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PREFACE

The following 82 pages contain high points of Army Ordnance satellite history, beginning with scientists Hermann Oberth and Robert Goddard after World War I. Still to be written is a detailed, technical account. However, a long and helpful step in this direction is this history's contemporary, called Explorers In Orbit, a technically oriented study prepared by Vitro Engineering Company for the Army Ballistic Missile Agency. The Development Operations Division, ABMA, as well as the ABMA Historical Section have copies of this Vitro Study on file.

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The Army's satellite program really began with the fiction-like story of Professor Hermann Oberth, "father of astronautics."[1] Born in Hermannstadt, Transylvania, in 1894, this soft spoken and mild mannered theorist entered the University of Munich in 1913. A Jules Verne fan all his life, Oberth wrote his doctorate thesis on space travel; to judge his reception one can imagine a doctorate student of today writing a thesis on flying through the air with superman wings. His thesis failed, though later published in German it proved a sell-out in first and second edition.[2] Crammed with formulas, the book's popularity suggests that German scientific temperament was already attuned toward space travel.

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1. Citation of the American Rocket Society to Prof. Oberth in 1956, said: "The intellectual forces set in motion by Prof. Oberth are largely responsible for the present high state of rocketry, missile technology, and astronautical research." Occasion was the presentation to Prof. Oberth of the G. Edward Pendray Award, now in possession of Prof. Oberth.
2. <u>Die Rakete zu den Planetenräumen</u> (<u>The Rocket Into Interplanetary Space</u>), Munich, 1923. Interviewed for this monograph in Sept. 1958, Prof. Oberth looked up busily from his drawing pencils and board at the Army Ballistic Missile Agency in Huntsville, explaining in broken English how some Agency employee had borrowed and lost his only copy.

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In America, while Professor Oberth in Germany emphasized space travel, scientist Robert H. Goddard emphasized rockets, or the means of getting into space. Oberth was a dreamer, a theorist, who early talked of satellite stations; Goddard was more immediately practical, interested in rockets, the means of getting there. Oberth's book begins with vehicles "that will not fall back to earth; furthermore, they will even be able to leave the zone of terrestrial attraction."[3] Dr. Goddard took out patents and wrote mainly for scientific journals; his early work began with a search for "a theory of rocket action" which would raise "recording apparatus beyond the range for sounding balloons..."[4] Goddard published little concerning space travel itself, at one point filing such things in a friend's safe, marking them: "To be opened only by an optimist."[5]

The foreword of a later Goddard book said: "There is evidence that the German rocket engines followed Dr. Goddard's work very closely from the time of publication of his first Smithsonian report in 1919 until his

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3. Ibid., Introduction.
4. Robert H. Goddard, Method of Reaching Extreme Altitudes, Washington, D. C. (Published by Smithsonian Institute), p. 1.
5. Ralph E. Jennings, "Father of Rocketry," Space Journal, Vol. I, No. 2, Spring 1958, p. 6.

REGRADED Unclassified BY AUTHORITY OF Security Classification Comm. S. M. [illegible] 13 Feb. 1959 ON 13 March 19 death."[6] However, ABMA German scientists say this idea is erroneous, that "there was not a Goddard publication in the library at Peenemünde," or, if there was, "no one seemed to consider it."[7] German missile success was due almost entirely to German scientific temperament."[8] Prof. Oberth disclaims the Goddard influence. His 1923 book referred to Goddard because he "had recently read of him in newspapers and I wanted to know that others experimented with space travel. We disagreed on propulsion systems, Dr. Goddard minimizing liquid propulsion for space travel."[9 & 10]

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6. Robert H. Goddard, <u>Rocket Development</u>, New York, 1948, Foreword by Harry F. Guggenheim, p. xi.
7. "I heard only of Dr. Goddard after coming here (to the U. S.)," says Mr. Eberhard Rees, who worked directly under von Braun at Peenemünde, and later as his deputy at ABMA. "But I did hear much of Oberth." Interview at ABMA, 19 Sept. 1958.
8. Interview with Mr. Helmut Hoeppner, Assistant to Prof. Oberth, ABMA Research Projects Laboratory, 16 Sept. 1958.
9. Interview with Prof. Oberth, 16 Sept. 1958.
10. A somewhat poor translation of an Oberth letter to Goddard appeared in <u>An Introduction To Guided Missiles</u>, published by the Antiaircraft Artillery and Guided Missile School, Fort Bliss, Texas, Apr. 1953, p. 11. Here it is in part:
"Dear Sir:
Already many years I work at the problem to pass over the atmosphere of our earth by means of a rocket. When I was now publishing the result of my examinations and calculations, I learned by the newspaper, that I am not alone in my inquiries and that you, dear Sir, have already done much important works at this sphere. In spite of my efforts, I did not succeed in getting your books about this object. Therefore, I beg you, dear

Later, the German "Society for Space Travel," of which Oberth was an early member, requested scientific information from Dr. Goddard but was refused.[11]

In general there was little space information exchanged between countries prior to the end of World War II. There were a few people in a few countries who had the Jules Verne vision and began experimenting. But these, except in Germany, worked in solitude, sometimes even secrecy. Not until 1926 or 1927[12] did Prof. Oberth hear of Russia's Ziolkovsky, who a quarter century earlier used liquid fuels on the same premise as Oberth, "because of their higher exhaust velocities." But where most scientists worked alone, in Germany they formed a rocket society. ABMA German scientists emphatically deny that such indications of missile emphasis stemmed from a Versailles Treaty loophole allowing them to practice on guided missiles. Before

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Sir, to let them have me. At once after coming out of my work I will be honored to send it to you, for I think that only by common work of the scholars of all nations can be solved this great problem.

Yours very truly
Hermann Oberth,
Student Math. Heidelberg"

This letter was written early in 1922. In May or June 1922, Oberth received a copy of Goddard's 1919 report directly from the author.

11. Willy Ley, Rockets, Missiles, and Space Travel, New York 1951, p. 133.
12. Interview with Prof. Oberth, 16 Sept. 1958.

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Peenemünde there seems to have been a spirit of space travel rather than guided missile work. Their pre-World War II writings emphasize space travel concepts. Even today, though under Army supervision as at Peenemünde, German scientists contend with such charges. Outsiders, including other services, sometimes call them "space theorists" rather than "missile makers," or "hand tooling theorists," implying an ABMA interest in design rather than production.[13] After SPUTNIK, understandably, such charges lessened. Even this monograph reveals that the Army now builds satellites. But before SPUTNIK I ABMA had no satellite mission.[14] As in Germany during Peenemünde, scientists might yearn for space but groceries came with "missile money." The Army Ordnance Missile Command, organized seven months after SPUTNIK I, wrote the first general mission directive allowing ABMA a satellite venture, even though several EXPLORER's orbited previously on special orders.[15]

Laymen in 1923 greeted Oberth's book more favorably than did scientists, who for the most part ignored or belittl it. There was no "recoil in space" some said, and anyway, "the most powerful explosive known could not even lift its

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13. The writer heard this charge several times at the Evaluation Staff, Air War College, Maxwell, AFB.
14. Ord. Corps Order No. 3-56, 19 Jan. 1956, Hist. Off. files.
15. See Ord. Corps Order No. 16-58, 1 July 1958, Hist. Off. files.

own weight to a greater height than about 400 kilometers (250 miles)." They derided Oberth's gasoline propulsion, unknowing that its exhaust velocity was higher than any high explosive.[16] Another early Oberth idea was a solar mirror orbiting the earth. Such a mirror would change local climates, create or prevent storms, and "in case of war, burn cities, explode ammunition plants, and do damage to the enemy generally."[17] Today Oberth knows of little backing for this mirror idea but maintains it's an even more valid concept. "Since I first described the giant mirror in 1923," he writes, in Man Into Space," much has been said and written about it--some of it right but most of it wrong.... I am certain that my space ship will one day be a reality. The critics object to its size...60 miles in diameter with an area of 70,000 sq. km (27,000 sq. miles) ...."[18] But Oberth explains that mirrors as large as this need not be built at first--only later.

Oberth's 1957 book contains less spectacular ideas but none show his early satellite interest as the "mirror in space."

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16. Willy Ley, Rockets, Missiles, and Space Travel, pp. 110-112.
17. Ibid., p. 338. Also, Hermann Oberth, Man Into Space, New York, 1957, pp. 110-112. Originally published in Germany in 1954.
18. Hermann Oberth, Man Into Space, pp. 97 and 98.

Meanwhile, Russia as early as 1882 was flexing "space muscles." In that year Fedor Kibaltschitsch, revolutionary, murdered Czar Alexander, and Kibaltschitsch's last request before execution was that a committee of scientists, technicians, and military people study his "rocket aircraft plans." The committee put its findings in a secret document, not opened until after the revolution of 1917, which revealed the committee's agreement with Kibaltschitsch that "reaction motors were the only way for achieving high velocities for space travel."[19] However, the committee had also decided that the present state of the art did not permit actual realization of Kibaltschitsch's plans.

In 1895 a small booklet by A. P. Feodoroff appeared in St. Petersburg, and its vague description of a reaction-propelled aircraft inspired the Russian scientist K. E. Ziolkowsky to study rocketry and space travel. Ziolkowsky, perhaps father of rocketry in Russia, in 1895 published his first scientific studies on rocketry and space travel, calling them <u>Dreams Of The Earth And The Sky</u>.[20] The articles

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19. Excerpts from A. B. Scherschevsky, <u>Die Rakete fuer Fahrt und Flug</u>, Berlin-Charlottenburg 2 1929, Hist. Off. files, translated in Sept. 1958 by Mrs. Friedrich Saurma, ABMA.
20. Ziolkowsky antedated Oberth and Goddard, but at first had little impact. "After Germany's rocket success," Oberth says, "the Russian people remembered how great

emphasized centrifugal acceleration and high velocities to counteract gravity. In 1903 the Russian magazine <u>Science Survey</u> printed his article "A Rocket into the Cosmic Space," in which he submitted the results of his first exploratory work on space ships. The article suggested the use of liquid fuel rockets and control by jet vanes.

In 1911 the bulletin of the Technical University of Leningrad <u>Wosduschny Put</u>, Vol. II, published plans by A. Gorochof for a so-called reaction airplane using crude oil and compressed air to fuel. At the same time Friedrich Arthurowitsch Zander in Moscow began work on a winged space ship.

In April 1925 the Military Air Academy in Moscow established a Central Committee to study rocketry in co-operation with the Aero-Hydrodynamic Institute.[21]

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was Ziolkowsky. That he was. In the foreword of his book published in 1924 it was said: 'Why must we learn from another country what began in our own, concerning information which died and was forgotten by lack of Russian interest.'" Interview with Prof. Oberth, 24 Oct. 1958.

21. Professor W. P. Wetschinkin headed this Institute and membership included M. J. Lapirof-Skoblo, K. E. Ziolkowsky, Tschigitar Zagut, N. A. Rynin, D. N. Seyliger, F. A. Zander, A. Gorochof, A. A. Kotenlnikof, and A. L. Tschischevsky. The objective of the committee was coordination of research work in Russia and foreign countries, promoting independent research work, publicity, and studies of military application. The Institute held a contest for the best design of a rocket with a range of 100 kilometers at about the same time that an Interplanetary Society began in Moscow.

Following Ziolkowsky, Goddard, and Oberth publications, the world began to look toward space. About 1926, after a reprinting of Ziolkowsky articles, a "space travel society" formed in Moscow, significant mainly because of its spectacular name: "World Center of All Inventors and Scientists." But in June 1927 a professional space society formed in Germany, Verein für Raumschiffahrt (Society for Space Travel), known as VfR, and Oberth accepted an invitation to join.[22]

Prior to Peenemünde German rocket development centered mainly in VfR, the other major interest being Oberth's second book, *Wege zur Raumschiffahrt*.[23] More explanatory than the 1923 book, this one also added an important last chapter: "The Electric Space Ship;" it was history's first scientific treatise on electric spatial propulsion, or use of similar type charges (either + or -) to recoil from each other and thus cause movement.[24] In a 1958 article prepared for the *Army Information Digest* Prof. Oberth advocated just this type propulsion for a space ship between an earth satellite and a landing craft to Mars.[25]

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22. Willy Ley, *Rockets, Missiles, and Space Travel*, pp. 116-117.
23. Hermann Oberth, *Wege zur Raumschiffahrt*, Munich, 1929.
24. Interview, 18 Sept. 1958, with Oberth and Hoeppner.
25. "Beyond Gravity," *Army Information Digest*, Oct. 1958, pp. 29-30.

Besides Oberth's book in 1929 a film company whetted German space-mindedness with the movie "Frau im Mond" (Girl in the Moon). Oberth was the picture's scientific advisor, but time and resources prevented a rocket launching to publicize the film's premiere. On the brighter side Oberth in 1929 became President of the German Space Society VfR, with its 870 members.[26]

Oberth met von Braun in 1930, through the kind offices of Willy Ley. "Oberth's assistants included myself," writes Dr. von Braun, "Rudolph Nebel and Klaus Riedel. Nebel was later to direct the Raketenflugplatz (rocket airdrome) while Riedel was to be in charge of testing at Peenemünde."[27]

Young von Braun, also busy with "my student engineering work at a Berlin locomotive shop," joined VfR and helped Oberth produce "the first appearance in Germany of the liquid fuel rocket motor as a full-fledged, officially recognized and attested member of the family of internal combustion engines."[28] This in August, 1930.

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26. Willy Ley, Rockets, Missiles, and Space Travel, p. 131.
27. Kenneth W. Gatland, Project Satellite, NYC, 1958, "From Small Beginnings," by Dr. Wernher von Braun, Ch. I, p. 20.
28. Dr. Wernher von Braun, Ibid., pp. 20-21.

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Shortly afterwards, money difficulties forced Oberth to resume a teaching job in Rumania, but his students continued space research projects.

Outside Berlin, City Fathers allowed free use of 300 acres, a former ammunitions area. As their finances dropped, their space-earnestness rose. Von Braun's friend, Rudolph Nebel, at one point talked a concern into giving them welding wire, because of immediacy of space travel. They then offered it to a welding shop, in exchange for a human welder, which they needed. Similar improvising was common.

Yet the donors demanded results and the young scientists had yet to get a rocket into the air. Renewed action resulted in a firing attempt in October 1931, onlookers paying a mark each but saw only a rocket limp halfway up its launcher and sink peacefully into position again. The "spectators retired in some doubt as to whether the admission fee should be returned." But "within a few weeks, launchings became commonplace. The pencil-shaped rocket...would slide smoothly out of the launcher rails and climb to 1,000 or 1,280 feet. Then a small parachute would emerge from the tail."[29] Leaping from a motor car the scientists would grab the rocket, like a football, before

29. Ibid., p. 24.

it hit the ground. Thus, cars chased rockets, powered by similar propulsion systems, except that rockets carried their oxygen as well as their gasoline.

Historically famous Peenemünde actually began with the spring of 1932. Though the young rocket scientists might be disinterested in Versailles Treaty loopholes, the German Ordnance Department was not. To meet the German scientists came three Ordnance Department representatives, dressed as civilians. These were "Colonel Professor Karl Becker, Chief of Ballistics and Ammunition, the Colonel's ammunition expert Major von Horstig, and Captain...Walter Dornberger in charge of powder rockets for the Army."[30] The visitors concentrated on "thrust balance (data) during

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30. Here is an interesting account of this meeting, written by Daniel Lang for the <u>New Yorker Magazine</u>, 21 Apr. 1951, p. 83, following an interview with Dr. von Braun.

"One day in the spring of 1932, a black sedan drew up at the edge of the Raketenflugplatz and three passengers got out to watch a rocket launching. 'They were in mufti, but mufti or not, it was the Army,' von Braun said to me. 'That was the beginning. The Versailles Treaty hadn't placed any restrictions on rockets, and the Army was desperate to get back on its feet. We didn't care much about that, one way or the other, but we needed money, and the Army seemed willing to help us. In 1932, the idea of war seemed to us an absurdity. The Nazis weren't yet in power. We felt no moral scruples about the possible future abuse of our brain child. We were interested solely in exploring outer space. It was simply a question with us of how the golden cow could be milked most static firing and on such meagre diagrams as we could lay before them.... Great was our satisfaction when Nebel signed with them a contract for the sum of 1,000 marks, contingent upon a successful firing of MIRAK II, at the Army Proving Grounds of Kummersdorf."[31]

A subsequent launching in July 1932 sent MIRAK II up only 200 feet, and to Ordnance experts it appeared too unpredicatable for meeting their long-range weapon needs. After many unsuccessful visits by Nebel, von Braun called upon Colonel Becker.

Becker at last agreed to limited support of the missile project, if the work would be done away from public view, under Army supervision. Need for funds overcame reluctance to Army authority and so the scientists agreed, choosing von Braun to represent them as a civilian employee at the Army rocket section.[32] Using a somewhat modern

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successfully.' After the appearance of the black sedan, the golden cow supplied the members of the Verein fur Raumschiffahrt generously with equipment, proving grounds, and skilled workmen."

31. Dr. Wernher von Braun, "From Small Beginnings," op. cit., p. 24.

32. The Air Force Historian on the proving grounds during the CROSSBOW experiments wrote this for Atlantic Monthly in 1951:

"When Dornberger assumed command of the German Army's new experimental station at Kummersdorf, early in 1931, he was instructed by General Becker to offer three alternatives to key members of the Spaceship inventor's concept of "sub-contracting for as many parts as possible,"the rocketeers in December 1934 succeeded in launching two A-2's to a height of 1½ miles. The military was pleased, purse strings loosened, and many good and bad tests of the A-3, A-4, and A-5 resulted.

Meanwhile, Hitler rose in Germany, and Hitler favored the Luftwaffe. The Luftwaffe, in turn, visited the Army's rocket works, ordering a rocket engine developed for the Heinkel 112. First static tests, in the summer of 1935, amazed and pleased the Luftwaffe; immediate work began on an all-rocket fighter. The Luftwaffe also suggested a jet-assisted takeoff device for heavy bombers, and offered five million marks for increasing the building facilities and the complement of only 80 people. But the Army countered

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Travel Club. They could turn over rocket patents and cease work; they could be jailed; if good enough, they could be absorbed into the Army's rocket program." Von Braun accepted the latter.

"The hardheaded captain and the blue-eyed wonder-boy became, with the help of capable and loyal assistants, not only the true progenitors of the ideal long-range weapon but, in all likelihood, the actual forerunners of 'the journey into space.' Their work on the V-2 will stand for all time as one of the twentieth century's greatest technical and scientific contributions." -- Joseph Warner Angell, "Guided Missiles Could Have Won," Atlantic Monthly, Dec. 1951, Part I, p. 11.

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by appropriating eleven million marks for the rocketeers to "stay Army."[33] "In this manner our modest efforts, whose yearly budget had never exceeded 80,000 marks, emerged into what the Americans call the 'big time.' Thenceforth million after million flowed in as we needed it."[34] Von Braun's parents helped in this search for larger accommodations, suggesting the Peenemünde area. In April 1937 an amazed and gratified group of rocketeers transferred into the large installation.

At Peenemünde there developed propulsion, personnel, and publicity subsequently valuable to the U. S. Army's satellite program. Peenemünde included the German Air

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33. Most sources agree that from this point, to the end of World War II, funds poured into this rocket project. Hitler's role in this whole thing, however, is nebulous, and would require a great amount of research to clarify. No two scientists at ABMA agree concerning him, though he was much in the forefront even at Peenemünde. In publications, they consistently regard him with dis-favor. In private, they seem to regard him as considerably more practical than generally thought. At any rate, Hitler was a Peenemünde enthusiast from 1942 on, and before that he caused no serious curtailment there. For different interpretations of Hitler's interest in rockets, read: Joseph W. Angell, "Guided Missiles Could Have Won," Atlantic Monthly, Dec. 1951, p. 10-12; Kenneth W. Gatland, Project Satellite, pp. 40-42; Daniel Lang, "A Reporter At Large," The New Yorker, Apr. 21, 1951, p. 83; and Walter Dornberger, V-2, New York 1954, pp. 98-108.
34. Dr. Wernher von Braun, "From Small Beginnings," op. cit., p. 32.

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Force (Luftwaffe) and the Army (Wehrmacht); the V-1 "buzz-bomb" and the V-2 rocket originated there. In each case the "V" stood for Vergeltungswaffe, Vengeance Weapon, a popular designation suggested by the Ministry of Propaganda. The V-2 rocket, identified as the A-4, was equivalent to the "M" numbers of the standard ordnance terms; it became famous after the Luftwaffe failed to subdue Great Britain and the Wehrmacht stood stymied at the gates of Stalingrad and Moscow. Then Hitler "became desperate and ordered an all out effort in the development of the A-4."[35]

After the successful A-4 launchings that began at Peenemünde in October 1942, the British Intelligence Service became interested, this as early as May 1943. In August 1943 the Royal Air Force launched a large scale raid, Peenemünde suffering 815 casualties. The raid destroyed the test stands and assembly hangers; yet mass production of A-4's began in October 1943 only one month after Hitler's deadline of 1 September. Also in 1943 a Peenemünde Planning Committee decided to establish three plants: a Southern Plant to be divided between Vienna-Neustadt and Friedrichshafen; a Central Plant in the southern Harz mountains, near Nordhausen; and an Eastern

35. History of German V-2 and "Operation Paper Clip," OML, 1958, Capt. Rudolph Nottrodt, p. 1, Hist. Off. files.

Plant in Latvia, near Riga. By July 1944 the Eastern Plant fell into Soviet hands; the plant in Vienna was damaged by Allied raids to such an extent that only partial assembly was possible there; and the Friedrichshafen Plant also suffered severely from air attacks. Thus the Central Plant remained alone to do most of the assembly work. By September 1943 the production of A-4's for research purposes reached about 20 missiles per month. By the fall of 1944 there was a critical need for manpower. So foreign workers and political and war prisoners began to work under skilled German employees, the Central Plant utilizing 9,000 foreign nationals of 10,000 employees.

