr, CG, MICOM, to Brig N. G. Wilson-Smith, Comdr, Canadian Army Staff, Washington, D. C., 10 Aug 65, n.s.

property, together with recommendations concerning the areas of MAULER technology and other benefits that might be salvaged for use in other programs.[11] In accordance with this plan, Colonel Luczak effected partial termination of the program on 2 August, and completed the remaining actions on 1 October 1965.[12]

(U) Having taken over the operation of the General Dynamics/ Pomona plant effective 1 July 1965,[13] the Department of the Navy had become the administering contracting officer for the MAULER project and therefore administered the close-out of GD/P's MAULER contract. MICOM's Procurement & Production Directorate served as the Army focal point for matters dealing with the transfer of residual MAULER property to the Navy to support the further evaluation of the system for shipboard use.[14]

([redacted]) The only phase of the development effort continuing beyond 1 October 1965 was the cost-sharing contract between MICOM and DeHavilland Corporation of Canada, through the Department of Defence Production of Canada and the Canadian Commercial Corporation. This contract, covering the period from February 1964 to 31 October 1965, provided for validating the feasibility of the principle and technique of the MAULER IRA unit to detect aircraft under varying background conditions by passive means. The results of tracking tests with the picket fence optical feasibility model of the IRA unit, begun in August 1965 at Eglin Air Force Base, indicated a potential requirement for this type of acquisition

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[11] Ltr, COL B. R. Luczak, thru CG, AMC, to OCRD, DA, 9 Jul 65, subj: MAULER Program.

[12] Add to MAULER TDP, 10 Dec 65, p. 5.

[13] Up to that time, General Dynamics had operated the Pomona plant under cognizance of the Department of the Navy.

[14] (1) Min, Staff Meeting No. 24, HQ MICOM, 10 Aug 65. (2) DF, Cmt 1, Chf, Facs & Resources Div, P&PD, to Dir, P&PD, 22 Oct 65, subj: Recent Devs on Dspo of MAULER Equip, & Cmt 2, Dir, P&PD, to MAULER PM, 25 Oct 65, same subj.

capability in other forward area air defense systems. Consistent with the Army's intention of capitalizing on MAULER technology, the American and Canadian Governments extended the DeHavilland contract for another 6 months. The MICOM R&D Directorate assumed technical direction of this effort on 1 October 1965.[15]

(U) After that, little remained to be done except for the final disposition of residual equipment.[16] Accordingly, the Special Assistant for Project Management, AMC Headquarters, announced the termination of the MAULER Project Manager's Office effective 10 November 1965. Thereafter, the Director of R&D at AMC would handle any matters formerly under the cognizance of the MAULER Project Manager.[17] Pursuant to provisions of the implementing MICOM order[18] and the aforementioned termination plan, the R&D Directorate assumed the residual Command functions pertaining to the technological aspects of the MAULER system, and the SAM-D and CHAPARRAL offices absorbed key members of the MAULER project staff, thereby maintaining the integrity and experience of the team.

(U) On 18 November 1965, the Office of the Secretary of the Army approved the formal termination of the MAULER project,[19] thus

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[15](1) Add to MAULER TDP, 10 Dec 65, p. 6. (2) The extension of Contract DA-20-018-AMC-1354(Z) in the amount of $500,000 provided for the development of a Universal IRA unit with potential application to the CHAPARRAL and other future air defense systems. Under the 50-50 sharing agreement, the Canadian Government paid $250,000 of the cost and the remaining $250,000 was funded by deobligated FY 1965 MAULER funds. SS AMSMI-RP-66-65, R&DD, 1 Dec 65, subj: Req for Apprl of Individual D&F for Univ IRA Sys, & incl thereto, Ltr, CG, MICOM, thru CG, AMC, to ASA (R&D), 1 Dec 65, same subj.

[16]TT AMSMI-IF-7-11, CG, MICOM, to CG, AMC, 10 Nov 65, subj: MAULER Termination Inventory.

[17]TT AMC-15202, CG, AMC, to MAULER PM, 10 Nov 65.

[18]MICOM GO 97, 18 Nov 65.

[19]AMCTCM 3872, 18 Nov 65. RSIC.

bringing to an unfruitful end the Army Light Antiaircraft Development Program begun 13 years earlier.

Cost Summary

(U) The net RDTE funds obligated during the FY 1958-65 period totaled $199,998,794, this sum including an obligation of $247,355 in FY 1965 funds for continued development of the IRA unit under the DeHavilland contract. In addition, the Missile Command received $830,000 in OMA funds, increasing the total program obligation to $200,828,794. The distribution of RDTE funds among contractors and Government agencies is shown in Table 2.

(U) As a result of termination actions and the withdrawal of multiyear RDTE funds during the FY 1966-68 period, a total of $2,701,529 was recovered and made available for reprogramming, thereby reducing the total RDTE program obligation to $197,297,265.[20]

[20] (1) Add to MAULER TDP, 10 Dec 65, pp. 3-4, 11-13. (2) Funding data for FY 1966-68 furnished by Thelma Stowe, Chf, Program Sec, Tech Programs Con Ofc, R&DD.

Table 2—Distribution of MAULER RDTE Funds - FY 1958-65

RECIPIENT	FY 1958	FY 1959	FY 1960	FY 1961	FY 1962	FY 1963	FY 1964	FY 1965	TOTAL
GOVERNMENT AGENCIES									
MICOM........................	$125,012	$ 7,000	$ 9,000	$ 372,639	$ 203,888	$ 1,864,105	$ 2,651,459	$ 1,973,619	$ 7,206,722
Watertown Ars - Canister....						10,000			10,000
TECOM - WSMR & APG..........		2,000	258,435	160,000	1,564,608	740,159	698,270	466,000	3,889,472
MOCOM - ATAC................		14,230	568,000	156,500	30,000	84,969	40,339	25,000	919,038
MOCOM - ERDL................				17,500	141,486	54,000	23,000	6,309	242,295
MUCOM - Picatinny Arsenal...	60,000		65,000	288,000	150,000	220,000	260,000	31,000	1,074,000
MUCOM - Frankford Arsenal...				15,000	3,000	39,000	5,000	5,000	67,000
MUCOM - CRDL................					23,760		40,943	500	65,203
ECOM				3,000	6,500		15,694		25,194
BRL - Sys Effns Study.......			70,000			26,000	30,000		126,000
HDL - Fuze..................	10,000	27,474	160,000	470,000		1,304,000	991,000	612,000	3,574,474
HEL - Human Engrg Study.....				45,000	623,900	36,000	13,000	143	718,043
USN - Tgts & Test Spt.......				34,760	103,693	70,000	190,473	209,505	608,431
USAF - Tgts & Cptv Flts.....							32,770	7,000	39,770
ARO - Consultant............							19,000	3,000	22,000
Duke Univ - FS Eval.........	25,000	75,000							100,000
Misc Instl - TDY/GFE/Trans..				19,635	14,584	15,293	58,831	46,795	155,138
Unissued Authority..........								168,192	168,192
SUBTOTALS	$220,012	$125,704	$ 1,130,435	$ 1,582,034	$ 2,865,419	$ 4,463,526	$ 5,069,779	$ 3,554,063	$ 19,010,972
CONTRACTORS									
BHPD (Martin)...............	50,000								50,000
BHPD (Gen Elec).............						78,000			78,000
CDDP/CCC (DeHavilland)......					801,582	48,713	553,213	1,191,694	2,595,202
LAPD (Convair - ORD-1253)...	190,000								190,000
LAPD (GD/P - ORD-1951(Z)....			13,675,896	18,271,391	31,798,006	44,714,315	21,625,538		130,085,146
LAPD (GD/P - AMC-345(Z).....							28,881,291	17,044,691	45,925,982
LAPD (JPL)..................			19,117	6,076					25,193
LAPD (Ryan Aero)............							380,151	112,489	492,640
LAPD (Hughes Acft)..........						49,996	324,196		374,192
MICOM (Texas Inst)..........							61,102	74,539	135,641
MICOM (WECo)................							11,000		11,000
MICOM (IBM).................							16,850	21,543	38,393
MICOM (Rohm & Haas).........				31,200				981	32,181
NYPD (Belock)...............					35,000	488,700			523,700
NYPD (Cornell)..............				18,686					18,686
NYPD (Sperry)...............	49,971								49,971
PHPD (RCA)..................					99,194				99,194
PHPD (Gen Elec).............	50,000								50,000
SFPD (Stanford Rsch Instit).				48,424					48,424
SLPD (Univ Match)...........					164,277				164,277
SUBTOTALS	$339,971	$ 0	$13,695,013	$18,375,777	$32,898,059	$45,379,724	$51,853,341	$18,445,937	$180,987,822
GRAND TOTAL.................	$559,983	$125,704	$14,825,448	$19,957,811	$35,763,478	$49,843,250	$56,923,120	$22,000,000	$199,998,794

SOURCE: Addendum to MAULER Technical Development Plan, 10 Dec 65, pp. 11-12.

CHAPTER X

([redacted]) CONCLUSION (U)

In Retrospect

(U) Like all complex missile development programs, the MAULER ran into trouble, but more than usual. The project was plagued by inadequate funding, a lack of firm and timely guidance from higher headquarters, changes and compromises in military requirements, unsolved technical problems, and a gradual loss of confidence in both the contractor and the weapon system. As a result of the revisions in system requirements, interface and packaging problems, piecemeal funding, and program stretchout, development costs increased from the initial estimate of $77.6 million in FY 1960 to a projected total of $380 million in FY 1965, with a slippage of some 6 years in the system readiness date.

(U) Officials at all echelons were well aware from the outset that the development of a weapon system meeting the stringent requirements of the forward area would present serious state-of-the-art problems. The Ad Hoc study report of July 1956 focused attention on the complex nature of the forward area air defense problem and warned that a full solution in the form of a guided missile could not be expected for at least another decade. Since the VIGILANTE program then appeared certain of producing an effective replacement for the M42 DUSTER at a comparatively early date, the plan was to approach the development of an optimum weapon system with great caution and deliberation. This plan was abandoned in 1957 when it became apparent that the conventional VIGILANTE system possessed certain operational limitations that could not be completely eliminated. In view of this revelation and the recent advancements in guidance technology, the Commanding General of CONARC concluded that the current state of the art would support the development of at least an interim guided missile system that would be more effective than any known predicted fire weapon.

(U) The immediate objective of the MAULER project thus approved in 1959 was to develop the best possible weapon within the established time frame using advanced techniques which were within the state of the art and required no major technical breakthroughs to meet the system military characteristics. Nevertheless, the results of the feasibility studies clearly showed that complex state-of-the-art problems would have to be overcome in order to meet certain critical technical requirements. Army officials approved the project with full knowledge of the magnitude of these problems; yet the resources and guidance essential for their solution never materialized. To compound the contractor's dilemma, the Army imposed certain additional technical requirements after the basic system design had been established, adding to the growing list of difficulties.

[redacted] In late 1963—after some 44 months of piecemeal funding and schedule revisions—major technical problems were yet to be solved, the total program cost had nearly tripled, the readiness date had slipped several years, and confidence in the contractor and the weapon system had sharply declined. At this point, it was generally conceded that the MAULER concept was in truth pushing the state of the art in several critical areas, and there was considerable doubt that the weapon system as then designed would be able to fulfill even the minimum technical requirements. Mr. Willis M. Hawkins, ASA (R&D), gave an excellent retrospective view of the obstacles encountered in the program in testimony before the Subcommittee on R&D of the House Armed Services Committee, on 20 January 1964. Referring to the technical problems that prompted the redirection of the program in late 1963, he said:

I think as we look back on this program we probably picked up a few too many customers for this concept before we really had solved all the problems. And as a result, we were, I believe, driving the program too rapidly in all of its aspects in order to try to meet the dates. We have concluded . . . that there are a couple of technical roadblocks, that would probably have held up the whole program and there was some doubt that we could remove these obstructions, certainly by the original date. There is some doubt that we will be able to solve them at all. We reevaluated the entire program and concluded that . . . we should concentrate on these specific problems and get them solved before we reallocate the dollars to the supporting elements . . . that make up the whole system.

* * * * *

We could, for instance, solve one of our problems by taking our radar off the vehicle putting it on another truck, but at this point we begin to approach the HAWK type of system and the HAWK is criticized because it has so many trucks that it is not really mobile. You can't get it up to the front lines. So as soon as we give up that much to solve the technical problem we have really given up the requirement.

We . . . are not going to give up mobility that should be achievable. There is no use making a new weapon system unless you can put it, in this forward line area, all on one vehicle, with all of the gear right there, so that the real requirement can be fulfilled.[1]

(U) Although the technical feasibility of the single-vehicle MAULER concept was successfully demonstrated, the time and money required to solve the remaining problems and complete development of the tactical system caused it to lose out in the competition with other air defense systems. None can say whether or not the outcome would have been any different if the MAULER program had been accorded adequate financial support and direction during the 1960-63 period. But there can be no doubt that short funding and poor guidance had a profound impact on both the rate and quality of technical progress and on management's ability to conduct an

[1] Quoted in CFP-OCRD-14, 10 Nov 64, atchd as incl to Ltr, MAULER PMSO, AMC, to CG, MICOM, 25 Nov 64, subj: Xmitl of MAULER CFP. MPCF, Bx 13-410, RHA.

orderly and dynamic program. Authorities at all echelons were in full agreement on the urgent need for the weapon system, but they were either unable or unwilling to provide the resources and guidance essential for the timely solution of known state-of-the-art problems and the phased development of the complete tactical system. The end result was a stretchout in the service availability date, escalation in program cost, and ultimate termination of the MAULER project in favor of an alternate development approach that presumably would provide an earlier operational capability at less cost.

(U) The editor of Army magazine put the whole matter of the MAULER's termination in proper perspective when he wrote:

> If research and development didn't have its failures as well as its successes, it wouldn't be called research and development.
>
> The termination of the Mauler air-defense weapon system is a failure only of the bright hopes of its original prospectus. The technical difficulties involved made the cost of continuing the system so high that it lost its attractiveness in competition with other developments. But much was learned from it.
>
> The system itself, as the official announcement stated, is technically feasible and components of the system may well be used in the future. The announcement noted that such elements as the infrared acquisition unit, the acquisition radar and the Mauler fuse show promise.
>
> As Major General J. G. Zierdt told the staff of Mauler development when announcement of its termination was made, "You have done as fine a job as could be done." The experience and knowledge that were obtained during the program will be of benefit to every succeeding Missile Command program.
>
> This is the aspect of research and development that is too often forgotten. Failure can be as instructive as success.[2]

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[2] Army magazine, Vol. 15, No. 14 (September 1965), p. 20.

[redacted]

The Alternative to MAULER

(U) With the termination of the MAULER project, the Army Staff adopted a forward area air defense plan which, for all practical purposes, implemented the recommendations made in the CDC Cost Effectiveness Study.[3] Under this plan, field commanders in forward battle areas would be provided with a number of Self-Propelled (SP) HAWK battalions, as well as composite missile-and-gun battalions consisting of the CHAPARRAL guided missile system and the M61 VULCAN, a six-barrel automatic gun. Each of the new composite battalions would have 755 men. Aside from the headquarters and headquarters battery, there would be two CHAPARRAL and two VULCAN batteries in each battalion, with each battery having 16 mobile firing units. These two weapons would complement each other in the daytime, fair weather air defense role, by combining the quick reaction and extremely low altitude capability of the VULCAN with the longer range capability of the CHAPARRAL. Together, they would complement the all-weather, low and medium altitude air defense role of the SP HAWK. The manportable, shoulder-fired REDEYE missile would also be procured for use in the forward area.[4]

(U) The three self-propelled air defense weapons designated to fill the gap left by the MAULER's termination would be built, in the main, with existing military hardware. Modified versions of the M113 family of Army-developed tracked vehicles would be used as the weapon carriers. Except for its vehicle-mounted launcher, the SP HAWK would use essentially the same equipment and principles of operation as the Basic HAWK guided missile

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[3] See above, pp. 233-35.

[4] (1) LTG William W. Dick, Jr., "A Promising Future in Military R&D," Army magazine, Vol. 15, No. 16 (November 1965), p. 55. (2) The Redstone Rocket, Vol. XIV, No. 41 (2 Mar 66), p. 1. (3) Also see Hist Sum, AMC HQ, FY 1966, p. 533.

[redacted]

system which reached the field in 1960.[5] The CHAPARRAL would use the Navy-developed, infrared heat-seeking SIDEWINDER missile and an optical sighting system. The VULCAN would employ a 20-mm. automatic gun which had some 20 years of experience and development, mostly with the Air Force as an aircraft gun. Like the VIGILANTE, the VULCAN would be developed in two configurations: the SP XM-163 model mounted on a modified M113A1 armored vehicle, and the XM-167 towed model. A towed version of the CHAPARRAL would also be developed for use with airborne and air mobile divisions.[6]

([redacted]) Ostensibly, the SP HAWK and CHAPARRAL/VULCAN were chosen as an alternative to MAULER on the premise that they would provide an earlier operational capability at less cost. Whatever the wisdom of the decision not to proceed with the MAULER program, there was no indication that the alternate approach would produce appreciable savings in either time or cost. Developers of both the SP HAWK and CHAPARRAL were plagued by technical and financial problems similar to those experienced in the MAULER program, with a resultant escalation in cost and stretchout of deployment schedules. Under the original plan, the initial HAWK and CHAPARRAL/VULCAN battalions were to be fully equipped, trained, and available for deployment by June 1967,[7] an improvement of 3 years over the