On 6 September 1944 the first tactical A-4 was launched against England--from a mobile unit--though such missiles left much to be desired. From 16 August to February 1945, 3,000 went to field units, and of the first thousand inspected, 339 were defective and returned to the factory, and about 5 per cent of the remaining 661 did not rise at all or tumbled after take-off. However, after October 1944, 85 per cent of the launchings were successful, 20 per cent reaching the specified target, and the remainder doing considerable damage. By the War's end, tactical units had launched 3,300 A-4's.[36]

Meanwhile, after 1944 Peenemünde operated in confusion. Exhausted workers trained in close combat and street fighting and received many decorations including Distinguished Services Crosses, to bolster morale. They made preparations to keep from the approaching Soviets any information which might help in reconstruction of the A-4.[37] Peenemünde evacuation began in the first month of 1945, personnel going to the southern Harz mountains and the Central Plant, 5,000 employees transferring under extremely difficult conditions. Amid air attacks, trains transported personnel over bombed tracks and bridges. Arriving finally at their new site, the personnel made prompt plans for an increase in missile production to 600 monthly by September 1945.

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36. Ibid., pp. 2-3. "Well before the end of the War we were averaging a thousand V-2's per month, a figure which didn't vary 10 per cent, despite bombings." Interview with Mr. Ernst Lange, ABMA, 22 Oct. 1958.
37. The leaders at Peenemünde were practical and perhaps decided this early to keep material from any victor, in order to be in a better bargaining position. Capt. Nottrodt, in his report prepared for Maj. Gen. H. N. Toftoy at RSA, says that after 1944 only "irresponsible elements within Germany" tried to continue. Ibid., p. 3.

During this time Russia captured Peenemünde and fought for Berlin. Shortly before the American Army occupied the Harz mountain and captured the A-4 production plant, German SS troops took about 500 top guided missile scientists and technicians to south of Munich, supposedly for elimination to prevent their capture by Allied forces.[38] However, events moved so swiftly that time ran out before the Nazis could carry out their dastardly plan.[39] SS officers did order three large trucks and trailers of documents to an abandoned mine in the Harz mountains, hid the material and blasted the mine shut, U. S. Army units not finding the hidden boxes until April 1945.

The ex-Peenemünde staff, to their moment of capture, "continued their scientific discussions," in the course of which "the HERMES II weapon was first conceived."[40] They had recognized A-4 tactical limitations from the start, knowing that maximum range could be little more than 300 km, reached against London from launching sites near The Hague. So the researchers early thought of two-

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38. "It is still considered possible, if not probable, that the SS Troops actually meant to do this," says Mr. Helmut Hoeppner of the ABMA Staff. Interview 22 Sept. 1958.

39. History of German V-2 and "Operation Paper Clip," Capt. Rudolph Nottrodt, p. 5.

40. Guided Missile Research And Development, probably prepared in 1952 by Hoffman A. Birney at Fort Bliss, unnumbered, Hist. Off. files.

stage rockets, suggesting a missile (A-10), with a booster of 200,000 lb. thrust carrying a modified A-4 rocket to more than 100 miles altitude.[41] There the booster would fall away, the A-4 continuing under its own propulsion. Another suggestion for increasing range was use of the A-4 as booster for a two-stage missile, the second stage using athodyd (ramjet) propulsion. This "transatlantic type rocket" never advanced beyond the planning stage.

Though missiles were Peenemünde's business, there are indications the researchers thought often of space flight. Opinions differ as to how much "space flight planning" there was at Peenemünde. However, von Braun writes that "An unbiased visitor to the planning group at Peenemünde would have heard little, if anything, discussed which related to other matters than reaching into space.... For the war-conscious officials, the object of the A-9 was explained as an extension of the range, to almost double that of the A-4." He added that "Our project drawings for A-9 showed a pressurized cockpit in place of the war-head; there was also a tricycle landing gear. As restricted as we kept these drawings from the Ordnance

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41. Ibid. The report says a "200,000-ton thrust."

visitors, we computed that the A-9 was capable of carrying a pilot a distance of 400 miles in 17 minutes."[42]

The above suggests more interest in space flight than missiles, again a charge sometimes leveled at ABMA researchers. Writes an Air Force historian, from officially approved Air Force history: "There is some substance in the charge later brought by antagonists in the Army and the SS, that both Dornberger and von Braun were guilty of having used huge sums of military funds as a means of fostering their planetary and interstellar goals." The account adds that in his later writings "Dornberger admits 'that from the beginning we wanted to go into space'." And that he did not hesitate to say, of the work he directed before 1939: "'It was the teamwork of fantically inspired and inseparable comrades...linked together for life and death and devoted to one single idea...the goal set our generation, the trip in space and to the stars.'"[43]

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42. Dr. Wernher von Braun, "From Small Beginnings," op. cit. pp. 47-48.
43. Joseph W. Angell, "Guided Missiles Could Have Won," <u>Atlantic Monthly</u>, Dec. 1951, Part I., p. 31. Several members of the USAF Air University Evaluation Staff studied the article before SPUTNIK I, perhaps again with the idea that the "Army was way out there in space flight."

There seems to be substance to the charge that German rocketeers from Oberth to ABMA, sometimes openly and sometimes submerged, maintained a long range goal of outer-space flight.

Meanwhile, Americans wanted to learn of rockets. In 1956 Gen. Toftoy wrote in the <u>Army Information Digest</u>: "There is no quicker way to stimulate interest in a new weapon than to discover it in use by the enemy."[44] America and the world discovered German use of guided missiles in 1943, and feverish interest resulted. True, as early as 1917 the U. S. Army Air Service experimented with pilotless aircraft or "flying bombs," and Dr. Robert H. Goddard later experimented with Army rockets. But not until World War II did American Army Ordnance, or any other Army Ordnance, do much with military rocketry; and not until the German guided missile did other German military men do much with guided missiles. There were U. S. proposals for developing a "V-1 type" missile, as early as 1941, but it was after the buzz bomb attacks on England that the War Department initiated this project."[45] Before these

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44. Maj. Gen. H. N. Toftoy, "Army Missile Development," <u>Army Information Digest</u>, Vol. 11, No. 22, Dec. 1956, p. 10.
45. <u>Ibid</u>., p. 22.

attacks Army missile progress centered mainly in the Army Air Force's Azon and Razon (radio and radar guided bombs) both of which saw only limited service in World War II.

The Army's rocket activity began showing life late in 1943 with organization of a Rocket Branch which provided for central management of rockets in the same manner as small arms, artillery, ammunition, and tanks. At the same time, Ordnance requested California's Jet Propulsion Laboratory to study development of long-range surface-to-surface guided missiles. In May 1944 Ordnance placed a $3,300,000 contract with JPL for general research on guided missiles, including rocket propulsion and supersonic aerodynamics. In less than a year a contract went to General Electric for the HERMES project[46] and in February

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46. Major R. B. Staver, something of a Billy Mitchell in advocating rocketry and utilization of German scientists, said of the HERMES project: "There has been a tendency of the Ordnance Department to place a contract such as this and then, not only to assume the engineers assigned to that project to be 'experts' but also to rely on their opinions as such. Truly, not one person on the whole HERMES project can be called a rocket 'expert'... They are now where the Germans were in about 1935... (and) with the present Ordnance program placing all of its research and developments with organizations outside the Army, no real experience will exist within the Ordnance Department..." The Future of Ordnance in Jet-Propulsion, 17 Dec. 1945, pp. 10-11, Maj. R. B. Staver, Ordnance Department, ARGMA Technical Library files.

1945 to the Bell Laboratories for the NIKE project.[47] Late in 1944 Ordnance built a wind tunnel at the Aberdeen Proving Grounds, and four years later one at JPL. In 1944 the Army established White Sands Proving Ground, a rocket testing range adjacent to Fort Bliss, and in October 1945 at Fort Bliss it activated the 1st Guided Missile Battalion.

The U. S. contract with German specialists after World War II resulted from far-sighted initiative by both Army Ordnance and the specialists themselves. Certainly, flushed with victory, it took more than ordinary foresight for Ordnance to pursue German scientific knowledge on a 24-hour a day basis, and it required as much foresight for the German specialists to formulate a master plan for selling scientific service to the Americans.

It is difficult to "pin-point" the American who first thought of Project PAPERCLIP, the code name for transfer to the U. S. of German guided missile specialists. We can at least be sure it was someone who believed in "to the victor belongs the spoils" rather than "this is a war to

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47. <u>Ordnance Department Guided Missile Program</u>, 13 Mar. 1947, pp. V-1 to VII-1 and VIII-1 to IX-1. Rocket Development Division, ABMA Technical Documents Library.

end all wars." Neither President Eisenhower's Crusade In Europe nor the Secretary of Defense's diary covers the subject.[48]

It is interesting that two years after PAPERCLIP began, President Eisenhower received a briefing concerning its origin and mission.[49] The briefing officer (of the War Department General Staff) told Eisenhower that the original impetus behind Project PAPERCLIP began near the end of 1944 when British and U. S. military organizations collaborated in the plan known as ECLIPSE. This plan would implement the U. S. State Department's SAFEHAVEN project "for the control of German individuals who might contribute to a revival of the German war potential by subversive activities in foreign countries after the war." Subsequently, the U. S. "sought out the most strategically important" centers of German scientific knowledge, and analyzed "the threat to world security involved in the

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48. Dwight D. Eisenhower, Crusade In Europe, Doubleday & Co., Inc., Garden City, N. Y. 1948. Also Walter Millis, Editor, Forrestal Diaries, Viking Press, N. Y. 1951.

49. "Outline for Briefing General Eisenhower on German Scientist Exploitation Program," Tab A, 11 Mar. 1947, Conference files, Special Expl. Br., MID, WDGS, Wash. Cited in Harriet Buyer and Edna Jensen, History of AAF Participation in Project Paperclip, May 1945 - March 1947 (Exploitation of German Scientists), Aug. 1948, p. 3, Research Studies Institute, Maxwell AFB, Ala.

proper and permanent control over a large group of German scientists, and the problems involved in achieving either proper or permanent control in Germany."[50]

In May 1945 Supreme Headquarters, AEF, cabled the Policy Staff of the War Department General Staff for policy instructions toward control of scientific and technical research in Germany. The Chief, Military Intelligence Service, WDGS, promptly answered with a "situation estimate" on "Long Range Policy on German Scientific and Technical Research."[51]

Meanwhile, along with interest among top U. S. officials, top Army men were advocating the use of German scientific knowledge. Major General H. J. Knerr, U. S. Strategic Air Forces, says that he early recommended to Lt. General Carl Spaatz, USSTAF, that the "AAF make full use of the established German Technical facilities and personnel before they were destroyed or disorganized." Knerr also discussed this subject with the Honorable Robert A. Lovett, Assistant Secretary of War for Air, during

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50. Ibid.
51. Memo, Chief, MIS, for Dir. of Intell., WDGS, Wash., 22 May 1945 (S); Cable, SHAEF-S88111, SCAF-394, to Chief, Policy Staff, WDGS, Wash., 15 May 1945, both Policies on German Scientist file, Special Expl. Br., MID, WDGS, Wash. Cited from Ibid., p. 4.

his first visit to the European Theater in April 1945. Knerr advocated to Lovett that the U. S. begin immediate exploitation of knowledge and experience of the German scientists, bringing their families with them to the United States, "not only for the mental stability it would give the men to know they were safe...but to prevent...their being taken hostage in the scientists' absence."[52]

Foremost among the individuals who closely supervised Project PAPERCLIP was "Mister Rocket," the then Colonel H. N. Toftoy. "At the close of World War II, when many officials wishfully chose to ignore the possibility of another global conflict, Toftoy advised, exhorted, begged, and hounded government officials to recognize the necessity of building an arsenal of rockets."[53] As leading officer in Operation PAPERCLIP, Toftoy called Washington in May 1945 and receiving no answer flew personally to

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52. Interview with Major General H. J. Knerr, Secy. Gen., Air Board, Hq., AAF, 24 Apr. 1947. Cited in Ibid., p. 5. Also see Ltr. from Joseph W. Angell, Jr., Asst. Chief, USAF Hist. Div. to David S. Akens, Chief, ABMA Hist. Sect., 3 Oct. 1958, ABMA Hist. Off. files.
53. Bob Ward, "Toftoy Kept America in World Missile Race," Huntsville Times, 19 June 1958. The Times article also says that Toftoy "was personally responsible for getting some 130 key German missilemen into the country." The Army Information Digest, under the title "Men Of The Missile Command," Oct. 1958, p. 61, says of Toftoy: "He recommended bringing to this country German scientists and engineers who had pioneered in rocketry."

request transfer to this country of some 300 German scientists and technicians. He managed to get 127 German scientists and technicians here.[54]

Working for young Col. Toftoy (now Maj. Gen. Toftoy) on Project PAPERCLIP was Maj. James P. Hamill of Ordnance Technical Intelligence. Not only did Col. Toftoy and Major Hamill pursue Project PAPERCLIP where directed, but

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54. Other top Army men early advocating use of enemy resources included Maj. General Gladeon M. Barnes, Chief of Research and Development. In 1942 he instituted a plan for getting technical information from theaters of operations to be used in U. S. research and development. The General persuaded Army Intelligence that trained Ordnance observers could collect data on enemy equipment, and in the last year of World War II intelligence staffs recruited additional men for Enemy Equipment Intelligence.

Also, there was Brig. Gen. Henry B. Sayler, Theater Ordnance Officer. In Europe where Allied invasion of the continent gave access to German factories, laboratories, and experimental stations General Sayler realized before D-day that captured German correspondence, laboratory equipment and records, as well as interviews with war prisoners...would give valuable knowledge of enemy development plans and methods.

Acting on General Sayler's suggestion the Chief of Ordnance assigned technical specialists to the task, and in October 1944 the first group began work. The resulting information was assembled by a Joint British-American Agency, the Combined Intelligence Objectives Sub-Committee (CIOS) with headquarters in London. Constance M. Green, Harry C. Thomson and Peter C. Roots, Washington 1951, <u>The Ordnance Department Planning Munitions for War</u>, pp. 262-266, Hist. Off. files.

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apparently beyond authorization they took material from under the Russian's noses at the valuable Nordhausen Plant. In an article entitled "How We Let The Missile Secrets Get Away," Major Hamill is quoted: "We knew about the Nordhausen plant long before we took it. The written orders I received indicated that Nordhausen was to be in the Russian zone and that all plans and equipment were to be left for the Soviet. These orders originated at a very high level. Unofficially and off the record I was told to remove as much material as I could, without making it obvious that we had looted the place."[55]

This U. S. official softness toward Russia resulted indirectly from a plan by the European Advisory Commission in November 1944, made up of Russian, British and American representatives (Ambassador John G. Winant for the U. S.). Gen. Dwight D. Eisenhower signed the plan in Berlin on 5 June 1945, and it stated: "All factories, plants, shops, research institutions, laboratories, testing stations, patents, plans, drawings and inventions...will be held intact and in good condition at the disposal of allied

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55. Peter Van Slingerland, "How We Let The Missile Secrets Get Away," Look Magazine, 4 Feb. 1958, p. 23.

representatives for such purposes as they may prescribe."[56] The decree did not state <u>which</u> allied representative, and apparently it did not refer to German <u>personnel</u>.

Those were days of crucial bargaining amid distrust, headed by U. S. desire that Russia intervene in the Pacific.

On April 26 the Joint Chiefs of Staff issued Order 1067, directing General Eisenhower to "preserve from destruction and take under your control records, plans, documents, papers, files and scientific, industrial and other information and data belonging to...German organizations engaged in military research."[57] Again the order apparently did not imply German scientists and technicians.

Meanwhile, there was lack of unanimity among our own Armed Forces as to what to do even with U. S. missile development. Within the Armed Forces, missile projects were "running around loose and being furthered by anyone aggressive enough to take the ball and run."[58] The U. S. Army's History of World War II, states: "Air Forces and

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56. <u>Ibid</u>.
57. <u>Ibid</u>.
58. Constance McLaughlin Green, <u>U. S. Army in World War II</u>, Washington, D. C., 1955, Ch. VIII, p. 234, quoting Brig. Gen. Richard C. Compland, Ordnance Officer assigned as liaison at Army Air Forces Headquarters in Washington.

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Ordnance Department, as well as the NDRC,* had for months been pursuing investigations of this type of weapon. German use of "buzz bombs" and later of the deadly V-2 rockets, about which specialists in the United States already knew a good deal, sharpened awareness of the urgency for work in this field...obviously the duplication of research or the withholding by one group of data useful to the other must stop."[59]

Of extreme significance is the initiative of the German specialists themselves toward joining the United States. Here was an example of the scientific elite of a defeated country not only surrendering en masse, but making definite plans for such several months before defeat. This group consisted of some 400 of Germany's top scientific "brains," not diehard Nazis but a cohesive group with a carefully considered plan for surrender. Major Hamill explained it this way in 1951. "That guy up there wants to go to the moon," he said, taking as an example von Braun, with office above his.[60]

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* National Defense Research Committee.

59. Ibid., p. 234.
60. Daniel Lang interview with Maj. James P. Hamill in 1951 at RSA. Cited in New Yorker Magazine, Apr. 21, 1951, "Reporter At Large," Daniel Lang, p. 81.

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Talks with German specialists at ABMA, during preparation of this monograph in 1958, indicate that much reproducible material was destroyed, so that "we could make ourselves wanted as well as our work." In an interview in 1951 Dr. von Braun said: "The (German) High Command and the Ministry of Armament wanted us to move west. The Army Corps commander defending Pomerania wanted us to stay and help him. In the end, we decided for ourselves." As to why he expected the West to be eager for them, von Braun added: "It all made sense. The V-2 was something we had and you didn't have. Naturally, you wanted to know all about it."[61]

After their trip to the mountains to await capture by Americans, the specialists stood ready from early April until almost the middle of May. No one suspected they were there. Meanwhile, "Hitler was dead, the war was over, an armistice was signed--and the hotel service was excellent."[62] Finally, on May 10th, 1945, von Braun grew tired of waiting and sent his brother Magnus down the mountain on a bicycle in search of the American Army. A GI in the valley directed him to a Counter Intelligence Corps headquarters

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61. Daniel Lang interview with von Braun, Ibid., pp. 86-87.
62. Ibid., p. 87.

in a nearby village. The result was that "Approximately 150 of the best scientists and technicians...after preliminary interrogation and background investigations by U. S. intelligence...were offered five year contracts to come to the United States and work for Uncle Sam." The United States promised to provide housing for the families remaining in Germany "until arrangements could be made to bring them to the United States at a later date. We also guaranteed to protect their families from die-hard Nazis who considered them traitors for agreeing to work for a former enemy."[63]

Transports brought to the United States 100 nearly complete V-2's, together with a large collection of plans, manuals, and other documents. Three hundred carloads of material went from Nordhausen to Antwerp to the United States. In June 1945, while evacuating remaining scientists and families (24 hours before the Russians arrived), the U. S. found five trunks filled with Dr. Dornberger's notes, hidden in abandoned salt mines. Later, one of the

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63. History of German V-2 and "Operation PAPER CLIP," 1958, p. 6, Capt. Rudolph Nottrodt, Executive Officer, OML, Hist. Off. files.

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German specialists said: "We probably got a complete set of plans, but the Russians probably got a nearly complete set too. You know, with things like plans, you always make copies." Before leaving Nordhausen, U. S. forces debated blowing up the plant, but since they lacked the authority, they felt forced to leave it for Russian capture a few hours later. Dr. Dornberger said some of the machine tools left in Nordhausen were unique in the world, and estimated that the plans for the A-9/A-10 may have helped 15 to 20 per cent in building the SPUTNIKs.[64]

Von Braun agrees that the Russians got much material and that "the United States got the best of our group. The Americans looked for brains, the Russians for hands. The Russians have a great many production engineers who can make wonderful copies of V-2's. The American approach has been to see the whole business as a field for development, to try for something better than anything made at Peenemünde." Grottrupp, an excellent electronics and guidance control man, went over to the Russians, but

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64. Peter Van Slingerland, "How We Let The Missile Secrets Get Away," Look Magazine, 4 Feb. 1958, p. 23.