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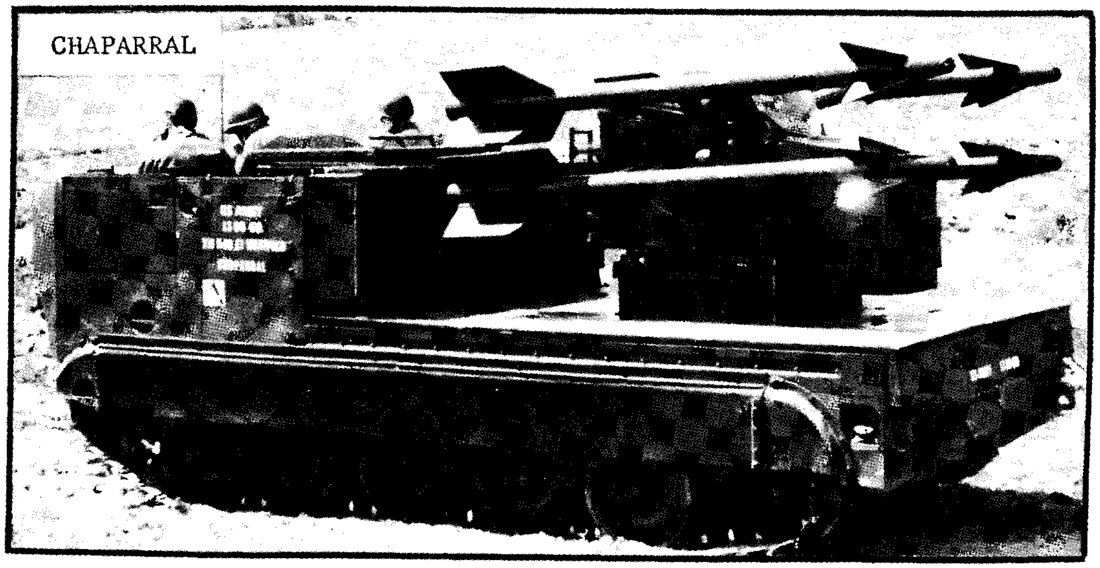
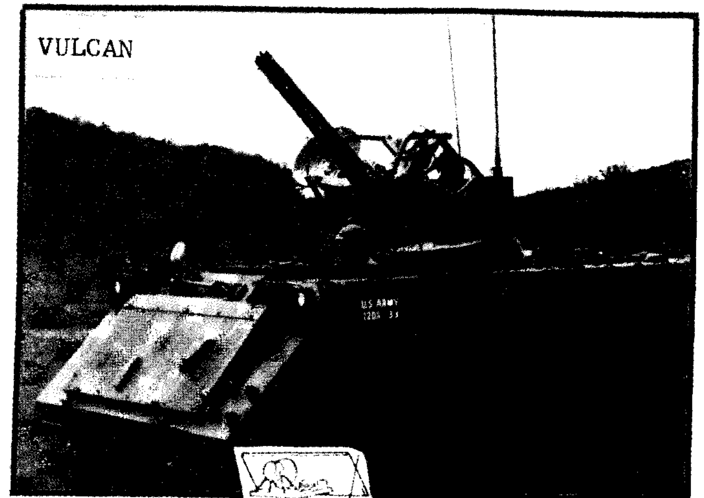
[5] ([redacted]) The SP HAWK firing battery would be comprised of two SP platoons and one towed platoon, the latter being identical to the Basic HAWK firing battery except for one less firing section. The SP platoon would consist of three SP launchers which would tow the radars and Battery Control Central and carry the missiles and on-board power supply. HAWK PM2P, Revision #1, 31 Mar 68, p. 2.

[6] (1) The Redstone Rocket, Vol. XVI, No. 22 (11 Oct 67), p. 1. (2) SSG Duke Richard, "Antiair Weapons on the Horizon," Army Digest, Vol. 23, No. 1 (January 1968), pp. 56-57. (3) Hist Sum, AMC HQ, FY 1966, p. 537.

[7] (1) Ltr, CG, MICOM, to Comdr, NOTS, 7 Jun 65, subj: Proc of Mat for the CHAPARRAL Program. (2) HAWK Briefing to GEN C. W. Abrams, Jr., VCofS, USA, 8 Jun 65, Vol. II, p. Q-3.



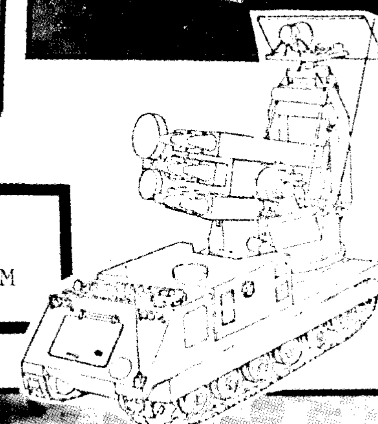
CHAPARRAL

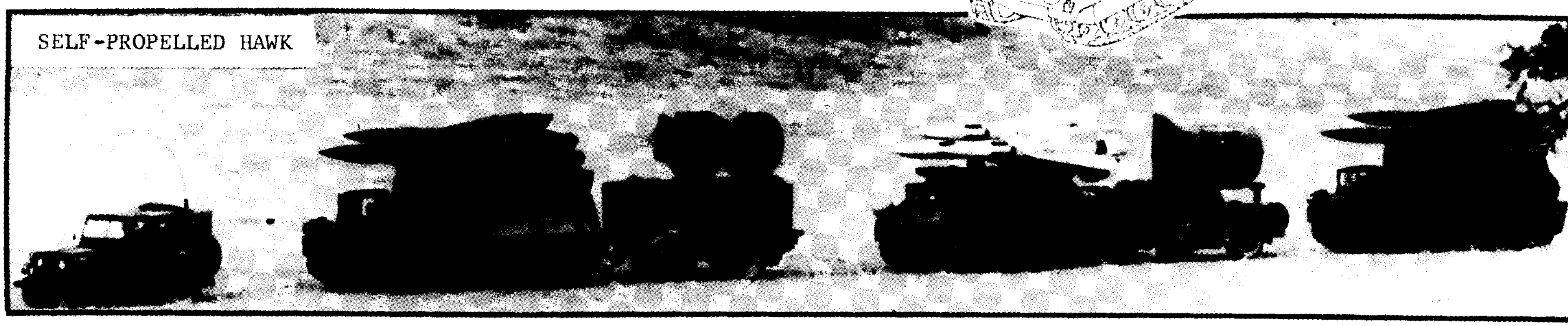


VULCAN

ALTERNATIVE TO THE MAULER

ALL-WEATHER FORWARD AREA AIR DEFENSE SYSTEM





SELF-PROPELLED HAWK

Table 3

COST COMPARISON

RF-IR MAULER versus CHAPARRAL/VULCAN & SP HAWK

(in millions)

Weapon System	Funding Period	Total Program Requirement RDTE	Total Program Requirement PEMA	Total Program Requirement TOTAL	Total Obligated Thru FY 1968 RDTE	Total Obligated Thru FY 1968 PEMA	Total Obligated Thru FY 1968 TOTAL
CHAPARRAL[a/]	FY 1965-73	$ 61.561	$516.404	$577.965	$49.056	$ 98.263	$147.319
VULCAN[b/]	FY 1964-71	25.405	206.712	232.117	19.596	92.235	111.831
SP HAWK	FY 1964-69	6.635	56.499	63.134	6.635	46.497	53.132
TOTALS		$ 93.601	$779.615	$873.216	$75.287	$236.995	$312.282
RF-IR MAULER	FY 1966-71	$180.000	$697.000	$877.000			

[a/] Cost figures include development and production of the mobile Forward Area Alerting Radar (FAAR) for support of Composite CHAPARRAL/VULCAN battalions.

[b/] Cost figures include development and production of the XM-163 (SP) and XM-167 (Towed) systems.

SOURCES OF COST DATA: CHAPARRAL - Mr. James Clark, Program Analyst, CHAPARRAL Mgt Ofc, MICOM.
VULCAN - Mr. Clifford W. Stephens, Command Historian, USAWECOM.
SP HAWK - HAWK PM_2P, Revision #1, 31 Mar 68, p. 41.
RF-IR MAULER - *See* above, p. 242.

deployment date projected for the MAULER. As of July 1968, however, the time advantage over the MAULER had shrunk to slightly more than a year and the total estimated RDTE/PEMA cost had increased to $873.2 million, in contrast to the $877 million projected for the all-weather RF-IR MAULER system (see Table 3).

([redacted]) Most of the loss in cost advantage over the MAULER resulted from changes in military requirements for the CHAPARRAL/VULCAN and the financial and technical reversals encountered early in the CHAPARRAL development program. Because of piecemeal funding, changes in requirements, and the major redesign necessary to correct deficiencies in the initial R&D model, the original cost estimate for the CHAPARRAL increased from $95.4 million ($17.5 RDTE, $77.9 PEMA) for FY 1965-69, to $577.96 million for the FY 1965-73 period.[8] The uncertainties surrounding the CHAPARRAL program in late 1967 were reminiscent of the MAULER's predicament some 4 years earlier. A formal Army position paper, signed on 2 November 1967, stated: "Certain requirements of the QMR may not be met, and appear to be beyond the capability of the developers to provide satisfactory solutions within present resources and time available."[9] The revised program schedules called for initial deployment of the CHAPARRAL/VULCAN battalions in April 1969 and a full SP HAWK operational capability (five battalions) by the end of May 1969.[10]

(U) Meanwhile, the American ground forces in South Vietnam would have to rely on the mobile 40-mm. M42 DUSTER and quad M55 .50-caliber machine gun as their first line of defense against

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[8](1) MFR, Mary T. Cagle, 22 Jul 68, subj: Cost Data on CHAPARRAL Program. (2) Also see MICOM Hist Sum, FY 1966, pp. 132-37; FY 1967, pp. 127-32.

[9]Quoted in Hist Rept, CHAPARRAL Mgt Ofc, FY 1968, p. 3.