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he "was the only one of the inner circle at Peenemünde who deliberately went over to the Russians."[65 & 66]

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65. Daniel Lang interview with Wernher von Braun at RSA in 1951. Cited in New Yorker Magazine, Apr. 21, 1951, pp. 89-90. Later in the interview von Braun mentioned his "Mars Project" novel. "But what about the moon?" he was asked. "Mars is more of a challenge," von Braun replied. "It would take two hundred and sixty days to get there. To the moon it's only a hundred hours." He hesitated momentarily. Then he spoke with an intensity he had not shown all evening. "Personally, though, I'd rather go to the moon than to Mars, even if the trip is shorter," he said. "After all, a journey to the moon is unquestionably a possibility... Spaceships will eventually be used by everybody. All this military application of rockets--it's only a part of the picture. A means to and end." Ibid., pp. 91-92.

66. Later Grottrupp returned to Germany and wrote an article "In The Shadow of the Red Rocket." Contrary to earlier opinion, "this article makes it clear that Grottrupp did not deliberately go to Russia." Interview with Mr. Ernst Lange, and later with Mr. Fritz H. Weber, ABMA, 23 Oct. 1958.

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II. ABERDEEN PROVING GROUND AND WHITE SANDS [redacted]

The first seven of the German specialists arrived in this country at Fort Strong, New York, 20 September 1945, the Army taking them from there to Aberdeen Proving Ground, Maryland.[1] Here they helped process German guided missile documents captured after the collapse of the German armies. With the help of these specialists Aberdeen segregated, translated, evaluated, and catalogued over 40 tons of reports, charts, and drawings. The specialists "often at a glance...could classify a document as important or trivial. Such speed was possible, because often these men were working with documents which they themselves wrote or helped compile." Meanwhile, 120 German specialists arrived at Fort Bliss, Texas, and White Sands Proving Ground, to be joined by the first seven specialists at the conclusion of the Aberdeen project, late 1945.[2]

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1. Headquarters, United States Forces, European Theatre, TO, 15 Sept. 1945, KCRC files, Kansas City, Mo. These first seven to arrive were Wernher von Braun, Erich W. Neubert, Theodor A. Poppel, August Schultze, Eberhard Rees, Wilhelm Jungert, and Walter Schwidetzky.
2. History of German V-2 and "Operation Paperclip," 1958, pp. 7-8. Capt. Rudolph Nottrodt, Executive Officer, OML, Hist. Off. files.

These first years in the United States contained various disappointments for the specialists, which at times must have hampered their assistance to U. S. research. There was the matter of sorting 40-tons of documents and at White Sands the firing of "rusty, dried-out V-2's," considerably inferior to the big-time research of Peenemünde. Frankly, said von Braun in 1951, "we were disappointed with what we found in this country during our first year or so. At Peenemünde, we'd been coddled. Here you were counting pennies. Your armed forces were being demobilized and everybody wanted military expenditures curtailed."[3]

One of the leading military figures in bringing the specialists to this country wrote in December 1945:

> "The German group was guaranteed the privilege of exchanging mail and small packages with their families located in the army housing project at Landshut, Bavaria.... Unless this situation is rectified immediately, serious trouble may result.... The German group all signed contracts written in English. This contract stipulated that in the United States they would be furnished room and board.... As stated to the undersigned by one of the German engineers, if these charges continue, it would appear that the word of even several American officers cannot be relied on." The report continued elsewhere: "The writer knows most of the German group and can say without fear of contradiction that there is only one basic incentive which has led this group to come to the United States--the future possibility of carrying

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3. Daniel Lang interview with von Braun, the New Yorker, 1951, op. cit., p. 89.

on research and development as citizens of the United States. To come to the United States and know they were all to be returned at the end of one year really offers them absolutely nothing." And "At times, the handling of this group has not been satisfactory, that is from the undersigned's viewpoint as well as the Germans. When these men began work at Aberdeen they were put in charge of an Army private... As yet no really concrete plan for the utilization of this body of expert personnel has been made known... It took considerable effort to persuade many of the German group to come to the United States.... A reasonable program should be instigated, and not one just to help in one way or another with the firing of a few V-2's in New Mexico."[4]

There were 1,136 German and Austrian specialists and dependents in the United States under Project PAPERCLIP on 18 May 1948; 492 were specialists and 644 were dependents. Of the 492 specialists, 177 were with the Army, 205 with the Air Force, 72 with the Navy, and 38 with the Department of Commerce but under Army custody.[5] It is interesting that the largest single group of specialists was with the

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4. This interesting 1945 report by an Ord. major who "feels qualified if not obligated to present his views" is entitled The Future of Ordnance In Jet-Propulsion, 17 Dec. 1945. See p. 12 and Enclosure A, Major R. B. Staver, Ord. Department, ARGMA Technical Library files.
5. Volume II Appendix to History of USAF Participation In Project Paperclip, Aug. 1948, final three pages of Appendix, "PAPERCLIP Strength Report," Research Studies Institute files.

Air Force and the second largest with the Army, 146 at Wright Field and 121 at Ft. Bliss.[6]

White Sands Proving Ground, in addition to having top personnel from Peenemünde as well as 300 freight-carloads of V-2 components, was an ideal testing range. A flat, isolated desert area, about 125 by 40 miles, the range had the world's most massive building, the firing site block house.

However, before either White Sands or the transported V-2's, there was rocket activity in the West. California Institute of Technology fired 24"Private A" rockets from Camp Irwin Reservation near Barstow, California, 1-16 December 1944. Within the next four months, by 15 April 1945, CIT fired 17 "Private F" rockets, these from White Sands Proving Ground.[7] Thus, the first rockets to rise

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6. "At Ft. Bliss, however, was a cohesive group, representing most of top echelon at Peenemünde." Interview with Walter Wiesman, ABMA, 13 Oct. 1958. Wiesman, one of the Germans, was at Ft. Bliss in 1948. "Most of Peenemünde's top echelon came to the U. S. Army, rather than elsewhere," further explains Col. W. J. Durrenberger "because the U. S. Army desired the 'whole team,' and "because of Colonel Toftoy's ability to get along with people." Interview with Col. W. J. Durrenberger, AOMC, 27 Oct. 1958.
7. Of this seventeen, two were dummies, for testing the launcher and boosters.

from White Sands were not V-2's, but American CIT "Private F's."[8]

The "Private" missiles were part of Project ORD-CIT (Ordnance-California Institute of Technology), "granddaddy" of the Army's guided missile projects. Project ORD-CIT actually began in 1936 at CIT, when a small group of researchers began designing rockets for high-altitude research work. This led to the first mass-produced American take-off unit (JATO),* followed by authorization from Major General G. M. Barnes to go ahead with a high altitude rocket project. The latter was in January 1944, and the rocket projects under the authorization became known as Project ORD-CIT.[9] In addition to the "Private" rockets,

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* Jet Assisted Take-Off.

8. Rocket Development Division, R&D Service, Office, Chief of Ordnance, <u>Ordnance Department Guided Missile Program</u>, 13 Mar. 1947, Chapter IV, ARGMA Technical Library files.
9. <u>The Future Of Ordnance In Jet Propulsion</u>, 17 Dec. 1945, p. 8, Maj. R. B. Staver, Ordnance Department, ARGMA Technical Library files. Major Staver added: "The writer can speak with some knowledge of the facts as it was he, who in December 1943, first recommended to General Barnes and Colonel Ritchie that the ORDCIT project be undertaken. Under the circumstances it appeared logical at that time."

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Project ORD-CIT included "Wac Corporals" and "Corporals," rockets which earned the following history as of 31 March 1947:

"Wac Corporal. Firings of the booster unit for the Wac Corporal commenced at White Sands Proving Ground in September 1945, with the first complete missile being fired in October 1945. A total of seventeen (17) of the complete missiles (including booster) have been fired to date. In addition, seventeen (17) of the booster rocket units, some with and some without dummy Wac Corporal missiles, have been fired. Firing of the last three missiles was conducted by the 1st AAA Guided Missile Battalion. Initial development tests are now considered to be complete. Twenty-five (25) of the missiles are to be made for the Signal Corps, and an additional fourteen (14) are to be constructed for further ORDCIT test requirements. Preparation of drawings for this production is now under way at Douglas Aircraft Company.

"Corporal. Fabrication and testing of the components of the No. 1 prototype of this missile are being pushed to enable the first round to be fired in May of this year. The critical components continue to be the tanks. The first unit of telemetering equipment for the missile has been completed and is now being calibrated. Sixty-three (63) motor and vane test runs have been made, the last test being of the motor which will be used in the Number 1 missile."[10]

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10. Ordnance Department Guided Missile Program, 13 Mar. 1947, Chapter IV-3, Rocket Development Division, R&D Service, Office, Chief of Ordnance, ARGMA Technical Library files.

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The "Private A and F" missiles carried instruments for reporting only on missile behaviour and hence tested missile design. Ordnance next scheduled a WAC CORPORAL missile for exploring atmosphere at an altitude of 100,000 feet. Since it would go higher than the PRIVATE, designers tagged it CORPORAL.

After the first 10 WAC CORPORAL firings, the new rocket proved itself capable not only of 100,000 feet, but of 230,000 feet altitude.[11] And of the subsequent WAC CORPORAL firings before 1948, the seventh one reached 240,000 feet, the eighth one 206,000 (the chute opened and Ordnance recovered this one almost intact), and the last one, on 12 June 1947, reached 198,000.[12]

Meanwhile, early in 1946 White Sands readied its first V-2's. The schedule called for firing about two V-2's a month, with No. 1 a static test at White Sands on 14 March

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11. _Ibid._, unnumbered table "General Conclusions After Series of First 10 Wac Corporal Firings," Chapter IV.
12. _Army Ordnance Department Guided Missile Program_, 1 Jan. 1948, p. 35, Office, Chief of Ordnance, ARGMA Technical Library files.

    WAC CORPORAL tilted the scales at 660 pounds; for propulsion it used an acid-aniline motor capable of developing 1,500 pounds thrust for 50 seconds. The missile, utilizing a "Tiny Tim" booster for initial thrust, lifted vertically from a 100-foot tower. Ibid., p. 21.

1946.[13] There were altogether 52 V-2 firings from White Sands Proving Ground and Florida Missile Testing Range, the last one on 28 June 1950. Rocket No. 17, 17 December 1946, reached the highest altitude, 116 miles, and No. 16 on 5 December 1946 the longest range, 111.1 miles.[14] With these firings Ordnance learned to handle and fire large missiles, and to experiment with designs for future rockets and ground support equipment.

The most historic achievement of the WAC CORPORAL was the part it played in February 1949 in lifting the BUMPER missile, which set altitude and velocity records which stood for half a dozen years.

The BUMPER missile resulted from the need to check theories and provide data on multi-stage rocket flight including (1) the separation and ignition of the second stage rocket in highly rarefied air, (2) the stability of

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13. Ordnance Department Guided Missile Program, 13 Mar. 1947, Chapter VII-3, Rocket Development Division, R&D Service, Office, Chief of Ordnance, ARGMA Technical Library files.
14. Final Report, Project Hermes, V-2 Missile Program, General Electric, Report No. R52 A0510, Sept. 1952, cited in Willy Ley, Rockets, Missiles, and Space Travel, p. 460.

a second stage missile launched at extremely high velocities and altitudes, (3) the aerodynamic effects at high Mach numbers obtainable in no other way at that time.

The BUMPER missiles, consisting of a V-2 with its nose modified to accommodate a WAC CORPORAL, represented the combined efforts of Army Ordnance, JPL, Douglas Aircraft, and General Electric. The first full-powered flight was entirely successful. On 24 February 1949 the WAC CORPORAL traveled upward at a speed of 5,000 m.p.h. to a height of 250 miles. Thus the Army was first to send an object outside the earth's atmosphere. The flight lasted 12 minutes, necessitating a directional correction of several miles to adjust for the earth's rotation.

In 1947 the Army cooperated with the Navy in the experimental firing of a V-2 from the deck of the U.S.S. Midway. The missile, not originally designed to counteract a ship's motion at launching, took off in an erratic manner, but did prove that large ballistic missiles could be successfully launched from ships.

One V-2 failed to respond to its preset flight path and passed over El Paso and over Juarez where a fiesta was in progress. Fortunately it impacted on a barren hill. White Sands operations halted pending a complex and effective safety system, consisting essentially of a combination of radar tracking with automatic plotting boards, precise and continuous electronic impact prediction, backed up by visual observation through a sky screen on which safety limits appeared.[15]

The V-2 program conducted at White Sands Proving Ground contributed much to the rapid postwar progress in the missile field. The Army fired many missiles in collaboration with scientific institutions seeking data on the upper atmosphere and the effects of cosmic radiation. This phase became so important that the Navy developed its VIKING missile to continue the work after the supply of V-2's was exhausted.[16]

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15. General Toftoy, Army Information Digest, Dec. 1956, Vol. 11, No. 12, p. 25-27, ARGMA Technical Library files.
16. Throughout this early history the Navy participated in rocket activities at White Sands. The Proving Ground's first history has this to say of Navy cooperation: "In the fall of 1945, the Chief of Ordnance (had) invited the Chief of the Bureau of Ordnance of the Navy, through the Office of the Secretary of the Navy, to participate in the activities at White Sands Proving Ground. This invitation was very favorably received in the Navy and, as a result, the Bureau of Ordnance and Bureau of Aeronautics jointly accepted and made available funds from both bureaus to augment the facilities at the Proving Ground. The concept of this acceptance and augmentation was definitely to avoid duplication and to provide additional facilities so that the potential value of the Proving Ground, for all military services, was greatly enhanced."- History of Activities, White Sands Proving Ground, Las Cruces, New Mexico, 9 July 1945--31 December 1952, p. 30, OCO Historical Br. files.

III. HUNTSVILLE [redacted]

Redstone Arsenal

By 1950 the Army's mushrooming missile program was in serious need of a central location and adequate facilities. Ft. Bliss Research and Development had performed its original mission of firing V-2's (A-Y's), of initiating studies on long range rocket propelled missiles of all types, and of rendering all possible assistance to the Army, Navy, and industrial organizations engaged in rocket or guided missile research.[1]

In September 1949 Ft. Bliss officials, after inspecting Huntsville Arsenal,[2] proposed a guided missile center in the area, and transfer of White Sands missile experts to it. The Secretary of the Army approved on 28 October 1949, and on 21 March 1950 the Adjutant General issued the movement directive.[3]

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1. The original mission is stated in Memo, Asst. OCO to CO, R&D Service Sub-Office, Ft. Bliss, 28 Feb. 1946, subj.: Mission R&D Service Sub-Office, Ft. Bliss, Kansas City Record Center files.
2. Huntsville Arsenal was a $70,000,000 Chemical Corps installation constructed during WW II. Inactivated later, the area became part of Redstone Arsenal. ARGMA Historical Summary, 21 Oct. 1958, p. 4, ARGMA Hist. Off. files.
3. Executive Office Diary, April 1950, Redstone Arsenal Historical files, Ibid., p. 8.

It was a significant move. By November 1950, 500 military personnel, 130 German specialists, 180 General Electric contractor personnel, and 120 Civil Service employees transferred from Ft. Bliss to Redstone. With them came the scientific and tooling equipment all of which would soon contribute toward the famed REDSTONE System.[4]

Meanwhile, the Army missile program flourished, considering that from 1944-1950 Ordnance received only 17 percent of the total guided missile funds authorized the Army, Navy, and Air Force combined.

The CORPORAL followed the WAC CORPORAL and PRIVATE series, as research test vehicles. General Electric was firing its HERMES A-1 interim surface-to-surface missile, moving along with its HERMES A-2, and working hard on the longer-range, high-performance and extremely accurate HERMES A-3. LACROSSE, initiated at Cornell Aeronautical Laboratories by the Navy for Marine Corps use against strong points, transferred to the Army by Joint Chiefs of Staff action and progressed out of its study phase into experimental design.

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4. Ibid., p. 9.

As time went on, reorientation of the Army's missile program became necessary for several reasons: new atomic warheads developed; funds available to the Army became limited; and the unsettled international situation intensified the urgency of obtaining operational missiles. Project HERMES was affected the most. Ordnance cancelled HERMES A-1 as a weapon and suspended HERMES A-2; this left only the A-3 as a major effort at General Electric. Responsibility for the HERMES C-1 study went to Redstone Arsenal and became the REDSTONE project (designated in the interim as Major).[5]

During the Korean action the requirement for a surface-to-surface missile became so urgent that the CORPORAL research vehicle was "crashed" as an interim weapon system; it could be operational sooner than the more refined HERMES.

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5. "The MAJOR will be a ballistic rocket with a range of 75-150 miles, a warhead weighing 6,900 pounds, and an inertial guidance system accurate within 150 yards in range and azimuth.... Since the initiation of Project MAJOR, Redstone Arsenal has been reorganized and the Ordnance Guided Missile Center has been designed as the Guided Missile Development Branch of the Technical and Engineering Division. The personnel and facilities for Project MAJOR have not been affected by the reorganization." - Progress Rpt. No. 1, XSSM-G-14 (MAJOR) Missile, 1 Jan. 1951--30 Sept. 1951, ABMA Hist. Off. files.

By 1951 the Army determined that its surface-to-surface requirements could be met by a family of guided missiles consisting of CORPORAL, HERMES A-3, and a proposed REDSTONE. These were to be the carriers of three different sizes of warheads, but later when two warheads satisfied the Army requirements and funds became extremely short the Army regretfully terminated the HERMES program.

Postwar developments of new and greatly improved solid propellants for rocket engines at JPL and Redstone Arsenal gradually placed them in a competitive position with liquid propellants for guided missile use, both as to performance and to size. First flight tests of a large solid-propellant motor were made in the HERMES RV-A-10 test vehicle.[6]

Army Ballistic Missile Agency

The Army established the Army Ballistic Missile Agency at Redstone Arsenal on 1 February 1956, thus taking a still more important step forward in space capability. The new agency took with it (physically only a few miles) the Arsenal's Guided Missile Development Division plus the

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6. Army Information Digest, Dec. 1956, Vol. 11, No. 12, pp. 31-32, ARGMA Technical Library files.

Arsenal's REDSTONE Missile mission. Even more important, the Secretary of the Army, through the Chief of Ordnance, delegated to the new agency unparalleled authority in the development and procurement fields. This unique, direct fixing of responsibility virtually eliminated delay.[7]

Apart from the age old argument of civilian versus military controls, there are special reasons for ABMA satellite success against difficult odds.[8] With the organization of the Army Ballistic Missile Agency on 1 February 1956, German "creative" genius joined Ordnance "production" genius in an organization granted powers perhaps unprecedented in military history. To say this is to give no

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7. History of Army Ballistic Missile Agency, 1 February--30 June 1956, Nov. 1956, p. viii, ABMA Hist. Off. files.
8. Those to become more and more aware of this included, as well, aircraft oriented civilian agencies. On 1 August the British magazine Flight and Aircraft Engineer editorialized:

"Their (U. S. Army's) total expenditure on research into re-entry problems and nose-cone design and construction can probably be assessed at several million dollars. In contrast, the U.S.A.F. have spent about one hundred times as much on similar investigations; the nose-cone contracts with Avco and General Electric alone amount to $111,308,359 and $158,000,000 respectively. Doubtless the U. S. Air Force will similarly achieve success with the problem, but the fact that the U. S. Army have done so first shows conclusively that the biggest man does not always win."

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bouquets to anyone, for it may be remembered that after World War II the Army was walking a somewhat lonesome path. World War II had validated "air power," and the Army's main claim to "air power" was the German missile scientists, which it had under contract. So the main wonder is that the Army took as long as it did in creating a special organization to best utilize German creativeness and Ordnance productivity.

In organizing ABMA the Secretary of the Army delegated the Commanding General, ABMA, through the Chief of Ordnance, "practically every authority in the development and procurement fields which could be delegated by the Secretary under the provisions of law and Department of Defense regulations. In effect, this...virtually eliminated delay except...in securing funds and approvals from the Department of Defense levels."[9] In addition, the Army transferred to the Agency "top Army experts," which helped assure a high calibre of work at the agency, as well as assure close liaison between the producer and the user, in this case liaison between the Agency (producer) and the military requirements specialists (user).

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9. <u>History of Army Ballistic Missile Agency, 1 February--30 June 1956</u>, p. ix, Hist. Off. files.

Esprit de corps became the Agency's trademark; commonplace remarks of visitors were "there seems to be a sense of mission here" and "people are in a hurry."[10] This sense of urgency was perhaps intrinsic in the coupling of creative and production experts, who were informed enough to be afraid for the West. Also involved was the fighting spirit of a small team, which was the Army's lesser role after World War II, a factor which undoubtedly fanned the flame. And there was the personal magnetism of ABMA's military leadership, which demanded that "schedules be met, no matter what the sacrifice."

The Agency, inadvertently perhaps, strengthened its sense of urgency by under-staffing rather than over-staffing its personnel complement. This meant "overtime," which itself suggested urgency, and reassured its employees and other Huntsville citizens that if funds ever grew short the first to suffer would be "overtime," not employees' positions.