[10](1) Hist Rept, CHAPARRAL Mgt Ofc, FY 1967, p. 6. (2) HAWK PM$_2$P, Revision #1, 31 Mar 68, pp. 5, 13.

low-level bombing and strafing attack. With the commitment of U. S. military forces to active combat early in 1965,[11] these battle-scarred veterans of World War II and Korea were taken out of mothballs and overhauled for deployment to South Vietnam, along with the Basic HAWK weapon system. Units of the Basic HAWK were emplaced at strategic sites in October 1965, and a number of composite M42/M55 gun battalions were deployed in the forward combat areas in 1966-67.[12]

The Air War in Vietnam

(U) So far, the North Vietnamese have not committed any of their aircraft for strafing or bombing missions south of the Demilitarized Zone (DMZ), leaving the American ground-to-air defense units no chance to test their skill. As in Korea, American warplanes have controlled the air over the battlefields in the South, provided close tactical support to the Allied ground forces, and carried out air strikes against supply lines and strategic targets north of the DMZ.[13] Official intelligence data on the North Vietnamese air defense system are not readily available, but unofficial reports clearly indicate its superiority over the

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[11] Departure from the "advise and assist" role came on 7 February 1965, when President Johnson ordered the first air strikes against North Vietnam. The first contingent of U. S. Marines landed at Da Nang on 6 March, and by December 1965, American forces had swelled from 22,000 advisers to more than 180,000 men actively engaged in battle. At the end of 1966, there were some 380,000 troops in Vietnam, backed by more than 1,000 combat planes, 2,000 helicopters, and several thousand artillery pieces. (See <u>World Book Year Books</u>, 1965-66.) A massive infusion of men and materiel in 1967 increased the U. S. forces to 470,000 combat and support troops, 2,600 planes, 2,500 helicopters, 540 tanks, 1,500 mortars, and 1,200 cannon. (<u>Newsweek</u>, Vol. LXXI, No. 1 [1 Jan 68], p. 20.)

[12] (1) Hist Sum, USAWECOM, FY 1967, p. 223. (2) SSG Duke Richard, "Poised to Kill," <u>Army Digest</u>, Vol. 23, No. 1 (Jan 1968), pp. 54-55.

[13] <u>Ibid</u>., p. 56.

Allied ground-to-air defenses in the South.

(U) With Soviet technical assistance and the help of Soviet MIG fighters, high-altitude surface-to-air missiles (SAM's), and antiaircraft guns, North Vietnam assembled what has been described as "the most advanced air-defense system U. S. planes have ever encountered."[14] According to an unconfirmed report in October 1966, major towns and strategic sites in North Vietnam were protected by a formidable network of 25 to 30 SAM-2 batteries;[15] some 7,000 radar-controlled 37-, 57-, 85-, and 100-mm. antiaircraft guns; and a fleet of 70 Soviet MIG fighter planes.[16] A highly sophisticated radar detection system, tied by radio to central control centers, provided early warning of U. S. attacks, permitted effective control of the larger-caliber guns, and alerted MIG fighters at nearby bases.[17]

(U) Surprisingly, the Soviet SAM-2's—counterpart of the U. S. BOMARC—were not the greatest menace to U. S. pilots. In Vietnam, as in Korea, the most effective ground-to-air defense proved to be the conventional automatic guns and well-organized small arms fire. During the first 19 months of the air campaign over North Vietnam

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[14] Newsweek, Vol. LXVIII, No. 16 (17 Oct 66), p. 40.

[15] The Soviet USZV-2, known in the West as the SAM-2, is effective between 2,000 and 12,000 meters, but has a maximum altitude of 18,000 meters (60,000 feet). Each SAM-2 battery has nine missiles in position on launching ramps and three in reserve on mobile pads. It is serviced by 22 specialized vehicles, 30 trucks, and 220 personnel. (For an objective appraisal of the SAM-2 and other Soviet weapons being supplied to North Vietnam and other Russian satellites, see Leo Heiman, "In the Soviet Arsenal," Ordnance, LII [Jan - Feb 1968], pp. 366-73.)

[16] Including 20 MIG-21's and 50 older MIG-15's and MIG-17's. The MIG-21, Russia's best plane, has a speed of 1,300 mph and is equipped with its own heat-seeking missiles. In contrast, the U. S. F-4 PHANTOM II has a top speed of 1,600 mph and is armed with both radar-guided missiles and the heat-seeking SIDEWINDER.

[17] Newsweek, Vol. LXVIII, No. 16 (17 Oct 66), pp. 40-41.

(February 1965 to October 1966), 393 modern U. S. warplanes were shot down in bombing missions—374 of them by conventional antiaircraft weapons, 14 by SAM's, and 5 by MIG fighters. Though notoriously ineffective against the evasive tactics of U. S. pilots, the SAM's did succeed in forcing U. S. planes down from high altitudes, where missiles work best, into the hail of deadly flak thrown up by radar-controlled antiaircraft guns. The outmanned and outnumbered North Vietnamese air force also fared poorly against U. S. pilots. The MIG interceptors shot down five American planes but suffered 21 "kills" at the hands of U. S. pilots.[18]

(U) The U. S. air campaign against North Vietnam gradually developed into the single most massive aerial bombardment in history. By the end of 1967, U. S. Air Force and Navy planes had dropped some 675,000 tons of bombs on North Vietnam, more than the tonnage dropped on Germany during all of World War II. But despite this awesome assault, Hanoi showed no signs of capitulation and its air defense system became even more deadly for U. S. pilots.[19] As a result of the rapid buildup in antiaircraft gun emplacements and missile launching sites, ground-to-air fire became so intense in places that much of the U. S. air effort had to be devoted to flak-suppression missions to give the bombers a reasonable chance of survival.

(U) As of early September 1967, about 670 U. S. warplanes valued at $1.34 billion had been lost in bombing missions and 7 helicopters valued at $2.1 million had been shot down in pilot rescue missions north of the DMZ. In the air war over the battlefields in South Vietnam, some 202 jet aircraft and 363 helicopters had been downed by the deadly ack-ack of conventional

[18] Ibid., p. 41.

[19] Newsweek, Vol. LXXI, No. 1 (1 Jan 68), pp. 25-26.

antiaircraft guns and small-arms fire, and 1,375 planes and helicopters had been lost in accidents, ground raids, and Red shelling. This brought the aggregate loss to 2,617 aircraft valued at some $3.5 billion over a 31-month period—nearly double the total U. S. losses during the 36-month Korean War.[20]

(U) The large number of U. S. air losses in South Vietnam, where the enemy forces had neither air support, SAM's, nor elaborate radar equipment, attests to the effectiveness of conventional weapons in the low-altitude air defense role. Today, the mobile M42 DUSTER and M55 machine gun of World War II and Korea are filling the gap in the field army's air defense screen and providing effective fire power in the ground support role as well. Far from being obsolete, conventional weapons such as these are likely to remain in the Army's supply system long after the Self-Propelled HAWK and CHAPARRAL reach the field.

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[20](1) U. S. News & World Report, Vol. LXIII, No. 12 (18 Sep 67), p. 41. (2) Also see above, p. 7.

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APPENDIX

APPENDIX I

([redacted]LAUNCH BLAST SIMULATOR FIRINGS (U)

(All Rounds Equipped with ZUNI Rocket Motor)

Msl Nr.	Date Fired	Canister Type	Pod Type	Results
1	16 Sep 60	Lt Wall	--	Canister ruptured along seam; all foam lining lost.
2	12 Oct 60	Hv Wall	--	Foam bond failure; pieces of foam blown 165 feet to the rear of canister.
3	1 Nov 60	Lt Wall	--	50% of foam ejected; canister distorted and forced to the rear.
4	4 Nov 60	Hv Wall	--	About 98% of foam ejected; FMC test plate distorted.
5	14 Dec 60	Lt Wall	B-1 Rack	Satisfactory - 1% loss of foam and very little canister distortion.
6	17 Jan 61	Lt Wall	B-1 Rack	About 40% of foam ejected; no significant damage to canister wall.
7	31 Jan 61	Lt Wall	B-1 Pod	Satisfactory - no damage to canister or pod.
8	3 Feb 61	Lt Wall	B-1 Pod	Satisfactory - no damage to pod, canister, or dummy missile.
9	16 Feb 61	Lt Wall	B-1 Pod	No blast damage to canister; dummy nose cones scorched and checked.
10	20 Feb 61	Lt Wall	B-1 Pod	No damage to pod or canister; nose cone on cell #5 torn off by blast.
11	24 Feb 61	Lt Wall	B-1 Pod	Connector bracket on firing canister bent; all dummy nose cones blown off.
12	7 Mar 61	Lt Wall	B-1 Pod	About 15% of canister foam lining ejected; nose cover on cell #10 blown off.
13	21 Mar 61	Lt Wall	B-1 Pod	Canister walls slightly expanded; instrumented nose cover scorched.
14	24 Mar 61	Lt Wall	B-1 Pod	No abnormal distortion of canister; instrumented nose cover scorched.
15	4 Apr 61	Lt Wall	B-1 Pod	Satisfactory - no damage to canister, pod, or instrumented nose cover.
16	7 Apr 61	Lt Wall	B-1 Pod	Nose cover on dummy round blown off; canister distorted; foam lining ejected.
17	18 Apr 61	Lt Wall	B-1 Pod	No damage to pod or dummy round; canister walls distorted.
18	21 Apr 61	Lt Wall	B-1 Pod	No damage to pod or dummy round; canister walls distorted.
19	27 Apr 61	Lt Wall	B-1 Pod	No visible damage to pod; front end of canister slightly deformed.
20	2 May 61	Lt Wall	B-1 Pod	Front end of canister deformed; cover on dummy round blown off.
21	5 May 61	Lt Wall	B-1 Pod	Canister deformed; 4-inch tear in plastic cover on dummy T-I radar antenna.
22	16 May 61	Lt Wall	B-1 Pod	Nose covers blown off cells #4 & 9; edge of nose cover on cell #1 damaged; 50% of styrofoam lining ejected; slight damage to dummy T-I antenna.