The above points became axiomatic at the Agency. Less well known was the role of the Agency's Missile Firing

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10. In 1958 Secretary of Army Wilber M. Brucker visited ABMA. Perhaps comparing the Agency to other installations he visited, he spoke to newsmen concerning ABMA's unusual sense "of urgency."

Laboratory.[*] During 1958, when the Navy's VANGUARD suffered six spectacular failures and the Air Force's THOR-ABLE exploded after seventy-seven seconds of a much publicized flight toward the moon, the Army's JUPITER often earned the newspaper's sobriquet of "old faithful." For explanation, in addition to the common ones mentioned above, an ABMA employee said: "The forgotten men in the whole thing are MFL[*] people. Those fellows, during a firing down in Florida, check every missile function and then do it again. Other missile firing teams are much less experienced in this kind of thing; the Army, before it pushes the button, makes sure it can do what it said it can do."[11] General Medaris explained it this way to a Congressional investigating committee: "...we find out everything we need to know through tests on the ground, in the laboratory, on the static test stand, and we look at firing tests as simply a verification of that which we believe we already know."[12]

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* Missile Firing Laboratory, the segment of ABMA responsible for final checkout and firing of ABMA missiles.

11. Interview with J. H. Draughon, Chief, Review Br., ABMA Cont. Off., 13 Sept. 1958.
12. Department of Defense Appropriations For 1958, Washington 1957, p. 1508, Subcommittee Of the Committee On Appropriations, Part II, Hist. Off. files. Later, this Subcommittee asked Dr. von Braun what he expected to learn from going to the moon. In answering, von Braun quoted Farraday, who was once asked about

Important Satellite Decision

ABMA came into being during the time of the famous "ORBITER decision." It will be remembered that in September 1954 Dr. von Braun published a paper entitled "The Minimum Satellite Vehicle Based Upon Components Available From Missile Development of the Army Ordnance Corps." This detailed engineering plan indicated that the Army could launch a satellite, with hardware then available.[13] Such belief on the part of the Army led it to suggest a joint undertaking with the Navy,[14] and the result was Project ORBITER.[15] However, Project ORBITER came to an

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his research on electrical induction. "What is the purpose of a newborn baby? We find out in time." Ibid., p. 1525.

13. Project ORBITER, 19 Sept. 1956, p. 7, ABMA, DOD, Hist. Off. files.
14. Previously, in 1954, the Army expressed desire that the Navy and Air Force join it in a mutual satellite program, the Navy initially to provide tracking stations at sea. The original concept was to orbit a 5-pound inert slug about 2 feet in diameter, using a 4-stage rocket with a REDSTONE booster and clustered LOKI rockets. The Navy agreed, but the Air Force declined such a program because of interest primarily in long range studies of heavier satellites. See Ltr., Chief, GMDD, Ord. Msl Labs, RSA, to Chief, Aeromedical Br., Air Research & Dev. Command, no subj., 23 Dec. 1954, Hist. Off. files.
15. This project, estimated to cost $17,700,000, actually used a half million dollars only, this money paying for preliminary design and engineering work, and some hardware experimentation on components. Inquiry Into Satellite and Missile Programs, Washington 1958, p. 1699, Committee on Armed Services, United States Senate, Part II, Hist. Off. files.

abrupt halt in 1955 in a surprising turn of events. It all began when the Air Force and the Naval Research Laboratories themselves began offering impressive new proposals for orbiting satellites, proposals supported by detailed theoretical statistics. These proposals, as compared to the Army's simpler plan, suggested use of radically new and, for the most part, untried components to produce an instrumented satellite vehicle.

Honorable Donald Quarles, in his capacity as Assistant Secretary of Defense for Research and Development, appointed a scientific panel, the Ad Hoc Advisory Group on Special Capabilities, to study these proposals. There is continuing speculation as to why this panel scrapped the Army's REDSTONE plan in favor of the ill-fated VANGUARD program. Certainly, the Army had no representative on the panel. Perhaps the best to be said for the panel's decision was its disunity, Chairman Homer J. Stewart taking the lead in a strong minority report that represented two members against a five-man majority. In addition to Stewart, serving on the panel were Dr.'s Richard R. Porter, C. C. Furnas, C. C. Lauritsen, John B. Rosser, Joseph Kaplan, and Mr. G. H. Clement.[16]

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16. Report Of The Ad Hoc Advisory Group On Special Capabilities, Office of the Asst. Secretary of Defense, Washington, August 1955, pp. i-17, Hist. Off. files.

In August 1955 the Department of Defense R&D Policy Council approved recommendations of the Ad Hoc Committee. This Council consisted of Mr. Trevor Gardner and Lt. Gen. Putt, of the Air Force; Mr. Marsh and General O'Meara, of the Department of the Army; Mr. Smith and Admiral Briscoe, of the Department of the Navy; and Mr. Martin, Mr. Newbury, and Dr. Macauley of the Department of Defense.[17]

Several days after the Council recommendations, OCO (R&D) wrote to ASD (R&D), pointing out what it considered errors of fact and reasoning in allowing the VANGUARD program to replace Project ORBITER.[18] This attempt failed, however, and the VANGUARD program continued without any of the nation's leading German scientists. "Were you prohibited at that time from going further?" Senator Estes Kefauver inquired of General Medaris in a 1958 Congressional hearing. "There was no statement of prohibition," Medaris

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17. Project ORBITER, 19 Sept. 1956, p. 7 ABMA, DOD. Also Report Of The Ad Hoc Advisory Group On Special Capabilities, Office of the Asst. Secy. of Defense (R&D), Aug. 1955, Hist. Off. files.
18. Memo for Asst. Secy. of Defense (R&D) from Asst. Chief of Ord., 15 Aug. 1955, subj.: Scientific Satellite Program; Rpt., "Comments to a Few Statements Contained in Majority Response to Minority Statement in Ad Hoc Committee Advisory Group Report," 17 Aug. 1955; and Rpt., GMDD, OML, RSA, subj.: "Comments on Project SLUG," 17 Aug. 1955. All filed in Cont. Off. files.

answered. "The decision was made that the national satellite effort would be the VANGUARD effort, and no funds were available for any further work, and no appeal for any."[19]

With the Army ruled out of the satellite project, ABMA shifted its ORBITER designs and hardware into a program for testing re-entry nose cones. It was "quickly evident that the same engineering design and the preliminary hardware work that had been done with this half million dollars under Project ORBITER could now be put to use," General Medaris explained further. "Project ORBITER envisioned a four-stage missile, the first being the REDSTONE booster liquid, and the second, third, and fourth being clustered solid-propellant rockets." By loading the fourth stage "with sand instead of powder...this would give a test of the multiple-stage rocket for use in testing the nose cone and in recovering one.... The result was the firing in September of 1956 of the famous or infamous Missile 27...(which) described a ballistic trajectory of about 3,330 miles in range, and, of course, in doing so achieved an altitude of about 600 miles."[20]

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19. Inquiry Into Satellite and Missile Programs, Washington 1958, p. 1699, Committee On Armed Services United States Senate, Part II, Hist. Off. files.
20. Ibid., p. 1700

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Meanwhile, in May 1956 the Special Assistant for Guided Missiles, Secretary of Defense, refused an OASD/R&D request, presented originally by ABMA,[21] that ABMA's JUPITER C re-entry test vehicle be an alternate to VANGUARD. In writing to the Assistant Chief of Staff, Research and Development, Department of the Army, the Special Assistant stated that "without any indications of serious difficulties in the VANGUARD program no plans or preparations should be initiated for using any part of the JUPITER or REDSTONE program for scientific satellites."[22]

Technical information from ABMA's missile programs went continuously to the Navy VANGUARD Project. On 29 January 1957 the Chief of Research and Development, Department of Army, requested ABMA information on satellite use of JUPITER-C missiles.[23] On 1 February 1957 ABMA answered that the Army satellite could accommodate the instrumentation of the VANGUARD payload but not the sphere itself;[24] and in April 1957 ABMA proposed to Chief, R&D,

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21. Presentation to Ad Hoc Study Group on Special Capabilities, 23 Apr. 1956, Hist. Off. files.
22. Ltr, Deputy Asst. Secy., Off. of the Asst. Secy. of Defense, to Lt. Gen. James M. Gavin, Chief of R&D, 15 May 1956, subj.: Army Capabilities for Scientific Satellite, Hist. Off. files.
23. TT, CG, ABMA, to Chf., R&D, D/A, 31 Jan. 1957, Cont. Off. files.
24. TT, CG, ABMA, to Chf., R&D, D/A, 1 Feb. 1957, Cont. Off. files.

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Department of Army, that it orbit, as a backup for VANGUARD, 6 satellites with JUPITER-C type vehicles, each satellite weighing about 17 pounds. The plan called for orbiting the first satellite not later than September 1957, and the second one by end of CY 1957, the program totaling about 18 million dollars.[25] However, on 7 May 1957 R&D, Department of Army, reiterated that there was no plan at present for having ABMA backup VANGUARD. On 21 June 1957 General O'Meara visited ABMA with instruction from the Department of Defense that ABMA's mission was not satellites.[26] As a result, General Medaris on 3 June directed recall of an ABMA satellite capability report requested a few weeks earlier by Dr. Hagen.

> "In various languages our fingers were slapped," explained General Medaris, "and we were told to mind our own business, that VANGUARD was going to take care of the satellite problem. We followed in the spring and summer of 1957 with 2 shots with the scale-model nose cone, the first of which we were unable to recover, it fell too far away from the target area, but the second of which went directly into the target area, was recovered, and was the one that was shown, was the nose cone that was shown by the President...."

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25. Memo for Record, Plans Br., Cont. Off., ABMA, 24 Apr. 1957, subj.: Project 618, Cont. Off. files, and Cont. Off. Rpt., Project 618 Program--Budget Requirements, 9 Apr. 1957.
26. Memo for Record, Deputy Chief, R&D, 22 June 1957, subj.: Conversation with Gen. Medaris at RSA, 21 June 1957, Hist. Off. files.

Senator Kefauver. "Do I understand then, General Medaris, that in September 1956 you had the hardware, the capability, and you proved that you had it by firing a satellite?"

General Medaris. "This is correct; yes, sir."

Senator Kefauver. "And you had the satellite ready?"

General Medaris. "Yes, sir. We did not have scientific instrumentation in it because we were outside of the scientific program. We did have tracking instrumentation...ready."

Senator Kefauver. "Now, were your plans since the directive of November 1957, to go ahead? Are you going to use substantially the same hardware you had available for the satellite back in the fall of 1957?"

General Medaris. "Exactly the same hardware except the satellite itself, the small orbiting portion ahead of the fourth stage will now be re-packaged and will contain the scientific experiments of the IGY. This is the only difference."[27]

After Russia's successful SPUTNIK I launching, 4 October 1957, Secretary of the Army Brucker wrote the Secretary of Defense again offering Army services in orbiting a satellite. "The first JUPITER-C attained an altitude of 650 miles and a range of over 3,300 miles," wrote Secretary Brucker. "We have already proven the

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27. Inquiry Into Satellite and Missile Programs, Washington 1958, pp. 1700-1702, Committee on Armed Services United States Senate, Part II, Hist. Off. files.

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three most difficult stages of a four-stage satellite vehicle." Secretary Brucker went on to say that the Army would require "four months from a decision date to the first launching of a missile designed to place a satellite in orbit. Over the period of a year the Army would be prepared to launch up to six such vehicles. We would require a total of $12,752,000 of non-Army funds for this purpose." Secretary Brucker added that prior to the first launch of a JUPITER satellite the Army could point out, if desirable for psychological purposes, "that we have already three satellite test vehicles (the JUPITER-C's fired in the JUPITER program)". He stated further that the Army "would continue to cooperate with regard to the scientific instrumentation presently planned for VANGUARD."[28]

When the Secretary of Defense responded by requesting the Army to restudy its proposal for supporting VANGUARD, Secretary Brucker wrote that "we recommend the launching of a JUPITER-C satellite in February and another in April. These would give us the basic knowledge which would help us to place a VANGUARD sphere in orbit in June." To give added

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28. Memo, Secy. of the Army to the Secy. of Defense, 7 Oct. 1957, subj.: Soviet Satellite, Hist. Off. files.

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assurance he suggested that plans include a fourth satellite to orbit in September 1958. The four-satellite project, known as Project 416, included orbiting of VANGUARD instrumentation, and the program would cost $16.2 million.[29]

At a meeting on 25 October 1957 the Homer J. Stewart Committee unanimously endorsed Project 416. Then on 8 November 1957 the Secretary of Defense directed the Army to prepare to attempt two satellite launchings during March 1958. On 15 November 1957 ABMA was authorized to obligate $3.5 million for this purpose.[30] A few days later Secretary Brucker recommended to the Secretary of Defense that the Army launch the first satellite on 30 January in order to make modifications, if necessary, for one to be launched on 6 March 1958. This would provide the most assurance for a successful launching of a satellite by the March 1958 date announced by the President.[31] The Department of Defense readily agreed, a decision that ended

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29. Memo, Secy. of the Army to the Secy. of Defense, 23 Oct. 1957, subj.: Army Support of the VANGUARD Program, Hist. Off. files.
30. ABMA Cont. Off., Review Br., <u>Satellite Information</u>, notebook, dated March 1958, Tab H.
31. Memo, Secy. of the Army to Secy. of Defense, 20 Nov. 1957, subj.: Scientific Satellite Program, Cont. Off. files.

REGRADED Unclassified BY AUTH Security Classification Comm. I.M.A 13 Feb. 1959 ON 13 Marc the SPUTNIK I and Project ORBITER era, in which Russia launched the world's first satellite while the U. S. did an unexpected turn from ORBITER to VANGUARD.

Questioned by the Senate subcommittee during this era between the SPUTNIK's and EXPLORER I, General Medaris said, concerning the Army's readiness to launch satellites:

> "...being obviously a Government instrumentality we do not need to make contractual changes in order to make a change in our program, and therefore all that is required to meet the day-to-day exigencies of a fast-moving development program is that I make up my mind.
>
> "If somebody asks the question and I can give them an answer, it can be done 5 minutes later....
>
> "And by having, as we have there, access to the complete ramification of resources as well as decision elements that are required to do these things, we just cut out all the falderal, if you want to put it in simple terms....
>
> "It is nothing for us to select somebody and tell him what to do and get him underway in a week's time...."
>
> Senator Kefauver. "Then, as I take it, in the research or in the first stage, you have there the heads of all the divisions where decisions can be made by pulling them in for a conference."
>
> General Medaris. "That is right."
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> Senator Kefauver. "Whereas if a research contract is placed with, say, Company A, then that company has got to get Company B, Company C, Company D, and Company E all together. That takes time.

"And then where there are changes in plans or decisions to be made, the Company A man has got to then get in touch with Companies B, C, D, and E at distant places--"

General Medaris. "That is correct...."

Senator Kefauver. "In other words, no one industry would have all the groups together that you have down there."

General Medaris. "No, sir. And, if they had them, they would have them in different plants scattered around over the country; whereas, as Dr. von Braun has so ably put it, those decisions are made over the intercom. I can flip 6 keys and I can talk to 6 laboratory chiefs and I can get an answer. They are all right there."

Senator Kefauver. "Then, as I understand it, you orient your contractor like you did with Chrysler, and as soon as the manufacturing is to be done, they can move right in."

General Medaris. "Well, they come right in at the beginning. We had them bring in, when we started on JUPITER; they sent a hundred people down there."

Senator Kefauver. "Now let us take just an average operation. Your system and the other system, how much would you say you cut the lead time by the way you operate?"

General Medaris. "I think, given equal quality and equal complexity of the system, that we take a year off as a minimum on fielding of the system...."[32]

Five EXPLORERS

JUPITER-C 29. The success of Russia's SPUTNIK I inflamed world imagination, but now its heart responded as

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32. Inquiry Into Satellite and Missile Programs, Washington 1958, pp. 1711-1713.

this country's Army did what it had claimed it could do. Within four months after SPUTNIK I, ABMA's JUPITER-C 29 on 31 January 1958 lofted EXPLORER I "when the chips were down," after bad weather postponed launching on 29 and 30 January. Special fuel, UDMH-Deta, raised the engine thrust from a normal 78,000 to 83,000 pounds.

Called EXPLORER I upon its successful launching from Cape Canaveral at 2248 hours E.S.T., the 30.8 pound satellite, including instruments, was a U. S. contribution to the International Geophysical Year. At 220 miles altitude, lowest point of orbit, the satellite reached a velocity of 18,500 miles per hour. At apogee, 1,700 miles altitude, there was a velocity of 15,400 miles per hour.[33]

For scientific purposes the satellite carried aloft a cosmic ray measuring device, a gauge for determining cosmic dust, thermometers, and telemetry equipment consisting of Microlock and Minitrack transmitters. One transmitter battery had a life expectancy of two weeks; the other transmitter had two months expectancy. Estimates of the life expectancy of the satellite were as low as 10 years and high as 20.[34]

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33. DOD, ABMA Rpt., 24 Mar. 1958, subj.: Firing Test Rpt. JUP. C Msl. 29, Hist. Off. files.
34. DOD, ABMA Rpt., 26 Feb. 1958, subj.: Artificial Earth Satellite 1958-Alpha, and Aeroball. Eval. Test Flight JUP. C-29, DA Memo #321, 1 Mar. 1958, both in Hist. Off. files.

[redacted]

Although Florida saw EXPLORER I launched, the city of Huntsville, Alabama, staged its greatest celebration to date. And at Huntsville ABMA employees interrupted their evening to drive onto the base for the occasion. As was customary with firings, but especially this one, teletype from Cape Canaveral gave ABMA Headquarters a second-by-second account of countdown and orbiting procedures.

In Florida was Maj. Gen. Medaris and several top ranking members of his staff. Dr. Wernher von Braun, in Washington for a Congressional hearing, stayed informed from there.

Around midnight, Huntsville time, President Eisenhower officially announced America's first satellite. There was national celebration, but probably nowhere like Huntsville, where automobile honking and street dancing continued late into the night.

In addition to the primary tests of this flight, secondary tests included testing of solid propellant stages and their payload and testing of proportional spatial attitude control.

<u>JUPITER-C 26</u>. Less successful than EXPLORER I, but also under less demanding circumstance, was EXPLORER II's failure to orbit from JUPITER-C 26, fired on 5 March 1958,

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1328 hours E.S.T. Lift-off was normal and the missile closely followed the predicted trajectory as indicated by optical, DOVAP, Beat-Beat, and radar tracking. Proper attitude was maintained and second and third stage ignition occurred.

The missile was to place an 18.83 pound instrument payload in orbit around the earth as a contribution to the International Geophysical Year. The scientific instruments included in the payload were: (1) Cosmic ray counter of the State University of Iowa; (2) Erosion gauges to determine the cosmic dust for the Air Force Cambridge Research Center; (3) Thermometer for the Jet Propulsion Laboratory; (4) Microlock instrumentation for tracking by microlock doppler; and (5) Antennae for telemetering of scientific data using minitrack instrumentation.[35]

The first stage performed satisfactorily, LOX depletion occurring approximately 7 seconds before the predicted cutoff time of 149.1 seconds. However, the electronic tracking system indicated the proper velocity of stage one was not obtained.

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35. S&M Lab. Rpt. No. DSD-TM-4-58, 23 May 1958, subj.: JUP. C. Msl. RS-26 Thermal Environment Analysis Sys. Rpt., Hist. Off. files.

Ignition of the second stage occurred at 390.41 seconds of flight time; 394.4 seconds had been predicted. The fourth stage did not fire, causing the satellite to fall. The Army's second satellite attempt thus ended in failure.[36]

JUPITER-C 24. However, on 26 March 1958 JUPITER-C 24, standby replacement for JUPITER-C 26, placed EXPLORER III in orbit. It went from Cape Canaveral, Florida, at 1238 hours E.S.T., and it too contributed to the International Geophysical Year. The 31-pound satellite carried aloft an 18.53 pound scientific payload.

Electronic tracking and telemetry records indicated a satisfactory launching, except that EXPLORER III orbited with greater eccentricity than predicted.[37]

EXPLORER III had the same type carrier vehicle as EXPLORER I. Its instrumentation, however, included a miniature tape recorder, not on the first satellite. This recorder made it possible to collect radiation information throughout the entire orbit, and then return the information

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36. Aeroball. Lab. Flight Eval. Br., DA Tech. Note No. 108, 2 Apr. 1958, Hist. Off. files.
37. TT, Dir., MFL, PAFB, to CG, ABMA, 29 Mar. 1958, subj.: Data Rpt. on Flight Test of JUP. C Msl. 24 (EXPLORER III), Hist. Off. files.

to earth upon signal as the satellite passed over ground stations. EXPLORER III's battery-powered transmitters had a life expectancy of about two months.

The tremendous sweep of EXPLORER III's somewhat eccentric orbit, from 117 to 1,740 miles above earth, made it "splendid for cosmic ray research."[38] EXPLORER III's perigee was the closest to earth of any satellite, U. S. or Russian, orbited to date. Though the satellite entered the unusual orbit, it outlasted its two-month batteries, thus furnishing all the data planned.