APPENDIX I - LBS Firings (Continued)

Msl Nr.	Date Fired	Canister Type	Pod Type	Results
23	23 May 61	Lt Wall	B-1 Pod	Old-type nose cover on cell #2 blown away; no damage to new (thick-wall) nose cover on cell #9; no damage to dummy acquisition radar antenna.
24	26 May 61	Lt Wall	B-1 Pod	Some paint blasted from rear of dummy acquisition antenna; 50% of foam lining ejected; cover of canister on cell #8 buckled outward.
25	2 Jun 61	Lt Wall	B-1 Pod	Front end of firing canister badly damaged and most of foam lining lost; front end of dummy round canister wall opened by blast.
26	16 Jun 61	Lt Wall	B-1 Pod	Rear walls of canister deformed about 1/8-inch.
27	7 Jul 61	Lt Wall	D-2 Pod	First test of D-2 Pod/XM-546 vehicle. Lower part of turret compartment dented; two pod mounting studs separated from vehicle because of weld failure; firing canister foam support structure split from front to rear; two dummy canisters separated from rack; paint damage to exposed surfaces of wooden canisters; driver, engine, and operator compartments filled with smoke.
28	14 Jul 61	Lt Wall	D-2 Pod	Paint damage to rotating platform of pod; paint removed to bare metal in 8 x 8-inch area on rear ramp of vehicle; crown structure of firing canister deformed inward; paint damage to exposed surfaces of all wooden rounds.
29	21 Jul 61	Lt Wall	D-2 Pod	Paint erosion on pod and vehicle; firing canister expanded and made contact with adjacent canister and T-I antenna mount; smoke in engine and driver compartments; foam from firing canister caused severe paint chipping on acquisition antenna; front cover on cell #5 slightly loosened by blast.
30	22 Sep 61	Lt Wall	D-2 Pod	Paint erosion on pod and vehicle; firing canister deformed 3/4-inch outward on three sides; large tear in cover of dummy T-I receiver antenna.

SOURCE: (1) Convair/Pomona TM-830-11, MAULER LBS Program Firing Reports - LBS-1 thru LBS-30. MAULER Proj Case Files, Bx 14-424, RHA. (2) MAULER Actv Rept, WSMR, atchd to Ltr, CG, WSMR, to ARGMA Comdr, 30 Mar 61, subj: Ltr of Transmittal. (3) MAULER Prog Rept, WSMR, atchd to Ltr, CG, WSMR, to ARGMA Comdr, 14 Jul 61, subj: Ltr of Transmittal. Same Files, Bx 13-649.

APPENDIX II

([redacted]) LAUNCH TEST VEHICLE FIRINGS (U)

Rd Nr	Date Fired	Type Canister	MAULER Rocket Motor	Type Fire Unit	Results
1	28 Sep 61	Double-Wall aluminum; Foam lined; Front cover w/ejection mechanism; Rear cover.	0.080-inch case; Low-Performance; Steel wings; Perchlorate igniter.	D-2 Pod w/o veh.	Satisfactory launch and motor performance. Large boost dispersion, potentially severe T-I radar blast load. Zero-lift 20 to 30% greater than predicted; base drag near prediction. Significant canister bulging. Proper front cover ejection; rear cover blew off but failed to fragment. Blast burned small hole in pod vent.
2	27 Oct 61	Same as Rd 1	Same as Rd 1	D-2 Pod w/XM-546 vehicle; fuel tank half full of combat gasoline.	Satisfactory launch and motor performance. Substantial vibration near wing first bending mode frequency from 2.6 to 6.9 seconds. Zero-lift drag averaged 20% high. Significant canister bulging and collapsed inner wall. Satisfactory front cover ejection; proper blowoff and fragmentation of rear cover. Satisfactory gasoline storage in fuel tank.
3	5 Dec 61	Same as Rd 1 w/improved foam bonding and new front cover ejection mechanism.	Same as Rd 1	Same as Rd 2	Satisfactory launch and motor performance. Severe wing vibrations from 2.2 to 7.2 seconds. Zero-lift drag 20% greater than predicted. Canister bulging reduced to satisfactory level. Proper performance of front and rear covers. Blast environment on pod/vehicle and personnel safety measurements were as predicted.
4	8 Jun 62	Double-Wall aluminum Foam lined; Rear cover; No front cover.	0.060-inch case; High-Perf; Aluminum wings; Nitrate igniter w/smoke generator.	D-2 Pod w/o veh.	Satisfactory launch and motor performance. Severe wing vibrations from 1.2 to 4.4 seconds. Smoke generator unsatisfactory. Significant boost dispersion. Missile zero-lift drag about 10% above wind tunnel data. Canister bulging satisfactory. Usable missile acoustic data obtained to 8 seconds.

SOURCE: GD/P CR-830-166-001, 24 Aug 62, MAULER LTV Program Firing Reports. MAULER Proj Case Files, Bx 14-424, RHA.

APPENDIX III

([redacted] CONTROL TEST VEHICLE FIRINGS (U)

Rd Nr	Date Fired	Rocket Motor	Summary of Results
1	15 Dec 61	Interim (LTV)	Satisfactory motor, airframe, and primary power performance. Loss of telemetry at 16.06 seconds prevented evaluation of self-destruct impact switch. Hot gas contamination caused tail deviations. Roll filter circuit failure caused roll-induced steering changes. Canister slightly bulged. Severe erosion on vent top and forward flange. Harness parted improperly because of improper repair.
2	28 Feb 62	Improved	Satisfactory motor, telemetry, self-destruct, airframe, and primary power performance. Hot gas contamination caused tail deviations. No roll-induced steering changes. Slightly bulged canister. Blast erosion on forward flange; ablative coating eroded over 15 sq. in. Rear canister cover fragmented improperly; harness separated improperly.
3	21 Jun 62	Improved	Satisfactory tail control, power, airframe, self-destruct, and rocket motor performance. Roll control and steering control system not activated (one-shot relay not not fired at launch). Telemetry lost at 31.82 seconds. Slight canister bulging. Rear cover fragmented improperly; harness separation improper. Nose cover on cell #5 partially blown off.
4	17 Jul 62	Improved	Tail control system satisfactory. Redesigned steering control activation circuits operated satisfactorily. Marginally stable steering induced roll oscillations. Telemetry lost for first 1.5 seconds. Slight canister bulging. Erosion on forward flange. Forward door of operator's compartment blown open. Harness separated improperly.
5	23 Aug 62	GTV-type	Roll and steering control proper to 1.5 seconds. Tail flutter damaged tail controls and resultant maneuvers caused missile breakup at "E" section joint. Some canister bulging and erosion on front flange. Rear cover fragmented improperly.
6	12 Oct 62	GTV-type	Tail, roll, and steering control satisfactory. Severe wing vibration but no damage. Firing canister completely disintegrated. Rear cover fragmented improperly.

SOURCE: GD/P CR-830-168-001, 15 Feb 63, MAULER CTV Firing Test Program Summary. MAULER Proj Case Files, Bx 14-424, RHA.

APPENDIX IV

([redacted]) FEASIBILITY VALIDATION TEST PROGRAM (U)

7 May 64 - 31 Aug 65

Test Equipment and Objectives

Test Series	Missile Configuration	Weapon Pod	Objectives
CTV-8 -9 -10	Long Airframe with 3-Axis Rate Feedback Circuitry; Length - 81.003 inches; Weight - 129 pounds	D-2 (Breadboard)	To determine that the GTV airframe with 3-axis gyro feedback had adequate roll and steering stability margin and maneuverability to meet the MAULER performance goals.
RTV-5 -6	Short Airframe with Reacquisition Circuitry; Length - 77.314 inches; Weight - 118 pounds	D-2 (Breadboard)	To determine that the GTV spinning dish seeker and reacquisition circuitry had adequate sensitivity and lock-on speed to meet the GTV performance goals, and to test the aided track and general seeker performance.
GTV-11 thru GTV-21	Same as CTV rounds with Reacquisition Circuitry & RF Guidance - Spinning Dish Seeker Head	EMFU-1	To determine performance (including miss distance) of the GTV airframe, spinning dish seeker, guidance computer, and autopilot against targets at low, medium, and high altitudes at various ranges.
GTV-3 -7 -22	GTV Missiles Retrofitted with Phased-Array Seeker Head	EMFU-1	To determine performance of the GTV missile with the phased-array seeker head.
MAULEYE SN 1 & 2	GTV Missiles Retrofitted with IR Seeker (REDEYE Missile Guidance Head)	EMFU-1	To determine performance of the GTV missile with the infrared guidance head.

APPENDIX IV - Feasibility Validation Test Program (Cont)

Msl Nr.	Date Fired	Summary of Results
CTV-8	7 May 64	All test objectives achieved: missile correctly executed 10 programmed step maneuvers and exhibited satisfactory roll control and stability. Motor blast caused complete disintegration of the canister and shut-down of the T-I radar transmitter during launch.
CTV-9	9 Jul 64	No Test. Power distribution failure occurred 1.4 seconds before launch.
CTV-10	22 Jul 64	Missile battery failure occurred at 2.3 seconds after launch; no test thereafter. Two of nine programmed maneuvers properly executed before the power failure.
RTV-5	25 Jun 64	Performance goal (i.e., target lock-on within 2 seconds and maintenance of lock through intercept) not met because of improper aided tracking gain. Lock was achieved at 1.6 seconds after launch but was not maintained because of noise on the RF rear channel aided track function.
RTV-6	8 Oct 64	Performance goal achieved with new accelerometer aided tracking system. Initial lock-on occurred at 0.5 second after launch. Because of a roll control problem, the reacquisition circuitry was exercised beyond that originally intended. Reacquisition of target was accomplished five more times after initial lock was lost because of antenna cross-polarization.