During its lifetime the satellite swung closer to Earth at the rate of several hundred feet a day. By early June both transmitters ceased to function reliably; but scientists had learned that cosmic radiation at higher altitudes was considerably more intense than anticipated. They also learned that atmospheric density was several times greater than that predicted in pre-satellite calculations. As for temperature, scientists discovered that man can control space vehicle temperature within limits acceptable for human survival.

<u>JUPITER-C 44</u>. Four months to the day after EXPLORER III, EXPLORER IV went into orbit, 26 July 1958. Weighing

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38. Dr. James A. Van Allen is quoted in <u>Redstone Rocket</u>, 9 Apr. 1958.

38.43 pounds, it went from Cape Canaveral, like its two predecessors. EXPLORER IV's instrumentation was oriented toward checking corpuscular radiation at extreme altitudes and latitudes. The findings of previous EXPLORER's prompted such investigation, indicating that high corpuscular radiation intensities were much greater than anticipated at high altitudes. EXPLORER IV carried four radiation counters, as compared to the single counters in I and III; it thus could provide many times the accurate counting rate. As with I and III, the State University of Iowa designed the counters, and JPL and the Naval Research Laboratories furnished communication equipment.

Because of the extra radiation counters in EXPLORER IV the Agency could not include a tape recorder, as in EXPLORER III, or the micrometeorite and temperature experiments of EXPLORER's I and III. As it was, both EXPLORER's IV and V carried unusually heavy instrumentation.[39] To have it cover most of the earth's surface, the Agency also increased the incline toward the equator of EXPLORER IV's orbital plane (and planned the same for V).[40]

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39. The Explorers, 25-30 August 1958, p. 8, Dr. Wernher von Braun, Speech before International Astronautical Federation, Amsterdam, Hist. Off. files.
40. Interview with Dr. Ernst Stuhlinger, ABMA, 5 Nov. 1958.

On 6 October 1958 Naval Research Laboratories received the satellite's final signals, though it would remain aloft about 8 months more. Already its more than 900 round trips had supported the high radiation findings of EXPLORER's I and III.[41]

<u>JUPITER-C 47</u>. EXPLORER V, with a mission similar to EXPLORER IV's, failed to orbit, though once more JUPITER-C lived up to its newspaper nickname "Old Reliable," for all four stages functioned properly. The trouble came when the "booster continued to accelerate and hit the upper-stages some 12.5 seconds after separation. There were at least two collisions thereafter...."[42]

<u>JUPITER-C 49</u>. This missile, in support of the Advanced Research Projects Agency, had the mission of lofting a new kind of satellite, a foil-covered inflatable sphere developed by NACA. However, neither the balloon nor its

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41. TT, from Research Dept. of Physics, State Univ. of Iowa, to Dr.'s von Braun and Stuhlinger, ABMA, 20 Aug. 1958, subj.: Report on 1st Two Weeks Radiation Measurement, EXPLORER IV, ABMA Central Files. The TT said, in part:

    "EXPLORER I and III results are being confirmed by detectors on EXPLORER IV...the radiation has been found to vary both in quantity and quality with latitude and altitudes."

42. Memo, Deputy Commander to Commander, ABMA, 3 Sept. 1958, subj.: Supplement to Post Firing Reports, JUNO I Missiles 44 and 47, ABMA Central Files.

container orbited, though the JUPITER-C vehicle functioned properly, once again proving itself "Old Reliable."

The balloon, if successful, would have inflated itself from a 35.5 pound satellite payload, thus testing the survival of a large sphere in space and providing psychological advantage for the "free world." JUPITER-C 49's satellite payload consisted of the aluminized plastic sphere, a pressurizing bottle for filling the balloon with nitrogen, a low-power (15 milliwatt) Microlock-type tracking beacon with two telemetering channels for a one week's nominal lifetime, and a small propellant motor for providing a "kick in the apogee"* technique. This latter would kick the satellite into a more circular orbit, and hence prolong its life. All of the satellite payload was in a cylindrical shell only 50 inches long and 7 inches wide.[43] Both the shell and the balloon would continue in orbit, with the balloon slowly dropping into lower elevation.

The orbiting difficulty began ten seconds before the second stage ignited, following a night firing from Cape

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* In this local expression, apogee referred to upper portion of orbit, not necessarily highest point.

43. Addendum I to Development and Funding Plan For Project One, ARPA Order Nr. 1-58, As Amended, 15 May 1958, 11 July 1958, p. 1, Hist. Off. files.

Canaveral, 22 August 1958. It was first reported that the "Microlock Transmitter may have broken off and separated at 110 seconds, which is the time a steep increase in vibration was indicated...."[44] This changed later to "oscillations building up in the front part of the missile, perhaps causing the total upper stage assembly to break off."[45]

There was much press coverage of both the firing and the unusual disappearance. Previous Army policy had withheld information of satellite attempts until after launching, but the press was fully alerted for this one. Change of Army policy in terms of advance publicity came at a time when the National Aeronautics and Space Administration was demanding the transfer to NASA of ABMA scientists, and also at a time of "wide open" Air Force publicity concerning its various launchings.*

Future ABMA Satellites

Two lunar and one earth satellite missions were on ABMA's schedule after 1 November 1958. The Advanced Re-

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* Several weeks earlier Army PIO began a "Truth Campaign" concerning Army missiles.

44. TT, Dir., MFL, Patrick AFB, to CG, ABMA, Redstone Arsenal, 23 Aug. 1958, subj.: Post Firing Report--JUPITER Missile CC-49, Hist. Off. files.
45. Interview with Dr. Ernst Stuhlinger, ABMA, 5 Nov. 1958.

search Projects Agency had requested the two lunar probes on 27 March 1958.[46]

On 27 March the Government published a summary of Congressional lunar hearings, which said in part:

"The early (lunar) experiments which should take priority are, in general, those which give information about the moon as a whole, rather than about the particular point of impact. These will reveal the most about the processes by which it was formed, its past history, and so forth, and will be most useful in planning for subsequent experiments...."

"....Although it is impossible to predict how quickly man himself will follow his exploring instruments into outer space, the inevitable culmination of his efforts will be manned space flight and his landing on the nearer planets. It is clear that he can develop the ability to do this, and it is hard to conceive of mankind stopping short when such a tempting goal is within reach.

"The attainment of manned space flight, however, cannot now be very clearly justified on purely rational grounds. It is possible, at least in principle, to design equipment which will do the sensing needed to explore space and the planets. Mobile vehicles could be designed to land and crawl across the face of each of these distant worlds, measuring, touching, looking, listening, and reporting back to earth all the impressions gained. They could be remotely controlled, and so could act like hands, eyes, and ears for the operator on earth. Moreover, such robots could be abandoned without a qualm when they ran out of fuel or broke down.

"Though all this could be done in principle, there may be a point at which the complexity of the

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46. Ltr. from Mr. Roy M. Johnson, Advanced Research Projects Agency, to CG, ABMA, 27 Mar. 1958, subj.: ARPA Order #1-58, Hist. Off. files.

machine to do the job becomes intolerable, and a man is found to be more efficient, more reliable, and, above all, more resourceful when unexpected obstacles arise...."[47]

JUPITER 11. JUPITER 11, the first lunar probe, was scheduled to go about 5/8 December 1958. JUPITER 11's fifteen pound satellite would measure cosmic ray intensities to very high altitudes, as well as provide a "dry run" for camera equipment in a moon satellite.

JUPITER 14. Tentatively, JUPITER 14,[*] to launch the second Army lunar probe, would go in February 1959, its 15-pound satellite then photographing the moon, and the image returning to earth by telemetry.

At no time did scientists expect this to be easy, but by the fall of 1958 there was growing apprehension as to difficulties that might really be involved. Prior to its third unsuccessful lunar try, 8 November 1958, the Air Force emphasized "one to twenty-five odds against success."

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* The preface JUNO, rather than JUPITER, is sometimes used when referring to ABMA satellite and space vehicles. When thus used, the designation JUNO I refers to JUPITER-C missiles and JUNO II to non-alphabetized JUPITER missiles that launch satellites.

47. Compilation of Material On Space and Astronautics No. 1, March 27, 1958, pp. 37, 44 Special Comm. On Space and Astronautics, United States Senate, ABMA Technical Documents Library files.

Earlier ABMA Commander Brig. Gen. John A. Barclay spoke of accuracy problems facing ABMA scientists, and others, interested in reaching the moon. "Cut-off velocity of the last propulsion stage must be accurate to within one part in one thousand," General Barclay told Detroit, Michigan listeners. "The injection angle of the vehicle into the earth-lunar ellipse must be accurate to within one-fourth of a degree." And without "continuous aiming of the launching platform and continuous changes in the initial trajectory program, the instant of firing must be timed to within one or two seconds because the earth is a rapidly rotating firing platform and the moon is a rapidly moving target."[48]

Prof. Hermann Oberth, returning to Europe in November 1958, informed the world's press of extreme odds facing lunar and other probes using conventional space vehicles.

<u>JUPITER 16</u>. The last Agency-scheduled satellite, as of 1 November 1958, was for March 1959. The vehicle, JUPITER 16, would orbit a 60-pound payload carrying IGY experiments, whose tests would include cosmic ray intensity, effects of solar radiation on terrestrial atmosphere, and

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48. <u>Missiles and Satellites</u>, 12 May 1958, pp. 7-8 Detroit speech by Brig. Gen. John A. Barclay, Hist. Off. files.

daily value of input to the atmospheric heat engine. Like its predecessor earth satellites, JUPITER 16 would go from Cape Canaveral, Florida.

Larger Vehicles and Larger Satellites. In September the nation's press gave wide coverage to an "Army plan for constructing a super-booster rocket engine," for orbiting a manned satellite. It followed a Defense Department announcement of a "$2 million Army contract award for a mammoth booster with an aim of 'placing very large payloads into orbit.'" It was believed that the booster, "missilemen's term for the first stage of a multi-stage rocket, will have a thrust of 1½ million pounds--approximately eight times more powerful than any existing propulsion unit in America's rocket arsenal.... The announcement of the Army contract said the super-booster will consist of already tested rocket motors packed into a single unit."[49]

This program became the Army's JUNO V Booster Program, under ARPA Order 14-59, dated 15 August 1958.

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49. "Super Rocket Engine Order Stirs Questions," Birmingham News, Birmingham, Ala., Sept. 13, p. 1. For an official summary of this JUNO V Booster Program comparing single engine designs and the proposed 1½ million pounds thrust, see Appendix, this monograph.

Army Ordnance Missile Command

Organization of the Army Ordnance Missile Command, 31 March 1958, unified ABMA and appropriate Ordnance agencies, thus improving Army space capability. As mentioned in an earlier chapter, Army Ordnance Missile Command wrote the first general mission directive allowing ABMA a satellite venture, though several EXPLORER's were orbited previously, on special orders.[50]

The new Command organization consisted of the Army Rocket and Guided Missile Agency, White Sands Missile Range, and Jet Propulsion Laboratory as well as ABMA. ABMA Commander Maj. Gen. J. B. Medaris became AOMC's first Commander.

National Aeronautics and Space Administration

Late in October 1958 NASA Chief T. Keith Glennan requested from the Army its ABMA scientists and engineers, plus all Jet Propulsion Laboratory facilities. This rivalled Secretary Wilson's "200 mile range limitation" in threatening Army space capability.

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50. Chapter I, p. 5.

Earlier, Dr. Wernher von Braun and Dr. Ernst Stuhlinger among others signed a November 1957 proposal for "A National Mission to Explore Outer Space." The proposal read, in part:

"In the interest of human progress and our national welfare, it is proposed that a national project be established with the mission of carrying out the scientific exploration and eventual habitation of outer space. It is imperative that the Nation do so to increase its scientific and technological strength....

"To carry out the objectives of the stated mission it is recommended that a National Space Establishment be created. This establishment in carrying out its mission shall have the authority, responsibility, and accountability to conduct the theoretical, experimental, developmental and operational work necessary, making best of the academic, industrial and military resources of the Nation....

"It is essential that the National Space Establishment be scientific in nature and in concept and be under civilian leadership and direction. It should be organized within the executive branch of the Government taking full account of the requirements of the Department of Defense in the field of space research and engineering to insure that the National Space Establishment contributes its maximum to the national security. The establishment should be staffed and operated on the basis of a salary and wage scale suitable to its needs....

"The Rocket and Satellite Research Panel is absolutely convinced that there are compelling reasons for our Nation to undertake the scientific exploration and habitation of outer space....

"The Rocket and Satellite Research Panel has devoted itself for the last 10 years to pioneering the Nation's effort in the research exploration of the threshold of space. The panel is dedicated to continuing these activites and looks forward to participating in the actual accomplishment of the stated mission...."[51]

Less than two months later, General Medaris had this to say before the Preparedness Investigating Subcommittee of the United States Senate:

General Medaris. "I cannot in conscience endorse an independent agency. I believe that at the present state of the development of missiles, techniques, technology, and the number of people and teams that are available and capable of doing it, that there is no need for erecting a separate agency with operating characteristics outside the Defense Department for doing this job.

"I believe sincerely that the best method for achieving it is that there must be someone responsive only to the Secretary of Defense...who through the medium of a very small staff can carry out the necessary job of assigning these projects...."

Mr. Vance. "When you say 'assigning these projects,' do you mean assigning them to the various services? Army, Navy, and Air Force?"

General Medaris. "Assigning them to the various services and agencies already in existence that can do the best job on it. There is no crippling there. I could not function in ABMA tomorrow were I removed from the framework of the Army support, I could not function. If you took ABMA as it exists, and I think it is a cracking fine outfit, and you put it out someplace by itself, I would have to double its size tomorrow, and I would not add one dollar's worth of productive effort.

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51. Compilation of Material On Space and Astronautics No. 1, March 27, 1958, pp. 14-16, Special Comm. On Space And Astronautics, United States Senate.

"I would have to do that in order to provide it with the basic living conditions in the Government atmosphere that are provided for me by living inside of the Army system, and by being able to call on other elements of the Army and of Army contractors and of Army resources for the work that I need done, the assistance that I need, and being able to receive from the Department of the Army the administrative support, allotment of personnel, and things that I require....

"There are no resources in this country that properly can be taken out for nothing but space work. This is improper, and if you did so you would create a degree of confusion with respect to other things that have to be done that you would be a year and a half getting over.

"I think that the creation of an operating agency apart from the Secretary of Defense, or as an operating agency even within the Office of the Secretary of Defense if it is made an operating agency, and supposedly administratively self-sufficient, and so on, will create a confusion that will set our program back a year."[52]

Prior to this, 14 December 1957, General Medaris appeared before the Space and Astronautics Special Committee of the United States Senate. Here is a Government summary of his remarks:

"Does he (General Medaris) agree with General Gavin's view that satellites should be given greater priority than ballistic missiles? He would not want to limit it to satellites. Priority should

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52. Inquiry Into Satellite and Missile Programs, Washington 1958, p. 1710, Committee On Armed Services United States Senate, Part II.

REGRADED Unclassified, BY AUTHORITY OF Security Classification Comm. BY I. M. Ratts
13 Feb. 1959 ON 13 March 1959

always be on the furthest thing out. The priority should be on the attainment of a space capability at the earliest possible date.

"Satellites and ballistic missiles have many basic techniques, they cannot be separated. Divorcement of the two impedes both....

"He does not agree with the recommendation for an independent agency. One individual must be charged with responsibility. If that individual is charged with setting up an organization we will impede the program. We already have too many committees and commissions...."[53]

It was understandable that the Army didn't want to lose its ace group of German specialists who played such an impressive role on its satellite team, an Army team of "producing scientists" and "using ordnance." The EXPLORER's were making themselves known.

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53. Compilation of Material on Space and Astronautics No. 1, March 27, 1958, pp. 6-7, Special Comm. On Space and Astronautics, United States Senate.

A P P E N D I X

[illegible] : [illegible] [illegible]

[illegible] : AGWAR [illegible]

INFO [illegible]: USFET [illegible]

[illegible] NO : [illegible]AR-36[illegible]

[illegible]essage as paraphrased:

ROUTINE

Shipment of [illegible] in [illegible] scientists in science and technology to the United States has been approved [illegible] States Chiefs of Staff with agreement of British [illegible] to conduct research related to Japanese war [illegible] be accomplished in this theater. Scientists must not [illegible] war criminals and must be volunteers. [illegible] theater will afford protection to their dependent [illegible] families. Separate message will follow [illegible].

Colonel [illegible] upon arrival in theater and the [illegible] Department.

As agreed in principle [illegible] related documents, equipment [illegible]. It is suggested you obtain [illegible] British [illegible] to ship, with scientists, [illegible] equipment, [illegible] pending receipt of [illegible] Staff [illegible]. [illegible] selected by your [illegible] Navy, [illegible] Service [illegible], equipment and records to accompany scientists [illegible] with EEIS and AIRS for direct shipment to United States. Washington [illegible] Documents Center will control documents. British [illegible] of exploitation.

ACTION: G-2

INFO: SGS
Ordnance
Log
Summary
AG Records

[illegible]

RESTRICTED

HEADQUARTERS
UNITED STATES FORCES
EUROPEAN THEATER

SEM/eed
(Rear) APO 887
15 Sept 1945

AG 300.4 (14 Sept 45) J-1120.

Subject: Orders (Statistical Code PTN).

To: Civilians Concerned.

1. The civilians named below, Germans, will proceed on or about 18 Sept 1945, from their present station in this theater by first available air (designators indicated) transportation to the United States, reporting upon arrival to the Port Commander, Port of Debarkation, for movement to Fort Standish, Boston, Mass, reporting upon arrival to the Commanding General for temporary duty, for the purpose of carrying out their assigned mission. Upon completion of this duty, the civilians named below will return to their proper station in this theater.

~~KARL BAUR~~	(ET-US-III-P0027-WDP-Sept)
~~OTTO BOCK~~	(ET-US-III-P0028-WDP-Sept)
~~GERHARD BRAUN~~	(ET-US-III-P0029-WDP-Sept)
WERNHER VON BRAUN	(ET-US-III-P0030-WDP-Sept)
~~RUDOLF [illegible]~~	(ET-US-III-P0031-WDP-Sept)
~~FRITZ HINDELANG~~ FRS	(ET-US-III-P0032-WDP-Sept)
WILHELM JUNGERT	(ET-US-III-P0033-WDP-Sept)
ERICH NEUBERT	(ET-US-III-P0034-WDP-Sept)
~~WOLFGANG NOEGGERATH~~	(ET-US-III-P0035-WDP-Sept)
THEO POPPEL	(ET-US-III-P0036-WDP-Sept)
EBERHARD REESE	(ET-US-III-P0037-WDP-Sept)
~~HANS RITTER~~ RISTER FRS	(ET-US-III-P0038-WDP-Sept)
AUGUST SCHULZE	(ET-US-III-P0039-WDP-Sept)
WALTER SCHWIDETSKI ZKY FRS	(ET-US-III-P0040-WDP-Sept)
~~ANDREAS SEBALD~~	(ET-US-III-P0041-WDP-Sept)
~~THEODOR F. STURM~~	(ET-US-III-P0042-WDP-Sept)
~~THEODOR ZOBEL~~	(ET-US-III-P0043-WDP-Sept)

2. Travel by military or naval aircraft, Army or Naval transport, commercial steamship, belligerent vessel, aircraft and rail transportation is directed.

3. In lieu of subsistence a per diem of six dollars ($6.00) is authorized each civilian named above while in a travel status to the United States, while on temporary duty in the United States, and while in a travel status returning to Germany. A copy of the voucher on which the per diem is paid will be furnished the Office of the Fiscal Director, European Theater. FDGA 60.

4. Information concerning War Department, Army or personal activities of a military nature within this theater will not be discussed in private or public and will not be disclosed by means of newspapers, magazines, books, lectures, radio or any other method without prior clearance through the War Department Bureau of Public Relations or the appropriate Public Relations Officer of Army Installations.

RESTRICTED

(Over)

WAR DEPARTMENT
Bureau of Public Relations
PRESS BRANCH
Tel. - RE 6700
Brs. 3425 and 4860

October 1, 1945

IMMEDIATE RELEASE

OUTSTANDING GERMAN SCIENTISTS BEING BROUGHT TO U.S.

The Secretary of War has approved a project whereby certain outstanding German scientists and technicians are being brought to this country to ensure that we take full advantage of those significant developments which are deemed vital to our national security.

Interrogation and examination of documents, equipment and facilities in the aggregate are but one means of exploiting German progress in science and technology. In order that this country may benefit fully from this resource a number of carefully selected scientists and technologists are being brought to the United States on a voluntary basis. These individuals have been chosen from those fields where German progress is of significant importance to us and in which these specialists have played a dominant role.

Throughout their temporary stay in the United States these German scientists and technical experts will be under the supervision of the War Department but will be utilized for appropriate military projects of the Army and Navy.

END

DISTRIBUTION: Aa, Af, B, Da, Dd, Dm, N,

4:30 P.M.

7

2.45 (1/2)

4

[redacted]

SAVE

IN REPLY REFER TO:

HEADQUARTERS, ARMY AIR FORCES
WASHINGTON

[redacted]
By Authority of
The Commanding
Army Air F
19 Mar 46
Date Initials

SUBJECT: Changing of the Code Word "OVERCAST"

TO: Commanding General, Air Materiel Command, Wright Field, Dayton, Ohio

Attention: Intelligence, T-2

1. Effective 13 March 1946, the code word PAPERCLIP was substituted for the code word OVERCAST, due to compromise of the latter word.

2. The meaning previously attached to OVERCAST was not compromised and will now attach to PAPERCLIP.

BY COMMAND OF GENERAL SPAATZ:

N. B. Harbold

N. B. HARBOLD
Brig. Gen., U.S.A.
Chief, Air Information Division
Office of Ass't Chief of Air Staff - 2

126

V-16662

[redacted]

8

[illegible] C O P Y

[illegible] AIR MATERIEL COMMAND

Subject: [illegible] Project Paperclip

[illegible]

[illegible] [illegible] Project Paperclip, [illegible] German [illegible] been brought to the United States.

[illegible] Coordinating Committees have approved [illegible] date for the procurement of these specialists. [illegible] only [illegible] cases will be processed thereafter [illegible] Chiefs of Staff. Justification must be [illegible] these scientists after this date and supporting evidence [illegible] Chiefs of Staff indicating sufficient reasons why [illegible] not been previously requested.

[illegible] any requests for scientists who are [illegible] or who may be desired in the near future be [illegible] September [illegible] in order that [illegible] these scientists and specialists may be initiated.

s/ Malcolm D. Seashore
M. D. SEASHORE
Lt Colonel, Air Corps
Acting Chief Analysis Division
Intelligence (T-2)

JH/[illegible]
222 5
[illegible]

Several scientists have been requested by more than one service and are accordingly credited to the service having chronological priority.

On temporary [illegible]

(1), (2), (3) On TDY in U. S.

NAME	ARRIVED	USING AGENCY		STATION	SPECIALTY
ADENSTEDT, Heinrich	21/1/47	AAF		Wright Field	Fuel & turbines & propulsion
AICHINGER, Gerhard E.	16/8/46	AC		Wright Field	Parachutes
ALBERS, Heinrich	14/7/46	AC	(1)	Wright Field	Rolling
ALBERTS, Leonard	24/6/46	QMC		BOM - Pittsburg	Hydrocarbons
AMMAN, Rudolph M	17/11/45	AC		Wright Field	Jet Engines
AMTMANN, Hans	4/12/46	AC		Wright Field	Aircraft Engines
ANGELE, Wilhelm	3/2/46	ORD		Fort Bliss	Guided Missiles
ARNOLD, Gottfried M.	17/11/45	AC		Wright Field	Supersonics
ASCHENBRENNER, Dr. Claus	14/8/46	AC	(2)	Wright Field	Aerial Photography
AULOCK, Wilhelm von	24/5/47	Navy		Nav/Bks, Wash.	Torpedoes
AXSTER, Herbert F.	17/11/45	ORD		Fort Bliss	Guided Missiles
BALJE, Otto Erich	17/12/46	AC		Wright Field	Turbines & Superchargers
BALL, Erich K.A.	17/11/45	ORD		Fort Bliss	Guided Missiles
BARTHOLOMEAUS, Hans	24/5/47	AC		Randolph Field	Medical technician
BAUMKER, Adolf	28/5/46	AC		Wright Field	Air Facilities
BAUSCHINGER, Oscar H.	17/11/45	ORD		Fort Bliss	Guided Missiles
BEDUERFTIG, Hermann F.	17/11/45	ORD		Fort Bliss	Guided Missiles
BEER, Heinz	13/10/46	AC		Wright Field	Jet Engines
BEICHEL, Rudi	17/11/45	ORD		Fort Bliss	Fuided Missiles
BEIER, Anton	17/11/45	ORD		Fort Bliss	Guided Missiles
BEINERT, Helmut	25/2/47	AAF		Randolph Field	Chemist
BENZ, Emil	25/2/47	AAF		Wright Field	Technician - Glass Blowing
BENZINGER, Theodor	25/2/47	Navy		NMRI, Bethesda	Physician
BERGELER, Herbert	9/4/46	ORD		Fort Bliss	Guided Missiles
BERKNER, Hans	13/10/46	AC	(3)	Wright Field	Diesel Engines
BERNDT, Rudi	16/8/46	AC		Wright Field	Parachutes
BIELITZ, Friedrich	4/12/46	AC	(3)	Wright Field	Dynamics
BIELSTEIN, Hans	13/10/46	AC	(3)	Wright Field	Chemist
BINGEL, Abraham	24/5/47	AC		Randolph Field	Medical technician
BOCCIUS, Walther	3/2/46	AC		Wright Field	Plane Tests
BOCK, Otto	20/9/45	AC		Wright Field	Supersonics
BOEHM, Josef M	17/11/45	ORD		Fort Bliss	Opided Missiles
BOSCH, Carl	24/5/47	Navy		Nav/Bks, Wash.	Optics & infra-red
BOST, Heinrich	24/2/47	AAF		Wright Field	Aircraft
BOTH, Dr. Eberhard	26/3/47	SC		Ft. Monmouth	Ceramics
BOTTENHORN, Hermann	14/7/46	AC	(1)	Wright Field	Rolling Mill Designer
BRABENDER, Carl W.	24/5/47	QM		F & C Inst, Chicago	Dev Engr/Scientific testing instr's
BRAUN, Gerhard	20/9/45	AC		Wright Field	Motor Research
BRAUN, Magnus V.	17/11/45	ORD		Fort Bliss	Guided Missiles
BRAUN, Werner V.	20/9/45	ORD		Fort Bliss	Guided Missiles
BREDE, Hans	21/7/46	AC	(3)	Wright Field	
BREDTSCHNEIDER, Kurt	10/4/47	QM		BOM Torrance Calif	Synthetic fuels

NAME	ARRIVED	SERVICE AGENCY	STATION	SPECIALTY
BR[illegible]IL, Rudolf	[illegible]	[illegible]	Ft Monmouth	Inorganic physical chemistry
BRINGEWALD, August	4/12/4[illegible]	AC	Wright Field	Aircraft Design
BRISKEN, Walter	4/12/46	AC	(3) Wright Field	Aircraft Engines
BRUCKMANN, [illegible]	[illegible]/46	AC	Wright Field	Jet Units
BUCHHOLD, Theodor	24/[illegible]	ORD	Fort Bliss	Guided Missiles
BUCHMANN, Erich	2[illegible]/47	Navy	Nav Bks, Wash.	Physicist
BUECHEL, Irwin	2/6/47	AC	Randolph Field	Research & technical translating
BUEHR, Hermann	2/6/[illegible]	Navy	TIEB, San Pedro/Calif	Machinist
BUEHRING, Willi	21/1/47	AC	Wright Field	Aero-medical research
BUESSEM, Wilhelm Dr.	24/2/4[illegible]	AAF	Wright Field	Ceramics
BUETTNER, Konrad	2/6/47	AC	Randolph Field	Bioclimatology
BURKHARDT, Ursula	2/6/47	AC	Randolph Field	Medical technician
BUROSE, Walter W.R.	3/2/45	ORD	Fort Bliss	Guided Missiles
BUSEMANN, Adolph	24/5/47	Navy	NACA, Langely Fld, Va.	Air flow gas dynamics
CLAMANN, Hans Georg	24/5/47	AC	Randolph Field	Aero medicine
DANIELIS, Kurt	13/10/46	AC	Wright Field	Aircraft Design
DANNENBERG, Konrad	17/11/45	ORD	Fort Bliss	Guided Missiles
DeBEEK, Gerd W.	17/11/45	ORD	Fort Bliss	Guided Missiles
DEBUS, Kurt	6/12/45	ORD	Fort Bliss	Guided Missiles
DELLMEIER, Gunther	28/5/46	AC	Wright Field	Wind Tunnels
DIECHMANN, Max	2[illegible]/47	AC	Wright Field	Electronics
DIRKSEN, Bernhard	26/10/46	AC	Wright Field	Materials
DOBLHOFF, Friedrich	24/6/46	AC	Wright Field	Jet-helicopters
DOBRICK, Herbert	6/12/45	ORD	Fort Bliss	Guided Missiles
DOEPP, Philip von	17/11/45	AC	Wright Field	Guided Missiles
DOHM, Friedrich	6/12/45	ORD	Fort Bliss	Guided Missiles
DONATH, Ernst	21/1/47	[illegible]	BOM Torrance Calif	Dehydrogenation
DRAEGER, Walter Wilhelm	30/11/46	NAVY	NOL W/Oak	Floating Crane
DRAWE, Gerhard	17/11/45	ORD	Fort Bliss	Guided Missiles
DUELL, Bernhard Dr.	23/8/46	QM	Army War College	Medical Geography
DUELL, Gertraud	23/8/46	QM	Army War College	Medical Geography
DUERR, Friedrich	17/11/45	ORD	Fort Bliss	Guided Missiles
EBER, Gerhard	3/2/46	NAVY	NOL White Oak, Md.	Supersonics
ECKENER, [illegible]	2[illegible]/47	Navy	GAC, Akron, O.	Aeronautics
ECKERT, Ernst R.G.	17/11/45	AC	Wright Field	Aerodynamics
ECKERT, Hans Ulrich	28/5/46	AC	Wright Field	Wind Tunnels
EDSE, Rudolf	20/9/45	AC	Wright Field	Rocket Fuels
EHRICKE, Kraft	21/1/47	ORD	Fort Bliss	Design & dev/rocket engines
EISENHARDT, Otto K.	17/11/45	ORD	Fort Bliss	Guided Missiles
EITEL, Wilhelm Dr.	17/12/46	NAVY	Port Wash	Silicates
ELIAS, Willy	13/10/46	AC	(3) Wright Field	Test Engineer
ERFURTH, Kurt	26/10/46	AC	Wright Field	Aircraft Design
ERNSTHAUSEN, Dr Wilhelm	24/5/47	AC	Wright Field	Physicist
FICHTNER, Hans J.	17/11/rt	ORD	Fort Bliss	Guided Missiles
FINZEL, Johannes	17/11/45	ORD	Fort Bliss	Guided Missiles
FISCHEL, Eduard	6/12/45	ORD	Fort Bliss	Guided Missiles
FISCHER, Hans	21/7/46	ORD	Frankford Arsenal	Ferrous metals
FISCHER, [illegible]	17/11/45	AC	Wright Field	Aerodynamics
FISCHER, Karl	4/7/46	[illegible]	Army War College	Oil Chemistry
FLECK, Horst	24/5/47	AC	Randolph Field	Medical technician
FLEISCHER, Carl O.	17/11/45	ORD	Fort Bliss	Guided Missiles
FOLTES, Hans	25-2-47	Navy	PhilaNavShipyard	Chemistry
FOERSTER, Arthur	2/6/47	Navy	NAMC, Phila/Pa	Airship Engr

NAME	ARRIVED	USING AGENCY	STATION	SPECIALTY
FORNET, Dr. Arthur	26/3/47	QM	F & C Inst, Chicago	Cereal Technology
FORNOFF, Heinz	26/10/46	AC	Wright Field	Jet Engines
FORSTER, Paul	26/10/46	Ac	Wright Field	Interferometers
FRANK, Johann	24/5/47	AC	Wright Field	Mechanic
FRANKE, Ernst Dr	24/5/47	AC	Wright Field	Physicist
FRANZ, Anselm	17/11/45	AC	Wright Field	Jet Engines
FRESE, Erich	24/6/46	QMC	[illegible] - Torrance, Cal	Hydration
FREYTAG, Ella	2/6/47	AC	Randolph Field	Medical technician
FRIEDRICH, Ernst	26/3/47	Navy	Fort Wash.	Radar Absorption
FRIEDRICH, Hans	6/12/45	ORD	Fort Bliss	Guided Missiles
FUCHSEL, Dipl Ing Karl	26/3/47	AC	Wright Field	Jet Engines
FUHRMANN, Herbert W.	17/11/45	ORD	Fort Bliss	Guided Missiles
GAUER, Otto	24/2/47	AAF	Wright Field	Aero Medicine
GEISSLER, Ernst	17/11/45	ORD	Fort Bliss	Guided Missiles
GENGELBACH, Werner K.	17/11/45	ORD	Fort Bliss	Guided Missiles
GERATHEWOHL, Siegfried	24/2/47	AAF	Randolph Field	Aero Medicine
GERBER, Eduard A.	24/2/47	SC	Ft. Monmouth	Crystals
GIENAPP, Eric	24/2/47	AAF	Wright Field	Mechanics
GIERKE, Henning von	24/5/47	AC	Wright Field	Physicist
GOETHERT, Bernhard	17/11/45	AC	Wright Field	Aerodynamics
GOUBAU, George	24/5/47	SC	Ft Monmouth	Applied physics
GRAF, Ernst	4/7/46	QMC	Army War College	Shale Oil
GRAU, Dieter	3/2/46	ORD	Fort Bliss	Guided Missiles
GRAULICH, Lambert	14/7/46	AC	Wright Field	Hollow Turbine Blades
GROSS, Rheinhold	16/8/46	AC	Wright Field	Parachutes
GROTH, Erich	13/10/46	AC	Wright Field	Aerodynamics
GRUENE, Hans	17/11/45	ORD	Fort Bliss	Guided Missiles
GRUNER, Heinz	24/6/46	CE	Army Map Service	Photogrammetry
GUDERLEY, Dr. Karl G.	16/8/46	AC	Wright Field	Aerodynamics
GUENDEL, Herbert	6/12/45	ORD	Fort Bliss	Guided Missiles
GUENTHER, Richard	24/5/47	SC	Ft Monmouth	Tech/Engr
GUMZ, Wilhelm	24/5/47	QM	H-C RI, Trenton, NJ	Synthetic gas & oil
GUTTWEIN, Gunther	26/3/47	SC	Ft. Monmouth	Metal Recording
HABER, Heinz	21/1/47	AC	Randolph Field	Biophysics, astrophysics.
HAGEMANN, Julius	24/5/47	Navy	Navy/Bks, Wash.	Naval mines
HAGER, Karl	17/11/45	ORD	Fort Bliss	Guided Missiles
HARR, Dr. Ing Otto	26/3/47	AC	(3) Wright Field	Electronics
HARTUNG, Friedrich	25/2/47	AAF	Wright Field	Electronics
HASINGER, Siegfried	21/1/47	AC	Wright Field	Jet propulsion for planes
HASS, Georg	9/4/46	CE	Ft. Belvoir	Infra-Red
HAUKOHL, Guenther H.F.	17/11/45	ORD	Fort Bliss	Guided Missiles
HEEP, Henrich	4/12/46	NAVY	NEES Annapolis, Md.	Submarine Design
HEGELE, Alfons M.E.	16/8/46	AC	Wright Field	Parachutes
HEIDELAUF, Ulrich	2/6/47	AC	Wright Field	Technician
HEIMBURG, Karl L.	6/12/45	ORD	Fort Bliss	Guided Missiles
HEINRICH, Hans	9/4/45	AC	Wright Field	Fuel Systems
HEINRICH, Helmut	26/5/46	AC	Wright Field	Parachutes
HELL, Wilfried	20/5/45	NAVY	Pt Mugu, Calif.	Guided Missiles
HELLEBRAND, Emil A.	17/11/45	ORD	Fort Bliss	Guided Missiles
HELLER, Gerhard	6/12/45	ORD	Fort Bliss	Guided Missiles
HELM, Bruno	17/11/45	ORD	Fort Bliss	Guided Missiles
HENNING, Alfred H.	3/2/46	ORD	Fort Bliss	Guided Missiles
HENSCHKE, Ulrich	4/12/46	AC	Wright Field	Aero Medicine
HERMANN, Ing Paul	[illegible] 47	AC	[illegible]	Engineer
HERMANN, Rudolf	17/11/45	AC	Wright Field	[illegible]
HERZOG, Albrecht	[illegible] 46	AC	Wright Field	[illegible]

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NAME	ARRIVED	USING AGENCY	STATION	SPECIALTY
HEUSINGER, Bruno	17/11/45	ORD	Fort Bliss	Guided Missiles
HEYBEY, Willi	3/2/46	NAVY	NOL White Oak, Md.	Supersonics
HICKERTZ, Mathias	14/7/46	AC	Wright Field	Turbines
[illegible]	[illegible]/2/47	CE	Ft.Belvoir	Supersonics
HINTZE, Guenther	6/12/45	ORD	Fort Bliss	Guided Missiles
HIRSCHLER, Otto H.	17/11/45	ORD	Fort Bliss	Guided Missiles
HOBERG, Otto	17/11/45	ORD	Fort Bliss	Guided Missiles
HOELKER, Rudolf	17/11/45	ORD	Fort Bliss	Guided Missiles
HOELZER, Helmut	28/5/46	ORD	Fort Bliss	Guided Missiles
*HOERMANN, Adolph von	29/9/45	TC	Brooklyn	Diesel Engines
HOERNER, Sighard Ing. Dr.	13/10/46	AC	Wright Field	Aerodynamics
HOFFMANN, Friedrich	25/2/47	CmlC	Edgewood Arsenal	Chemist
HOH, Siegfried	28/5/46	AC	Wright Field	Wind Tunnels
HOHMANN, Bernhard	13/10/46	AC	(3) Wright Field	Guided Missiles
HOLDERER, Oskar F.	17/11/45	ORD	Fort Bliss	Guided Missiles
HOLLMANN, Hans	22/4/47	Navy	ONR/Port Wash.	Designing/Oxygen Equipment
HOPPMANN, Kurt	24/5/47	Engr	Ft Belvoir	Gyros
HORN, Helmut	17/11/45	ORD	Fort Bliss	Guided Missiles
HORRES, Leo	14/7/46	AC	Wright Field	Turbines
HOSENTHIEN, Hans H.	17/11/45	ORD	Fort Bliss	Guided Missiles
HUBER, Franz Dipl Ing	13/10/46	AC	Wright Field	Power Plants
HUBERT, Josef J.	16/8/46	AC	(3) Wright Field	Aerodynamics
HUBMANN, Otto	28/5/47	QM	BOM Pittsburg	Shale Oil
HUETER, Hans	17/11/45	ORD	Fort Bliss	Guided Missiles
HUSSMANN, Albrecht	21/1/47	AC	Wright Field	Combustion, transmission-mechanics
HUZEL, Dieter K.	3/2/46	ORD	Fort Bliss	Guided Missiles
JACOBI, Walter	17/11/45	ORD	Fort Bliss	Guided Missiles
JAHNKE, Helgo	4/12/46	AC	(3) Wright Field	Rocket Motors
JAKOB, Richard J.	29/9/45	TC	Brooklyn	Diesel Engines
JENTSCHKE, Willibald	26/3/47	AC	Wright Field	Physicist
KAMM, Wunibald	17/11/45	AC	Wright Field	Power Plants
KAPPUS, Peter Dipl Ing	13/10/46	AC	Wright Field	Jet Engines
KASCHIG, Erich	17/11/45	ORD	Fort Bliss	Guided Missiles
KASSNER, Rudolf	26/10/46	AC	Wright Field	Jet Engines
KEDESDY, Horst H.	2/6/47	SC	Ft Monmouth	Microscopy
KEIL, Alfred	[illegible]/4/47	Navy	Nav-[illegible]ks, Wash.	U/water detonations
KEILHOLZ, Dr Theodor	26/3/47	QM	QM EFS, Louisiana, Mo.	Synthetic fuels
KERRIS, Wolfram	13/10/46	AC	Wright Field	Instruments
KITZINGER, Dr. Charlotte	2[illegible]/[illegible]/47	AC	Wright Field	Aero Medicine
KLAUSS, Ernest E.	17/11/45	ORD	Fort Bliss	Guided Missiles
KLEIN, Johann	17/11/45	ORD	Fort Bliss	Guided Missiles
KLINGER, Georg	26/10/46	AC	Wright Field	Aerodynamics
KNACKE, Theodor	2[illegible]/[illegible]/46	AC	Wright Field	Parachutes
KNACKSTEDT, Wilhelm	13/10/46	AC	Wright Field	Supersonics
KNAUSENBERGER, [illegible]	2[illegible]	Navy	ONR P/Wash	Aerodynamics
KNECHT, Dr. [illegible]	[illegible]	A[illegible]	[illegible]	[illegible]
KNOERNSCHILD, Eugen	26/10/46	AC	Wright Field	Thermodynamics
KOEHL, Hermann	14/[illegible]	[illegible]	[illegible]	[illegible]
KOLB, Axel	26/10/46	AC	Wright Field	Aerodynamics
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Metals
KRAMER, [illegible]	[illegible]	A[illegible]	Randolph Field	Medical technician
[illegible], Max	26/10/46	NAVY	NOL White Oak, Md.	Guided Missiles
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Missiles