APPENDIX IV - Feasibility Validation Test Program (Cont)

Msl Nr	Date Fired	Target Traj	Target Speed (knots)	Miss Distance (feet)	Remarks
GTV-12	24 Nov 64	MR/MA	400	17	Lock achieved at 1.13 secs and maintained through intercept at 10.65 secs.
GTV-11	10 Dec 64	MR/MA	335	35	Lock achieved at 0.705 sec and maintained through intercept at 8.65 secs.
GTV-13	17 Dec 64	MR/MA	300	--	No Test. Rocket motor nozzle failure at 0.2 sec.
GTV-14	4 Feb 65	HA	332	0	Direct hit of target at 4.1 km altitude; time to intercept 7.63 secs.
GTV-15	19 Feb 65	LA	468	23	Lock achieved at 0.56 sec and maintained through intercept at 5.75 secs. Target altitude at time of intercept, 660 meters.
GTV-16	25 Feb 65	LA	480	18	Lock achieved at 1.94 secs and maintained through intercept at 8.92 secs. Target altitude at time of intercept, 390 meters.
GTV-17	15 Mar 65	LA	399	--	No Test. High pressure failure of rocket motor case at launch.
GTV-18	5 Apr 65	LA	369	--	No Test. Hold relay failure prevented target lock-on.
GTV-19	20 Apr 65	SR	400	0	Direct hit of target at 2.2 km slant range; time to intercept 3.64 secs. Initial lock at 0.35 sec, solid lock at 0.63 sec, and maintained through intercept except for momentary loss at 2.1 secs.
GTV-20	22 Apr 65	SR	495	--	No Test. Missile structural failure at 1.7 secs.
GTV-21	25 May 65	LA	463	--	No Test. Missile lost lock at launch and did not reacquire, apparently because high clutter levels degraded the target doppler signal in the missile video. Target was below 100 feet altitude.
GTV-22	14 Jun 65	HA	375	2.5	Lock achieved at 0.65 sec and maintained through intercept of target at 5.1 km altitude and 5.25 km slant range; time to intercept 12.1 secs.
GTV-3	23 Jun 65	LA	500	--	No Test. Malfunction of phased-array seeker.
GTV-7	21 Jul 65	LA	450	--	No Test. Lock was achieved late and guidance was intermittent, resulting in a miss distance of 1,040 meters.
MAULEYE SN 1	4 Aug 65	LA	267	0	Direct hit of QF-80 target flying an outbound course at 300 meters altitude and 4 km slant range. Missile flew directly up the target jet engine exhaust tube.
SN 2	31 Aug 65	LA	300	0	Direct hit and destruction of Q2-C target flying an outbound course at 300 meters altitude and 6 km slant range.

Target Trajectory: MR/MA - Medium Range/Medium Altitude; HA - High Altitude; LA - Low Altitude; SR - Short Range

SOURCE: (1) GD/P Rept CR-820-453-001, 30 Jul 65, subj: MAULER FVP Final Rept - 8 Dec 63 thru 28 May 65. (2) GD/P Rept CR-820-453-002, 31 Aug 65, subj: MAULER FVP Addendum to Final Rept - 1 Jun 65 thru 31 Aug 65. (3) MICOM Rept, 27 Jul 65, subj: Eval of the MAULER FVP as of 1 Jun 65. All in RSIC.

GLOSSARY OF ABBREVIATIONS

- A -

AA-------- Antiaircraft
AADS-70--- Army Air Defense System for the 1970's
AAGM------ Antiaircraft Guided Missile
ABMA------ Army Ballistic Missile Agency
Acft------ Aircraft
ACofS----- Assistant Chief of Staff
Act------- Acting
Actv(s)--- Activity, Activities
AD-------- Air Defense
Add------- Addendum
ADEX------ Air Defense Executive (Conference)
Admin----- Administration, Administrative
AEDG------ Army Equipment Development Guide
Aero------ Aeronautic, Aeronautical
AF-------- Air Force
AFB------- Air Force Base
Agcy------ Agency
Agrmt----- Agreement
AHMWG----- Ad Hoc Mixed Working Group
ALA-2----- Army Launching Area Number 2 (WSMR)
Alt------- Altitude
AMC------- Army Materiel Command
AMCTCM---- Army Materiel Command Technical Committee Minutes
AMRAFO---- Atlantic Missile Range Army Field Office
Anal------ Analysis
Anl------- Annual
Ant------- Antenna
AOMC------ Army Ordnance Missile Command
APE------- Advance Production Engineering
APG------- Aberdeen Proving Ground
App------- Appendix
Apprd----- Approved
Apprl----- Approval
AR-------- Army Regulation
ARADCOM--- Army Air Defense Command
ARD------- Army Readiness Date
ARGMA----- Army Rocket and Guided Missile Agency
ARO------- Army Research Office
Ars------- Arsenal
ASAP------ Army Scientific Advisory Panel
ASA (R&D)- Assistant Secretary of the Army (Research and Development)
Asgmt----- Assignment
ASPR------ Armed Services Procurement Regulation
Asst------ Assistant, Assistance

ATAC------ Army Tank-Automotive Command
Atch(d)--- Attach, Attached
Auth------ Authority
Awd------- Award

- B -

BCP------- Battery Command Post
Bd-------- Board
BG-------- Brigadier General
BHPD------ Birmingham Procurement District
Br-------- Branch
BRL------- Ballistics Research Laboratories
BRL/APG--- Ballistics Research Laboratories, Aberdeen Proving Ground
BTV------- Blast Test Vehicle
Bu-------- Bureau
Bx-------- Box

- C -

CAPT------ Captain
CBR------- Chemical, Bacteriological, & Radiological
Cbt------- Combat
CD-------- Current Data
CDC------- Combat Developments Command
CDCADA---- Combat Developments Command Air Defense Agency
CDCCAG---- Combat Developments Command Combined Arms Group
CDDP/CCC-- Canadian Department of Defence Production, Canadian Commercial Corporation
CDOG------ Combat Development Objectives Guide
CE-------- Corps of Engineers
CFP------- Congressional Fact Paper
CG-------- Commanding General
Chf------- Chief
Chmn------ Chairman
Ch(s)----- Change(s)
Cir------- Circular
Civ------- Civilian
Cl-------- Class
Cmdty----- Commodity
Cmt------- Comment
CNO------- Chief of Naval Operations
Cntn(r)--- Contain, Container
Co-------- Company
CO-------- Commanding Officer
CofEngrs-- Chief of Engineers
CofOrd---- Chief of Ordnance
CofS------ Chief of Staff
COL------- Colonel

Com-------	Committee
Comd------	Command
Comdr-----	Commander
Comdt-----	Commandant
Comp------	Component
Con-------	Control
CONARC----	Continental Army Command
Condg-----	Conditioning
Condl-----	Conditional
Condr-----	Conditioner
Conf------	Conference
Contr-----	Contract, Contractor
CONUS-----	Continental United States
Coord-----	Coordination
Corp------	Corporation
CPFF------	Cost-Plus-Fixed-Fee
CPIF------	Cost-Plus-Incentive-Fee
Cptv------	Captive
CRD-------	Chief of Research and Development
CRDL------	Chemical Research and Development Laboratories
CSigO-----	Chief Signal Officer
CTV-------	Control Test Vehicle
CW--------	Continuous Wave
CWSP------	Conditional Weapon System Plan
CY--------	Calendar Year

- D -

D&F-------	Determination and Findings
DA--------	Department of the Army
db--------	Decibel
DCG, ADS--	Deputy Commanding General, Air Defense Systems
DCG, GM---	Deputy Commanding General, Guided Missiles
DCR-------	Design Characteristics Review
DCRD------	Deputy Chief of Research and Development
DCSLOG----	Deputy Chief of Staff for Logistics
DDRE------	Director of Defense Research and Engineering
Dep-------	Deputy
Detm------	Determination
Dev-------	Development
DF--------	Disposition Form
DIB-------	Design Information Bulletin
Dir-------	Directive, Director, Directorate
Dist------	District
Distr-----	Distribution
Div-------	Division
Dlvr(y)---	Deliver, Delivery
DMZ-------	Demilitarized Zone
Docu------	Document

GLOSSARY OF ABBREVIATIONS (Cont)

DOD------- Department of Defense
DOD/NASA-- Department of Defense, National Aeronautics and Space Administration
DODRE----- Department of Defense Research and Engineering
DOFL------ Diamond Ordnance Fuze Laboratories
Dsgn------ Designation
Dspo------ Disposition

- E -

ECCM------ Electronic Counter-Countermeasures
ECI------- Engineering Concept Inspection
ECM------- Electronic Countermeasure
ECOM------ Electronics Command
ECR------- Engineering Concept Review
Ed-------- Editor
Eff(ns)--- Effective, Effectiveness
Elct------ Electronics
Elec------ Electric, Electrical
EMFU------ Engineering Model Fire Unit
Engr------ Engineer
Engrg----- Engineering
Enl------- Enlisted
Equip----- Equipment
ERDL------ Engineer Research and Development Laboratories
Estb------ Establish, Establishment
Eval------ Evaluation
Exec------ Execution

- F -

Fac------- Facility
FAAR------ Forward Area Alerting Radar
Fld------- Field
Flt------- Flight
FMC------- Food Machinery and Chemical Corporation
FM/CW----- Frequency Modulated/Continuous Wave
Fn-------- Footnote
Fr-------- From
Frag------ Fragment, Fragmentation
FS-------- Feasibility Study
Ft-------- Fort
FU-------- Fire Unit
FVP------- Feasibility Validation Program
Fwd(g)---- Forward, Forwarding
FY-------- Fiscal Year

- G -

GD/P------ General Dynamics/Pomona
Gen------- General

GLOSSARY OF ABBREVIATIONS (Cont)

GFE------- Government-Furnished Equipment
GIMRADA--- Geodesy Intelligence and Mapping Research and Development Agency
GM-------- Guided Missile
GO-------- General Order
Govt------ Government
Gp-------- Group
GS-------- General Staff
GTV------- Guidance Test Vehicle

- H -

HDL------- Harry Diamond Laboratories
HE-------- High Explosive
Hel------- Helicopter
HEL------- Human Engineering Laboratories
Hist------ History, Historical
HQ-------- Headquarters
Hr-------- Hour
Hv-------- Heavy

- I -

IBM------- International Business Machines Corporation
IFF------- Identification, Friend or Foe
Impln----- Implementation
Incl------ Inclosure
Ind------- Indorsement
Indus----- Industrial
Info------ Information
Inst------ Instrument
Instit---- Institute
Instl----- Installation
Intvw----- Interview
IR-------- Infrared
IRA------- Infrared Acquisition
IRMA------ Infrared MAULER

- J -

JCS------- Joint Chiefs of Staff

- K -

km-------- Kilometer

- L -

Lab(s)---- Laboratory, Laboratories
LAOD------ Los Angeles Ordnance District
LAPD------ Los Angeles Procurement District
lb(s)----- Pound(s)
LBS------- Launch Blast Simulator

GLOSSARY OF ABBREVIATIONS (Cont)

Lmt(n)---- Limit, Limitation
Ln-------- Liaison
LOC------- Launch Order Computer
Log------- Logistics
Lt-------- Light
LTC------- Lieutenant Colonel
Ltd------- Limited
LTG------- Lieutenant General
Ltr------- Letter
LTV------- Launch Test Vehicle
Ltwt------ Lightweight

- M -

Maint----- Maintenance
MAJ------- Major
Mat------- Material, Materiel
Mbr------- Member
Mbrshp---- Membership
MCG------- Materiel Coordination Group
MC's------ Military Characteristics
Memo------ Memorandum
MFR------- Memorandum for Record
MG-------- Major General
Mgr------- Manager
Mgt------- Management
MICOM----- Missile Command
Mil------- Military
Min------- Minutes
Misc------ Miscellaneous
mm-------- Millimeter
MOCOM----- Mobility Command
MPCF------ MAULER Project Case Files
mph------- Miles per Hour
MSAMS----- Mobile Surface-to-Air Missile Systems
Msl------- Missile
Msn------- Mission
MSP------- Missile System Plan
MTE------- Multisystem Test Equipment
Mtg------- Meeting
Mtr------- Motor
MUCOM----- Munitions Command

- N -

NASA------ National Aeronautics and Space Administration
NATO------ North Atlantic Treaty Organization
Nav------- Naval
n.d.------ No Date
No.------- Number

GLOSSARY OF ABBREVIATIONS (Cont)

NOTS------	Naval Ordnance Test Station
n.s.------	No Subject
NTDC------	Naval Training Device Center
NYPD------	New York Procurement District

- O -

OASD------	Office of the Assistant Secretary of Defense
OCE-------	Office, Chief of Engineers
OCO-------	Office, Chief of Ordnance
OCofS-----	Office, Chief of Staff
OCRD------	Office, Chief of Research and Development
OCTI------	Ordnance Corps Technical Instruction
ODDRE-----	Office, Director of Defense Research & Engineering
Ofc-------	Office
Off-------	Officer
OMA-------	Operations and Maintenance, Army
Op--------	Operation, Operational, Operator
Ord-------	Ordnance
OrdCorps--	Ordnance Corps
Org-------	Organization, Organizational
OSD-------	Office of the Secretary of Defense
OSRD------	Ordnance Support Readiness Date
OSWAC-----	Ordnance Special Weapons-Ammunition Command
OTAC------	Ordnance Tank-Automotive Command
OTC-------	Ordnance Technical Committee
OTCM------	Ordnance Technical Committee Minutes
OVE-------	On-Vehicle Equipment
OVM-------	On-Vehicle Material

- P -

P&P-------	Procurement and Production
P&PD------	Procurement and Production Directorate
PA--------	Picatinny Arsenal
Part------	Participate, Participation
PCP-------	Program Change Proposal
Pd--------	Period
Pdn-------	Production
PEMA------	Procurement of Equipment and Missiles, Army
PEMA/S----	Procurement of Equipment and Missiles, Army, in Support of Research and Development
Perf------	Performance
Pers------	Personnel
PERT------	Program Evaluation and Review Technique
PHPD------	Philadelphia Procurement District
Plcy------	Policy
Plng------	Planning
PM--------	Project Manager
PM$_2$P------	Project Management Master Plan

PMRAFO---- Pacific Missile Range Army Field Office
PMSO------ Project Management Staff Officer
Pos------- Position
Ppsd------ Proposed
Ppsl------ Proposal
Prcht----- Parachute
Presn----- Presentation
PRF------- Pulse Repetition Frequency
Proc------ Procurement
Prof------ Professor
Prog------ Progress
Proj------ Project
PSAC------ President's Scientific Advisory Committee

- Q -

QMC------- Quartermaster Corps
QMR------- Qualitative Materiel Requirement

- R -

R&D------- Research and Development
R&DD------ Research and Development Directorate
R&DO------ Research and Development Operations
RCA------- Radio Corporation of America
RCS------- Reports Control Symbol
RDTE------ Research, Development, Test, and Evaluation
RDTEA----- Research, Development, Test, and Evaluation, Army
RE-------- Research and Engineering
Reasg----- Reassign
Reasgd---- Reassigned
Reasgmt--- Reassignment
Recm(n)--- Recommend, Recommendation
Recov----- Recover, Recovery
Reg------- Regulation
Rel------- Release
Rep------- Representative
Rept------ Report
Req------- Request
Rev------- Review
RF-------- Radio Frequency
RF-IR----- Radio Frequency - Infrared
RHA------- Records Holding Area
Rkt------- Rocket
ROTCM----- Reserve Officers' Training Corps Manual
Rqrmt----- Requirement
RSA------- Redstone Arsenal
Rsch------ Research
RSIC------ Redstone Scientific Information Center
Rspv------ Respective, Respectively

GLOSSARY OF ABBREVIATIONS (Cont)

RTV------- Reacquisition Test Vehicle

- S -

SA-------- Secretary of the Army
SAM------- Surface-to-Air Missile
SAM-D----- Surface-to-Air Missile, Development
SB-------- Selection Board
Scd------- Schedule
SCR------- Senior Command Representative
SDR------- Specific Development Requirement
Sec------- Section
SECDEF---- Secretary of Defense
Secy------ Secretary
SFPD------ San Francisco Procurement District
SHAPE----- Supreme Headquarters, Allied Powers, Europe
Sig------- Signal
SigC------ Signal Corps
SLPD------ St. Louis Procurement District
Smanl----- Semiannual
SO-------- Special Order
SOR------- Specific Operational Requirement
SP-------- Self-Propelled
Sp-------- Special
Spec------ Specification
Spt------- Support
SS-------- Summary Sheet
SSG------- Staff Sergeant
Stdzn----- Standardization
STRAP----- Stable Reference and Position
STV------- Special Test Vehicle
Subj------ Subject
Subpara--- Subparagraph
Sum------- Summary
Suppl----- Supplement
Sur------- Surface
Svc------- Service
SXR------- Senior ARGMA Representative
Sys------- System

- T -

TADS------ Tactical Air Defense System
TAG------- The Adjutant General
TBM------- Tactical Ballistic Missile
TD-------- Table of Distribution
TDP------- Technical Development Plan
TDY------- Temporary Duty
TEC------- Track Evaluation Computer
Tech------ Technical

GLOSSARY OF ABBREVIATIONS (Cont)

TECOM-----	Test and Evaluation Command
Tel-------	Telephone
Tgt-------	Target
T-I ------	Tracker-Illuminator
TIR-------	Technical Information Report
TM--------	Technical Manual
Tng-------	Training
TR--------	Technical Requirements
Trans-----	Transport, Transportation
Trf-------	Transfer
TSPO------	Tactical Systems Project Office
TT--------	Teletype
TTV-------	Tracking Test Vehicle

- U -

U.K.------	United Kingdom
Univ------	Universal, University
U.S.------	United States
USA-------	United States Army
USAADS----	United States Army Air Defense School
USACDC----	United States Army Combat Developments Command
USACDCADA-	United States Army Combat Developments Command Air Defense Agency
USACDCCAG-	United States Army Combat Developments Command Combined Arms Group
USAECOM---	United States Army Electronics Command
USAERDA---	United States Army Electronics Research and Development Agency
USAERDL---	United States Army Engineer Research and Development Laboratories
USAF------	United States Air Force
USAMC-----	United States Army Materiel Command
USAMICOM--	United States Army Missile Command
USAOMC----	United States Army Ordnance Missile Command
USARADBD--	United States Army Air Defense Board
USARADCOM-	United States Army Air Defense Command
USASMSA---	United States Army Signal Missile Support Agency
USASRDL---	United States Army Signal Research and Development Laboratory
USATECOM--	United States Army Test and Evaluation Command
USAWECOM--	United States Army Weapons Command
USCONARC--	United States Continental Army Command
USMC------	United States Marine Corps
USN-------	United States Navy
USRO------	United States Mission to NATO and European Regional Organizations

GLOSSARY OF ABBREVIATIONS (Cont)

- V -

Veh------- Vehicle
VCofS----- Vice Chief of Staff
VIP------- Very Important Person
Vol------- Volume

- W -

WD-------- War Department
WECo------ Western Electric Company
Whd------- Warhead
Wpn------- Weapon
WSMR------ White Sands Missile Range
WSPG------ White Sands Proving Ground
Wt-------- Weight

- X -

Xmitl----- Transmittal
XO-------- Executive Office(r)

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GLOSSARY OF TECHNICAL TERMS

ACQUISITION—See TARGET ACQUISITION.