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NAME	ARRIVED	USING AGENCY	STATION	SPECIALTY
KUEFER, Heinrich	14/7/46	NAVY	NOL W/Oak	Bomb Fuses
KUERS, Werner	17/11/45	ORD	Fort Bliss	Guided Missiles
KUGEL, Ernst	21/7/46	AC	(1) Wright Field	Rolling Mills
KURZWEG, Hermann H.	3/2/46	NAVY	NOL W/Oak	Supersonics
KUTZSCHER, Edgar	24/5/47	Navy	Pt Mugu, Calif	Infra-red detection
LAENDLE, Willi	4/12/46	AC	Wright Field	Jet Engines
LAHDE, Reinhard	20/5/45	NAVY	Pt Mugu, Calif.	Guided Missiles
LANG, Wolfgang	29/9/45	TC	Brooklyn	Diesel Engines
LANGE, Hermann E.	17/11/45	ORD	Fort Bliss	Guided Missiles
LANGNER, Oskar	2/6/47	AC	Randolph Field	Medical technician
LEHNERT, Richard	3/2/46	NAVY	NOL W/Oak	Aerodynamics
LEHOVEC, Kurt	2/6/47	SC	Ft Monmouth	Metal Rectifiers
LEPESCHKIN, Waldemar	24/[illegible]/47	Navy	NMRI, Bethesda	Bio-physicist
LINDENMAYR, Hans	17/11/45	ORD	Fort Bliss	Guided Missiles
LINDNER, Kurt A.	17/11/45	ORD	Fort Bliss	Guided Missiles
[illegible], Alexander	3/2/46	NAVY	NAMC, Phila.	Tailless Aircraft
[illegible], Hannes	[illegible]/12/45	ORD	Fort Bliss	Guided Missiles
LUFT, Ulrich	2/6/47	AC	Randolph Field	Aero medicine
[illegible]	[illegible]	NAVY	[illegible] Bethesda	[illegible]
MAIER-LEIBNITZ, Heinz	24-[illegible]-47	AC	Wright Field	Physicist
MANDEL, Karl Heinz	4/7/46	Ord	Fort Bliss	Guided Missiles
[illegible], Frank	[illegible]	NAVY	White Oak, Md.	Infra-red
MATT, Heinrich	26/10/46	AC	Wright Field	Supersonics
MAUCH, Hans	4/12/46	AC	Wright Field	Engineer
MAUS, Hans	3/2/46	ORD	Fort Bliss	Rocket Power Units
MAYER, Hans	9/4/46	AC	Wright Field	Acoustic Homing Devices
MAYER, Ludwig	13/10/46	AC	Wright Field	Magnetrons
MERK, Helmut E.	17/11/45	ORD	Fort Bliss	Guided Missiles
[illegible], Willi	[illegible]	AAF	Wright Field	[illegible]
[illegible], Hermann	[illegible]/47	AC	Wright Field	Technician
MEYER, Hermann	[illegible]/2/47	Navy	PhilaNavShipyard	Synthetic Fuels
MICHEL, Josef M.	17/11/45	ORD	Fort Bliss	Guided Missiles
[illegible], Hans	17/11/45	ORD	Fort Bliss	Guided Missiles
MILLINGER, Heinz	3/2/46	ORD	Fort Bliss	Guided Missiles
MINNING, Rudolf	17/11/45	ORD	Fort Bliss	Guided Missiles
MIRUS, Ferdinand	26/10/46	AC	Wright Field	Aerodynamics
MOELLMANN, Heinz	21/1/47	AC	(3) Wright Field	Turbines, jet-propulsion
MRAZEK, Willi	9/4/46	ORD	Fort Bliss	Guided Missiles
MUEHLNER, Joachim	6/12/45	ORD	Fort Bliss	Guided Missiles
MUELLER, Fritz	17/11/45	ORD	Fort Bliss	Guided Missiles
MUELLER, Hans F.	29/9/45	TC	Brooklyn	Propellers, Marine
MULLER, Heinz	26/10/46	AC	Wright Field	Bomb Sights
NAUMANN, Erwin	13/10/46	AC	(3) Wright Field	Power Plants
NEHLSEN, Hermann	21/7/46	AC	(1) Wright Field	Rolling Mills
NEUBERT, Erich	29/9/45	ORD	Fort Bliss	Guided Missiles
NEUGEBAUER, Franz	17/11/45	AC	Wright Field	Aerodynamics
NEUHOEFER, Kurt K.	17/11/45	ORD	Fort Bliss	Guided Missiles
NOEGGERATH, Wolfgang	20/9/45	NAVY	NOL White Oak, Md.	Rocket Fuel
NOELL, Werner	21/1/47	AC	Randolph Field	Medicine, physiology, electroencephalograph
NOWAK, Max E.	17/11/45	ORD	Fort Bliss	Guided Missiles
NUELL, Werner V.D.	9/4/46	AC	Wright Field	Superchargers
NUTZ, Carl	21/1/47	AC	(3) Wright Field	Engr for jet propulsion
OESTREICHER, Hans	2/6/47	AC	Wright Field	Mathematician
OHAIN, Hans Faust von	25/2/47	AAF	Wright Field	Jet Engines
OPITZ, Rudolph	16/8/46	AC	(3) Wright Field	Rockets
OPPELT, Walter H.	8/7/45	QM	War College	Shale Oil

NAME	ARRIVED	USING AGENCY	STATION	SPECIALTY
PAETZ, Robert	3/2/46	ORD	Fort Bliss	Guided Missiles
PALAORC, Hans	6/12/45	ORD	Fort Bliss	Guided Missiles
PATIN, Albert K.	17/11/45	AC	Wright Field	Jet Engines
PATT, Kurt P.	17/11/45	ORD	Fort Bliss	Guided Missiles
PAUL, Hans	17/11/45	ORD	Fort Bliss	Guided Missiles
PENZIG, Fritz	26/3/47	AC	Wright Field	Jet Engines
PETER, Willi	4/7/46	NAVY	NOL W Oak	[illegible]
PEUCKER, Max	9/4/46	NAVY	NOL White Oak, Md.	Supersonics
PICHLER, Helmut	[illegible]	[illegible]	[illegible]	[illegible]
PICHOTKA, Josef	24/5/47	AC	Randolph Field	Medical technician
PLENDL, Hans	24/2/47	AAF	Wright Field	Ionosphere
POHLHAUSEN, Dr. Karl	16/8/46	AC	Wright Field	Aerodynamics
POLTE, Johannes	4/12/46	AC	Wright Field	Lab Technician
POPPEL, Theo	20/9/45	ORD	Fort Bliss	Guided Missiles
PRANT, Johannes	[illegible]	AAF	Randolph Field	[illegible]
RAABE, Herbert	26/3/47	AC	Wright Field	
RAMBAUSKE, Werner	21/1/47	AC	Wright Field	Electronics, astrophysics
RAMM, Heinrich	3/2/46	AC	Wright Field	Supersonics
RATZ, Otto	24/6/46	CE	Army Map Service	Photogrammetry
REES, Eberhard #	20/9/45	ORD	Fort Bliss	Guided Missiles
RIEGER, Leonz	2/6/47	Navy	NAMC, Phila.	Water recovery
REINDORF, Heinrich	13/10/46	AC	Wright Field	Power Plants
REISIG, Gerhard	6/12/45	ORD	Fort Bliss	Guided Missiles
REISSMANN, Kurt	24/5/47	AC	Randolph Field	Medical technician
RICHTER, Heinz	26/10/46	AC	Wright Field	Jet Engines
RIEDEL, Walter	17/11/45	ORD	Fort Bliss	Guided Missiles
RINECKER, Franz Georg	16/8/46	AC	(3) Wright Field	Textiles
RINGLEB, Freidrich	3/2/46	NAVY	NAMC, Phila.	Aerodynamics
RISTER, Hans	20/9/45	AC	Wright Field,	Aerodynamics
RITTER, Arnold	4/12/46	AC	Wright Field	Electronics
ROLF, Erich	26/3/47	Navy	Port Wash.	Engineer
ROSE, Heinrich	25/2/47	AAF	Randolph Field	Physicist
ROSIN, Herbert	26/10/46	AC	Wright Field	Jet Engines
ROSINSKI, Werner	6/12/45	ORD	Fort Bliss	Guided Missiles
ROSSMAN, Theoder	13/10/46	AC	Wright Field	Weapons
ROTH, Ludwig	17/11/45	ORD	Fort Bliss	Guided Missiles
ROTHE, Heinrich Ing	23/8/46	Ord	Fort Bliss	Guided Missiles
RUDOLPH, Arthur	6/12/45	ORD	Fort Bliss	Guided Missiles
RUF, Franz	26/3/47	AC	Wright Field	Aircraft Design
RUHNKE, Martin	26/10/46	AC	Wright Field	Jet Engines
RYSCHKEWITSCH, Eugen	17/11/45	AC	Wright Field	Carbides
SARAPU, Erich	21/7/46	QMC	Army War College	Shale Oil
SAUERLAND, Hans	26/10/46	AC	Wright Field	Jet Engines
SCHAFFELD, Wolfdietrich	24/2/47	AAF	Wright Field	Magnetrons
SCHAPER, Otto F.	17/11/45	NAVY	Port Wash.,L.I.	Guided Missiles
SCHARNOWSKI, Heinz	17/11/45	ORD	Fort Bliss	Guided Missiles
SCHELP, Helmut	10/4/47	AC	Wright Field	Jet Power Units
SCHERZER, Otto	24/5/47	SC	Ft Monmouth	Physics
SCHEUFELEN, Klaus E.	3/2/46	ORD	Fort Bliss	Guided Missiles
SCHILLING, Martin	17/11/45	ORD	Fort Bliss	Guided Missiles
SCHLICKE, Heinz	29/9/46	Navy	Port Wash.N.Y.	Electronics
SCHLIDT, Rudolph K.	17/11/45	ORD	Fort Bliss	Guided Missiles
SCHLITT, Helmut	17/11/45	ORD	Fort Bliss	Guided Missiles

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NAME	ARRIVED	USING AGENCY	STATION	SPECIALTY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible], Tatjana	[illegible]	AC	Randolph Field	Research analyst
SCHMITT, Heinze E.	17/11/[illegible]	AC	Wright Field	Jet Engines
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible], Herbert	[illegible]/47	[illegible]	[illegible], Los Angeles	Amputee
[illegible]	[illegible]	[illegible]	[illegible], Los Angeles	Amputee
SCHUGT, Josef	26/10/46	AC	Wright Field	Jet Engines
SCHULER, Albert E.	17/11/45	ORD	Fort Bliss	Guided Missiles
[illegible]	[illegible]	[illegible]	Fort Bliss	Guided Missiles
[illegible]	[illegible]	[illegible]	[illegible] Arsenal	[illegible] metals
SCHWARZ, Frederich	3/2/46	ORD	Fort Bliss	Guided Missiles
[illegible], Dr. Bernard	[illegible]/47	SC	Ft Monmouth	Camera Design
[illegible]	[illegible]	[illegible]	Fort Bliss	Guided Missiles
[illegible]	[illegible]	[illegible]	[illegible]	Equipment for High Altitudes
SENDLER, Karl	17/11/45	ORD	Ft. Bliss	Guided Missiles
SIEBER, Werner	3/2/46	ORD	Fort Bliss	Guided Missiles
SIELAFF, Ernst	16/8/46	AC	(3) Wright Field	Aircraft Construction
SINGELMANN, Dietrich	24/6/46	AC	Wright Field	Guided Missiles
SMAKULA, Alexander	24/6/46	CE	Fort Belvoir	Optics
SNAY, Hans Gunther	28/5/46	Navy	NOL, White Oak, Md	Underwater Explosions
[illegible], Erich	[illegible]/46	AC	Wright Field	Ceramics
SOESTMEYER, Christopher #	24/12/46	AC	Wright Field	Aerodynamics
SPOHN, Eberhard	6/12/45	ORD	Fort Bliss	Guided Missiles
STAIGER, Kurt	4/12/46	AC	Wright Field	Electronics
STEINHOFF, Ernst A.	17/11/45	ORD	Fort Bliss	Guided Missiles
STEURER, Wolfgang H.	17/11/45	ORD	Fort Bliss	Guided Missiles
STOLL, Reinhold	24/6/46	QM	Phila. QM Depot	Textiles
STOLLENWERK, Edmund	3/2/46	NAVY	NOL White Oak, Md.	Supersonics
[illegible], Gustav	[illegible]	AC	Wright Field	Aerodynamics
STROTT, Adolf	13/10/46	AC	(3) Wright Field	Chemist
[illegible], Oscar	[illegible]	AC	Wright Field	Radar
STUHLINGER, Ernst	3/2/46	ORD	Fort Bliss	Guided Missiles
STURM, Theodor	20/9/45	NAVY	Port Wash., L.I.	Guided Missiles
[illegible], Bernhard	17/11/45	ORD	Fort Bliss	Guided Missiles
THIEL, Adolf	14/7/46	ORD	Fort Bliss	Guided Missiles
TILLER, Artur	11/10/46	TC	Brooklyn	Small Boats
TILLER, Werner	24/6/46	ORD	Fort Bliss	Guided Missiles
TIMM, Herbert	4/12/46	AC	(3) Wright Field	Jet Engines
TONNDORF, Juergen	2/6/47	AC	Randolph Field	Medical technician
TRAPP, Dr. Adolf	25/3/47	QM	QM EFS, Louisiana, Mo.	Synthetic fuels
TROCKEL, Walter	4/7/46	CMC	Army War College	Oil Chemistry
TSCHINKEL, Johann	17/11/45	ORD	Fort Bliss	Guided Missiles
URBANSKI, Arthur	17/11/45	ORD	Fort Bliss	Guided Missiles
VANDERSEE, Fritz	17/11/45	ORD	Fort Bliss	Guided Missiles
VILBIG, Dr. Friedrich	26/[illegible]/47	AC	Wright Field	Ionospheric Research
VOGEL, Ludwig K	3/2/[illegible]	NAVY	ONR P/Wash	Fighter Planes
VOGT, Richard	25/2/47	AAF	Wright Field	Aircraft Design
VOIGT, Waldemar	24/2/47	AAF	Wright Field	Aircraft Design
VOLK, Karl	9/4/46	A.C.	Wright Field	Electrical Research
[illegible], Werner	21/7/46	ORD	Fort Bliss	Guided Missiles
VOWE, Theodor K.	3/2/46	ORD	Fort Bliss	Guided Missiles

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NAME	ARRIVED	USING AGENCY	STATION	SPECIALTY
WAGNER, Carl W.	17/11/45	ORD	Fort Bliss	Guided Missiles
WAGNER, Dr. Herbert	20/5/45	Navy	ONR P/Wash,L.I.	Jet Structures
WAHL, Hendrik	23/8/46	[illegible]	Army War College	Shale Oil
WALCHNER, Dr. Otto	16/8/46	AC	Wright Field	Supersonics
WALK, Emil	28/5/46	AC	Wright Field	Wind Tunnels
WAZELT, Friedrich	13/10/46	AC	(3) Wright Field	Aerodynamics
WEBER, Berthold Dr.	24/2/47	AAF	Wright Field	Chemist
WEGENER, Peter	3/2/46	NAVY	NOL White Oak, Md	Aerodynamics
WEIDNER, Herman	6/12/45	ORD	Fort Bliss	Guided Missiles
WEIHE, Werner C.	17/11/45	CE	Ft. Belvoir	Infra-Red
WEL[illegible]G, Fritz	17/11/45	AC	Wright Field	Turbines
WEISS, Hildegard	2/6/47	AC	Randolph Field	Research & technical translating
WERNICKE, Bruno	2/6/47	AC	Wright Field	Technician
WIESEMANN, Walter P.	17/11/45	ORD	Fort Bliss	Guided Missiles
WILLICH, Norman	3/2/46	A.C.	Wright Field	Jet Engines
WINKLER, Ernst H.	3/2/46	NAVY	NOL White Oak, Md.	Supersonics
WINKLER, Eva Dr.	25/2/47	Navy	White Oak	Physicist
WITTERN, Wolf-Wito von	24-5-47	AC	Wright Field	Physicist
WITTMAN, Albin	6/12/45	ORD	Fort Bliss	Guided Missiles
WITZKY, Julius E.	9/4/46	TC	Brooklyn	Diesel Engines
WOLLFRAM, Max	25/2/47	AAF	Wright Field	
WOERDEMANN, Hugo	28/5/46	ORD	Fort Bliss	Guided Missiles
WUNDT, Dr. Folf	26/3/47	AC	Wright Field	
ZEIGLER, Dr. Hans	26/3/47	SC	Ft. Monmouth	Resistors
ZEILER, Albert	3/2/46	ORD	Fort Bliss	Guided Missiles
ZETTLER-SEIDEL, W.	3/2/46	NAVY	NOL White Oak, Md.	Supersonics
ZIEBARTH, Hans	18/12/46	AC	Wright Field	Exhaust-turbines
ZOBEL, Theodor	20/9/45	A.C.	Wright Field	Aerodynamics
ZOIKE, Helmut M.	17/11/45	ORD	Fort Bliss	Guided Missiles
ZOTT, Sepp	21/1/47	AC	Wright Field	Dev & designing/steering "holds"

(1) TDY, Loewy Hydropress, Inc., New York City.

(2) TDY, Optical Research Lab, Boston University.

(3) TDY, Rome Army Air Field, Rome, New York.

SPECIALISTS ON ORDER FROM EUCOM

NAME	DATE REQ	REQ BY	DATE ALLOC	ORD FR USFET	ADDRESS	SPECIALTY
[illegible]	2 [illegible]	[illegible]			Bavaria	Supersonics
ASCHOFF, Dr. Volker	13/12/46	Navy	14/1/46	23/12/46		Electrical Engr.
BAARS, Dr. Prof	13/8/46	SC	21/10/46	30/10/46	Westfalen	Batteries
[illegible], Dr. Al[illegible]	[illegible]47	[illegible]	[illegible]47	11/4/47	Stuttgart	Metallurgy
[illegible]	[illegible]	[illegible]		[illegible]	Freising	Cereals
[illegible]			[illegible]	[illegible]	Stuttgart	[illegible]
[illegible] Prof. Dr. Max	[illegible]	AC	4/2/47	5/2/47	Wetzlar	Crystalographer
[illegible]	[illegible]	[illegible]	19 [illegible]	8 3 [illegible]	Duisburg	Electrician
[illegible]				[illegible]	[illegible]	[illegible]
BOTHE, Prof. Walter	20/12/46	Navy	13/1/47	20/1/47	Heidelberg	Physicist
BRAETSCH, Dr. Hein[illegible]	13/[illegible]	Navy	22/4/46	23/12/46	MAN Augsburg	Diesel Engines
[illegible], Dr [illegible]	6/2/47	Navy	24/12/46	11/2/47	Hanover	Gas dynamics
COLISEN, Dr.	13/8/46	SC	13/1/47	4/4/47	Stuttgart	Batteries
CZERNY, Prof. Marius	13/12/46	Navy	2/1/47	8/1/47	Frankfurt	Infra-red
[illegible]		[illegible]		[illegible]	[illegible]	Guided Missiles
[illegible], Dr. [illegible]	13/[illegible]	[illegible]		[illegible]	Gottingen	Cereal Technician
[illegible]	[illegible]	TE	[illegible]/2/47	[illegible]	Darmstadt	Physicist
[illegible], Dr. Walter	[illegible]12/46	S[illegible]	13/1/47	20/1/47	Salzburg	Meteorology
[illegible], Hans	12/3/47	AC	[illegible]/3/47	29/3/47		Remote control
[illegible]			[illegible]	[illegible]	Duisburg	Floating Crane
HECHT, Otto Dr.	10/4/46	QMC	22/5/46	22/11/46	CWS, USFET	Chemist
[illegible], Dr. [illegible]	[illegible]	QMC	[illegible]	[illegible]/47	Berlin	Cancer
[illegible], Prof. [illegible]	[illegible]	Navy	[illegible]	[illegible]	Heidenheim	Physicist
HILLIGARDT, Erich	12/12/46	Navy	23/12/46	17/12/46	Friedrichshafen	Elec-installation
[illegible]	27/2/47	[illegible]	[illegible]	[illegible]	Hamburg	Model basin Test Eng
HOENNER, Dr. Kurt	13/12/46	Navy	15/11/46	24/12/46	Am. Zone	Infra-red
HOLT, von Dr.	11/9/46	Navy	13/11/46	18/11/46	Rheinsdorf	Rocket Development
[illegible]		[illegible]	[illegible]	[illegible]/47	Kochelsee	Mathematics
JOSENHANS	13/1/47	QMC	10/3/47	4/4/47	Heidelberg	Synthethic fuels
[illegible]	[illegible]	[illegible]	1[illegible]	25/2/47	Salzburg	Meteorology
[illegible]				[illegible]		Metals
[illegible]				[illegible]/47	[illegible]	[illegible] aerodyn.
KNOLL, Dr. Ing. Max	13/8/46	SC	15/11/46	19/12/46	Munich	Iconoscopes
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				22/[illegible]/47	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1[illegible]	1[illegible]/47	Brunswick	Mechanical Engr
[illegible]	[illegible]	[illegible]	[illegible]		Heidelburg	Organic Chemistry
LEIST[illegible], Dr. Karl	13/8/46	SC	22/4/46	10/12/46	Zeiss-Jena	Infra-red
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			Heidelberg	
LEYER, Erwin Dr	12/8/46	Navy	22/4/46	19/12/46	Berlin	Fuels
M[illegible]A, Dr.	[illegible]12/46	Navy	11/1/46	24/12/46	Kiel	Magnetism
MOELLER, Prof. [illegible]rt	11/12/47	Navy	2/1/47	8/1/47	Heidenheim	Infra-red