AERODYNAMIC MISSILE—A missile which uses aerodynamic forces to maintain its flight path, generally employing propulsion guidance. Also see BALLISTIC MISSILE, GUIDED MISSILE.

AERODYNAMICS—That field of dynamics which treats of the motion of air and other gaseous fluids and of the forces acting on solids in motion relative to such fluids.

AIDED TRACKING MECHANISM—A device consisting of a motor and variable drive which provides a means of setting a desired tracking rate into a director, or other fire control instrument, so that the process of tracking is carried out automatically at the set rate until it is changed manually.

AIRFRAME—The assembled principal structural components, less propulsion system, control, electronic equipments, and payload of a missile.

ANTENNA—A device (i.e., conductor, horn, dipole) for transmitting or receiving radio waves, exclusive of the means of connecting its main portion with the transmitting or receiving apparatus.

ATTENUATION—Decrease in intensity of a signal, beam or wave as a result of absorption of energy and of scattering out of the path of a detector, but not including the reduction due to geometric spreading.

BALLISTIC MISSILE—Any missile which does not rely upon aerodynamic surfaces to produce lift and consequently follows a ballistic trajectory when thrust is terminated. See also AERODYNAMIC MISSILE, GUIDED MISSILE.

BALLISTICS—The science or art that deals with motion, behavior, appearance or modification of missiles or other vehicles acted upon by propellants, wind, gravity, temperature, or any other modifying substance, condition or force.

BALLISTIC TRAJECTORY—The trajectory traced after the propulsive force is terminated and the body is acted upon only by gravity and aerodynamic drag.

BAND, FREQUENCY—In communications and electronics, a continuous range of frequencies extending between two limiting frequencies.

BANDWIDTH—The difference in frequencies between the lowest and highest frequency parameters of a circuit, such as tuned circuit, modulated radio signal, servo-mechanism, or radio station channel assignment.

CLUTTER, RADAR—Visual evidence on the radar indicator screen of sea return, or ground return, which if not of particular interest, tends to obscure the target indication. See also FIXED ECHO, SUBCLUTTER VISIBILITY.

CONTROL, PROPORTIONAL—Control in which the action to correct an error is made proportional to that error.

CONTROL SYSTEM (MISSILE)—A system that serves to maintain attitude stability and to correct deflections. See also GUIDANCE SYSTEM (MISSILE).

COUNTERMEASURES—That form of military science which, by the employment of devices and/or techniques, has as it objective the impairment of the operational effectiveness of enemy activity. See also ELECTRONIC COUNTERMEASURES.

DAMPING—The effect of friction or its equivalent in reducing oscillation of a system.

DISH, RADAR—The parabolic reflector which is part of certain radar antennas.

DOPPLER EFFECT—The apparent change in frequency of a sound or radio wave reaching an observer or a radio receiver, caused by a change in distance or range between the source and the observer or the receiver during the interval of reception.

DRAG—That component of the total air forces on a body, in excess of the forces owing to static pressure of the atmosphere, and parallel to the relative gas stream but opposing the direction of motion.

ELECTRONIC COUNTER-COUNTERMEASURES—That major subdivision of electronic warfare involving actions taken to insure our own effective use of electromagnetic radiations despite the enemy's use of countermeasures.

ELECTRONIC COUNTERMEASURES—That major subdivision of electronic warfare involving actions taken to prevent or reduce the effectiveness of enemy equipment and tactics employing or affected by electromagnetic radiations and to exploit the enemy's use of such radiations.

FIXED ECHO—A radar echo that is caused by reflection from a fixed object such as a terrain form or building visible to the radar set. See also CLUTTER, RADAR; SUBCLUTTER VISIBILITY.

GUIDANCE—The entire process by which target intelligence information received by a guided missile is used to effect proper flight control to cause timely direction changes for effective interception.

GUIDANCE, HOMING—A system in which a missile steers toward a target by means of radiation which the missile receives from the target, either by reflection (radar or visible light) or by emission from the target (infrared or acoustic energy).

GUIDANCE, HOMING, ACTIVE—A form of guidance wherein both the source for illuminating the target and the receiver are carried within the missile.

GUIDANCE, HOMING, PASSIVE—A system of homing guidance wherein the receiver in the missile uses natural radiations from the target.

GUIDANCE, HOMING, SEMIACTIVE—A system wherein the receiver in the missile uses radiations from the target which has been illuminated from a source other than in the missile.

GUIDANCE SYSTEM (MISSILE)—A system which evaluates flight information, correlates it with target data, determines the desired flight path of the missile, and communicates the necessary commands to the missile flight control system. See also CONTROL SYSTEM (MISSILE).

GUIDED MISSILE—An unmanned vehicle moving above the surface of the earth, whose trajectory or flight path is capable of being altered by an external or internal mechanism. See also AERODYNAMIC MISSILE, BALLISTIC MISSILE.

IDENTIFICATION, FRIEND OR FOE (IFF)—A system using radar transmission to which equipment carried by friendly forces automatically responds, for example by emitting pulses, thereby distinguishing themselves from enemy forces. It is the primary method of determining the friendly or unfriendly character of aircraft and ships by other aircraft or ships and by ground forces employing radar detection equipment and associated IFF units.

ILLUMINATOR RADAR—An integral part of a guided missile weapon system used to track and illuminate the target. The illuminating energy is reflected by the target, detected by the missile, and used by the missile in homing on the target. In ACTIVE HOMING GUIDANCE system, the illuminator radar is on board the missile, whereas in the SEMIACTIVE HOMING system this radar may be aboard a ship, an aircraft, or on land.

KILL PROBABILITY—A measure of the probability of destroying a target. Also see SINGLE SHOT HIT PROBABILITY; SINGLE SHOT KILL PROBABILITY.

LOBE—One of the three-dimensional portions of the radiation pattern of a directional antenna.

MACH NUMBER—The ratio of the velocity of a body to that of sound in the surrounding medium.

PITCH—An angular displacement about an axis parallel to the lateral axis of an airframe.

PLAN POSITION INDICATOR—Radar oscilloscope on which the sweep is a radius of the tube face and moves through 360 degrees, giving a plan view or map-like representation of the area scanned by the radar beam. Azimuth is given by the direction of the radial sweep line, and range by distance of the signal from the center of the screen.

PULSE—A single disturbance of definite amplitude and time length, propagated as a wave or electric current.

RADAR—Radio detection and ranging equipment that determines the distance and usually the direction of objects by transmission and return of electromagnetic energy.

RADAR CLUTTER—See CLUTTER, RADAR.

RADAR DISCRIMINATION—The ability to distinguish separately on a radar scope several objects which are in close proximity to each other.

RADAR DISH—See DISH, RADAR.

ROLL—An angular displacement about an axis parallel to the longitudinal axis of an airframe.

SEEKER, TARGET—A receiving device on a missile that receives signals emitted from or reflected off the target that is used in guiding on the target.

SINGLE SHOT HIT PROBABILITY—Probability that a single projectile fired against a target will hit that target under a given set of conditions, regardless of whether or not the target is defeated or destroyed by the single hit.

SINGLE SHOT KILL PROBABILITY—The probability that a single projectile fired at a target will destroy or effectively disable that target. Also see KILL PROBABILITY.

SUBCLUTTER VISIBILITY (RADAR)—The ability to detect moving targets submerged in a background of echoes from terrain or other reflecting objects. Also see CLUTTER, RADAR; FIXED ECHO.

TARGET ACQUISITION—The detection, identification, and location of a target in sufficient detail to permit the effective employment of weapons. Also, the process of positioning the tracking apparatus of a weapon system so that a designated target is tracked.

TARGET ANALYSIS—An examination of potential targets to determine military importance, priority of attack, and weapons required to obtain a desired level of damage or casualties.

TARGET DISCRIMINATION—The ability of a guidance system to lock onto and subsequently home on any one target when multiple targets are present.

TARGET TRACKING RADAR—A precision tracking radar which is an integral part of a weapon system and is used to track the target. This radar serves to illuminate the target in a missile system which uses SEMIACTIVE HOMING GUIDANCE.

TELEMETERING SYSTEM—The complete measuring, transmitting, and receiving apparatus for remotely indicating, recording, and/or integrating information.

THEODOLITE—An optical instrument for measuring horizontal and vertical angles with precision.

TRACKING RADAR—See TARGET TRACKING RADAR.

YAW—An angular displacement about an axis parallel to the "normal" axis of an aircraft.

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