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NAME	DATE REQ	REQ BY	DATE ALLOC	ORD FM USFET	ADDRESS	SPECIALTY
[illegible], Hubert	[illegible]	AC			[illegible]	[illegible]
OBERMUELLER, [illegible]	[illegible]	[illegible]	[illegible]			
OSTHOFF, Ing Leopold	[illegible]/47	[illegible]	[illegible]	[illegible]/47	[illegible]	[illegible]
PENNDORF, Prof Dr [illegible]	[illegible]	AC			[illegible]	[illegible]
PIE[illegible], Dr. Werner	[illegible]	[illegible]	2[illegible]/47	[illegible]/47	[illegible]	[illegible]
[illegible], Dr. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
PLANK, Rudolph	13-[illegible]-47	[illegible]	1[illegible]/46	[illegible]/47	[illegible]	[illegible]
[illegible]TSCH, Dr. J.	**13/12/46**	**Navy**	**15/11/46**	**24/12/46**	**Gottingen**	**Aerodynamics**
[illegible], Dr. Kurt Guenther	[illegible]/47	CmlC	[illegible]	[illegible]	[illegible]	[illegible]
RAITHEL, Dr Wilhelm (Ing)	7[illegible]/47	[illegible]	[illegible]/47	[illegible]/47	[illegible]	[illegible]
RAJ[illegible]SKI, Prof. Boris	**13/12/46**	**Navy**	**2/1/47**	**8/1/47**	**Frankfurt**	**Biophysics**
RANFT, Ludwig Dipl Ing	[illegible]	[illegible]	1[illegible]-47	1[illegible]/47		
REIN, Hermann Prof.	6/[illegible]/47	AC	[illegible]	[illegible]	Heidelberg	
RIECKMANN, Dr. E.	[illegible]/47	[illegible]	[illegible]	[illegible]	[illegible]	
RODER, Karl Ing.	**13/12/46**	**Navy**	**7/11/46**	**24/12/46**	**U.K.**	**Acoustic Sweep Gear**
RUCKES, L.	13/3/47	QM			Frankfurt	Coal Gasification
RUEF, Hans	1[illegible]/2/47	AC	[illegible]	[illegible]	Bavaria	[illegible]
RUEFF, Dr. Fritz	**13/12/46**	**Navy**	**2/1/47**	**8/1/47**	**Augsburg**	**Material testing**
SANGER, Dr Eugen	14/2/47	AC	[illegible]/46	1[illegible]/47	[illegible]	Fuels
SAUER, Prof. Dr.	13/12/46	Navy	2[illegible]	[illegible]	[illegible]	[illegible]
SCHAEFER, Hans	17/3/47	CmlC	[illegible]	[illegible]	[illegible]	Electro-[illegible]
[illegible]	[illegible]	[illegible]	2[illegible]/5/47	27/5/47		Physicist
SCHEUNERT, Dr.	13/3/47	QM	[illegible]		Leipzig	Nutrition Research
SCHILLING, [illegible]	13/3/46	SC	21/10/46	[illegible]/46	Heidelberg	Relays
SCHRAPPERT, Dr	**13/1/47**	**QMC**	**10/3/47**	**4/4/47**	**Manheim**	**Synthethic fuels**
SCHULZ, Werner P.	[illegible]/47	Navy	22[illegible]/47	[illegible]	Berlin	Television
SCHWAN, [illegible]	[illegible]	[illegible]	2[illegible]/47	27/5/47		[illegible]
SCHWARTZ, Dr. Hans	[illegible]/47	[illegible]	20/5/47	27/5/47	[illegible]	[illegible]
SCHWENKHAGEN, Dr.	13/12/46	Navy	2/1/47	[illegible]	UK	A[illegible]tics
SIEG, Dr Helmuth	[illegible]	AC	[illegible]	[illegible]		
S[illegible]EL, Dr. Karl	[illegible]	[illegible]	2[illegible]/47	2[illegible]/47		[illegible]
SOTTORF, Dr Ing W.	2[illegible]/2/47	Navy	[illegible]	[illegible]	[illegible]	[illegible]
SPANNHAKE, Prof Wilhelm	2[illegible]/2/47	Navy	[illegible]	[illegible]	[illegible]	[illegible]
STAUFF, Dr. [illegible]	[illegible]	[illegible]	20/5/47	27/5/47		[illegible]
STRUGHOLD, Hubertus Prof.	**21/6/46**	**AC**	**14/8/46**	**10/10/46**	**Heidelberg**	**Aero Medicine**
THAUER, Dr. [illegible]	[illegible]	[illegible]	20/5/47	27/5/47		[illegible]
[illegible]RY, [illegible] Dipl-Ing	[illegible]-47	AC	[illegible]	[illegible]/47	[illegible]	
TRISCHMANN, Dr. Hans	**10/4/46**	**QM**	**22/5/46**	**19/7/46**	**Frankfurt**	**Synthetic Rubber**
[illegible], Dr. Hans-Joachim	17/[illegible]/47	CmlC	[illegible]	[illegible]	[illegible]	Physiology
VIEWEG, Prof Dr Richard G.	**16/24/47**	**Navy**	**4/2/47**	**3/2/47**	**Darmstadt**	**Plastics**
WALTER, Alwin Dr.	[illegible]	Navy	[illegible]	[illegible]	[illegible]	[illegible]
WARBURG, Otto Dr. H.	**9/7/46**	**CWS**	**16/7/46**	**16/7/46**	**Berlin**	**Cancer Research**
[illegible], Heinrich	[illegible]		[illegible]			
WEISE, Erwin	1/[illegible]/47	AC	13/11/46	2[illegible]/47	Kiel	Mathematician
[illegible], Ing	[illegible]	[illegible]	[illegible]/47	[illegible]	[illegible]	[illegible]
[illegible], [illegible] Walter	[illegible]	[illegible]				
ZAHN, Mr Eng Helmut	**25/3/46**	**QM**	**24/4/46**	**3/5/46**	**Badenweiler**	**Microscopy**

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NAME	DATE REQ	REQ BY	DATE ALLOC	ADDRESS	SPECIALTY
[illegible]	[illegible]	[illegible]		[illegible]	Radar tracking dev.
[illegible]	[illegible]	[illegible]		Frankfurt	Coal Gasification
[illegible]	[illegible]	AC	[illegible]	Karlsruhe	Meteorology
[illegible]	[illegible]	AC	To 1st L.		Guided missiles
[illegible]	[illegible]	[illegible]		Brunswick	Physicist
[illegible]	[illegible]	AC		Berlin	Theoreticist
HACKEMANN, Dr. P.	13/12/46	NAVY		Braunschweig	Aerodynamics
[illegible]	[illegible]	[illegible]	[illegible]	Weisbaden	Radar
[illegible]	[illegible]	AC	[illegible]	Munich	Electronics
[illegible]	[illegible]	[illegible]		Mannheim	Chemist
[illegible]	[illegible]	AC	[illegible]	Lake Constance	Tube development
[illegible]	[illegible]	[illegible]		[illegible]	Nuclear physics
[illegible]	[illegible]	NAVY		[illegible]	Testing mach/design
[illegible]	[illegible]	AC		Erlangen	Low temp/physics
[illegible]	[illegible]	[illegible]		[illegible]	Parachute expert
[illegible]	[illegible]	[illegible]			Submarine engines
[illegible]	[illegible]	AC	[illegible]	Munich	Chief electrician
[illegible]	[illegible]	AC	[illegible]	Heidenheim	Wind tunnels
[illegible]	[illegible]	AC		Berlin	Electronics
[illegible]	[illegible]	[illegible]		Buxtehude	Propeller design
[illegible]	[illegible]	AC		Ansbach	Photogrammetrics

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NAME	DATE REQ	REQ BY	DATE ALLOC	ADDRESS	SPECIALTY
[illegible]	[illegible]	AC		Berlin	[illegible]
[illegible]	[illegible]	AC	[illegible]	[illegible]	[illegible] System
[illegible], Dr.	[illegible]	AC		Berlin	[illegible] Systems
OSWATITSCH, Dr. Klaus	13/12/46	NAVY		Gottingen	Diffuser Res.
[illegible]	[illegible]	AC		[illegible]	[illegible]
[illegible]	[illegible]	AC		[illegible]	[illegible]
[illegible], Dr. Hans	1[illegible] 12/46	Navy		Berlin	Hydrodynamics
RITZ, Dr. W.	9/7/45	AC		Gottingen	Ceramics
[illegible]	[illegible]	Navy		[illegible]	[illegible]
[illegible], Dr. Robert	[illegible]	Navy		Berlin	Physicist
[illegible]	[illegible]	Cmlc		[illegible]	Electro-physiology
[illegible]	[illegible]	AC	[illegible]	[illegible]	Designer [illegible]
SCHNEIDER, Gerhard		NAVY			Pumps & Gears
[illegible]	[illegible]	AC	[illegible]	[illegible]	Designer [illegible]
[illegible], Dr.	[illegible]	AC		Stuttgart	High [illegible] Res.
SCHRADER, Gerhardt Dr.	12/12/46	NAVY			Organic Chem.
[illegible]	[illegible]	AC	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	AC		[illegible]	Mechanical [illegible]
[illegible], Dr. [illegible]	[illegible]	Cmlc		Frankfurt	[illegible]
[illegible]	[illegible]	AC		[illegible]	[illegible]
WEIZSACKER, Prof C. F. von	20/12/46	Navy		Goettingen	Physicist
[illegible], Dr. [illegible]	[illegible]	AC		[illegible]	Theoretical [illegible]
[illegible]	[illegible]	AC	[illegible]	[illegible]	Designer [illegible]
[illegible]	[illegible]	A	[illegible]	[illegible]	[illegible]

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FILE NO.	SUBJECT		
ORDAB-DV	Russian Comments to the American Satellite Project		
TO See Distribution	FROM Director, Research Projects Office	DATE 29 October 1957 EStuhlinger/tch/4625	COMMENT NO. 1

1. The undersigned, while attending the Eighth Congress of the International Astronautical Federation in Barcelona, Spain, had the opportunity to meet members of the Russian delegation to the Congress. The head of the delegation, Professor Leonid Sedov, made some comments regarding the American Satellite Project which are reported in this memorandum. The conversations between Prof. Sedov and the undersigned were held in German. Notes of the talks were written immediately afterwards. While they may not be entirely accurate word by word, the opinions and thoughts expressed by Prof. Sedov are reflected very closely by these notes. Mr. H. Koelle was present during some of the talks (See Trip Report by H. Koelle).

2. This memorandum is for Official Use Only. If parts of it should be published, the publication must not contain the names of Prof. Sedov or the undersigned.

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NOTES ON TALKS WITH
PROF. SEDOV ON 7 AND 8 OCT 57 IN BARCELONA, SPAIN

PROF. SEDOV: We could never understand why you people picked such a strange design for your Satellite carrier. It was complicated, difficult to develop, and very marginal. The development time which you allotted to the project appeared much too short. Why did you try to build something entirely new, instead of taking your excellent engines from your military projects, such as the REDSTONE or the IRBM? You would have saved so much time, not speaking of troubles and money. This design would have given you also a very good growth potential, whereas the VANGUARD will always be limited to about 20 lbs. One wants to have more weight in a Satellite, and a design based on one of your big engines would have given you that. After all, we are only at the beginning of a new and very great development. Why did you not choose this very natural, straight-forward approach? Why did Dr. von Braun select this other design instead?

DR. STUHLINGER: Dr. von Braun? He did not decide this. He is not a member of the VANGUARD Committee; in fact, he is even not a consultant or an adviser for the American VANGUARD Satellite.

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PROF. SEDOV: Is that true? Was he really not connected with the VANGUARD Project? Well, if that is so, I think that we can understand a few things better. When we first learned about the VANGUARD Project and the design of the vehicle, we were really stupefied. But why was Dr. von Braun not a member of the VANGUARD Project?

DR. STUHLINGER: He would have loved to be, as you probably can imagine, and his team would have loved it too. But he was kept busy with other assignments, while the VANGUARD Project was given to the Navy.

PROF. SEDOV: In our Country, we gave the Satellite Project highest priority, because we considered it to be of utmost importance, not only for scientific reasons, but from the political angle. We felt that it was really a national project of the first order. We started our Satellite Project less than two years ago*, and we concentrated our best forces on it. We took the engines we had from other programs, which we knew thoroughly, and we combined them with other well-proven components. We worked very hard until we finally succeeded. In particular, we avoided any novel designs as far as possible, but rather made the approach as logical and straight-forward as could be. Why did you not do the same? It would have been the natural choice, and you were in an excellent position with all your missiles. After all, Dr. von Braun has done such an outstanding development job with this early V-2, and he has been in business ever since.

DR. STUHLINGER: Was your Satellite group an independent body under the Ministry of Education or some other Ministry, or was it part of the Armed Forces?

PROF. SEDOV: Our Satellite group worked in very close cooperation with segments of the Armed Forces, but the group was independent enough to make decisions of its own. The cooperation was always excellent, they supported each other in a perfect way. There was no friction to speak of. Otherwise we could not have achieved the successful development in such a short time. You will be able to understand this from your own experience, I guess.

*This puts it on the end of 1955, i.e. <u>after</u> the President had announced our project, and <u>after</u> NRL started its work!

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DR. STUHLINGER: What do you think will be the next step now?

PROF. SEDOV: Well, space flight with manned vehicles to other planets is still a number of years off. A rocket to the Moon is much closer. Manned Satellites will soon be achieved, too. We are just at the beginning, but the start has been made. We in Russia are in a good position, since we have now demonstrated our capabilities, and the soundness of our designs. Many doors will be open to us now as far as Government support goes. But after all, von Braun has proven his outstanding capabilities 15 years ago, with his V-2! But Dr. von Braun lost years of extremely valuable time. He may not realize it himself yet, but I am sure that he will soon.

DR. STUHLINGER: I could imagine that he has that feeling too, but as a rule a scientist, even when he is convinced, cannot force a political decision.

PROF. SEDOV: But that is exactly where the scientist's responsibility begins! Of course the higher-ups do not know by themselves, but they must be informed and persuaded! It is not enough that a man is a good scientist and an expert in his field; he must speak up and talk and talk, until the success is achieved. One should not rest until they are convinced. We in Russia had to talk very much before our higher-ups were convinced, but we did it. Of course our higher authorities had the basic understanding for the tremendous importance of a scientific or technical achievement; maybe yours just don't. Dr. von Braun definitely had the responsibility to speak up and persuade those who have the power. He should not have left this responsibility to the Military, because this is not their responsibility. It would be unrealistic to expect any initiative from their side. It was definitely von Braun's responsibility, and his duty.

DR. STUHLINGER: Do you feel that the recognition and the standing of scientists in Russia is satisfactory?

PROF. SEDOV: Several years ago, it was definitely not. But things are different now. I should say that now we have no difficulties persuading the higher authorities of the things we deem necessary. They have an excellent understanding of the requirements, and also of the great potential value, of scientific research and development work.

DR. STUHLINGER: Does your satellite contain scientific instrumentation?

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PROF. SEDOV: We prepared our first satellite only for optical and radio tracking. Even in this simple form, it will give us invaluable scientific information. We did not want to complicate the first launching unnecessarily. After all, the training of the launching crews was one of the major points of the first launching. The next satellite will contain a number of instruments for cosmic rays, solar radiation, meteors, etc. You know what kinds of measurements can be made with a satellite. The next one will be heavier than the first.

DR. STUHLINGER: Do you think that you will launch a Moon rocket soon?

PROF. SEDOV: I don't know. Well, you know yourself how close a Moon rocket is to a Satellite rocket. I think there may be one soon.

DR. STUHLINGER: Are there enough young physicists and engineers in Russia to fill your ever-increasing need?

PROF. SEDOV: Yes, definitely. There is no problem in this area any longer.

DR. STUHLINGER: How did you achieve this? By higher pay, or by giving them recognition and a higher social standing, or by efficient propaganda?

PROF. SEDOV: No, just by increasing the number of schools, and by improving the quality of the teachers. This alone attracted so many young students that we are no longer worried about scientists and engineers.

DR. STUHLINGER: What impression did you obtain of the United States when you visited your colleagues over there?

PROF. SEDOV: America is very beautiful, and very impressive. The living standard is remarkably high. But it is very obvious that the average American cares only for his car, his home, and his refrigerator. He has no sense at all for his nation. In fact, there exists no nation for him. Government, yes; but this is always something transient and evasive. Nation, no. He also has no sense for great ideas which take as long as a number of years to achieve, and which do not pay off immediately. He just does not feel attracted by them, and he even has not much understanding for them. Russians do! Well, you certainly know what I mean, because you are a former German.

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Prof. Sedov mentioned repeatedly that he and his colleagues consider Dr. von Braun as the foremost rocket developer in the world. He is well informed about the V-2 and the REDSTONE, and fairly well about JUPITER and THOR. It was completely

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ORDAB-DV 29 October 1957
SUBJECT: Russian Comments on the American Satellite Project

incomprehensible to him why Dr. von Braun should have given his approval to the VANGUARD Project, which in his opinion is entirely inadequate and poorly conceived. He said repeatedly that he just could not understand why Dr. von Braun's demonstrated outstanding capabilities in the field of big rockets and satellites were not used. "That would have given you a sure success, you could have beaten us so easily. In fact, we always waited for a REDSTONE Satellite, and we were surprised that it did not come!"

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EXCERPTS

From

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COMPILATION OF MATERIALS ON SPACE

AND ASTRONAUTICS

No. 1

SPECIAL COMMITTEE ON SPACE AND

ASTRONAUTICS

UNITED STATES SENATE

Eighty-Fifth Congress
Second Session

March 27, 1958

Secretary Neil H. McElroy

(November 27, 1957)

The newly created post of manager of antimissile and military space project developments has not been filled. He would pull under a single manager the actual operating units for research and development in antimissile field and in satellite and space applications field.

The missile head has enough to do without taking in the antimissile job.

The antimissile chief would take over from the service. His authority would be through the Secretary of Defense.

The kind of satellite applications to be supervised in the newly created post are not the type which are in the IGY. The latter would continue with Mr. Holaday.

Dr. Killian can make a real contribution if he improves coordination in various research activities in Government, such as National Science Foundation, NACA, and Atomic Energy Commission. Many things in basic or "upstream" research will be undertaken by the DOD, because they obviously have military potentialities.

Should there be a Secretary of Science? He has not given it careful consideration.

He thinks we do not have as much guarding of secrets within military departments as many people have been led to believe. It should not be tolerated.

Had they known the sputniks were to be launched we would have done things differently. The United States satellite effort has been governed, not by the Defense Department but the Scientific Committee.

Sputnik surprised him. If he had been privy to the intelligence knowledge he would not have been so surprised.

Maj. Gen. John B. Medaris

(December 14, 1957)

Early or in the middle of 1955 the Army had proposed along with the Navy a proposal for launching a satellite, called Project Orbiter. On August 3, 1955, the Stewart committee approved the Vanguard project and Project Orbiter was stopped.

Project Orbiter contemplated using the Jupiter-C missile. This is not a Jupiter at all. It is so named because of the fact that the missions that it has had have been missions in the Jupiter program. It contemplated the use of the Redstone as the booster missile with upper stages of propellents. The outgrowth of this Project Oribiter became the reentry test vehicle for the Jupiter program. The Oribiter proposal was for a satellite weighing 19 pounds.

The first flight of the Jupiter-C test vehicle was in September 1956. This was flown actually in the satellite configuration although the fourth stage was not loaded. In the meantime the changes necessary to put the head aboard were being engineered.

The test was successful. The Jupiter-C flew 3,000 miles.

Then there were two reentry flights. The second was fully successful; the nose cone was recovered.

The Army has hardware that was prepared for the reentry program which becomes the basis for launching the satellite the Army has been directed to launch.

There is a limit to their authority to engage in research beyond the definitive program on which they are engaged.

This must be corrected because if you wait until the time when you can envisage a final product to go ahead and break the barriers and develop all the pieces that go into that product, you are going to be late and you will never get caught up.

The way to correct the situation is to go ahead with research on a primary element that contributes to an advanced weapon system so that when you can see from the whole state of the art that you can have a new weapon, you already have the advances made in the subordinate areas. For example, one of the great holes in missiles is that there is no big thrust engine. In the summer of 1956 such an engine was recommended—of 220,000-pound thrust. It was turned down. At North American there is in the engineering stage an engine of much greater thrust.

The engines being developed are for existent weapons. There are none being developed for future weapons. The North American project should be carried out on a crash basis.

They were turned down on the rocket engine because they couldn't prove it was needed for the Jupiter.

We should always have as an objective something that is out of reach.

The Jupiter program was impeded because there was a great debate over whether the Army needed it or not, and this took time. The rate of output was limited also. Half of the amount recommended was approved. The apportionments were "always protested by reclamas." With the inauguration of the Jupiter program and the requirement for Redstone missiles as flight-test vehicles to support Jupiter, the firings of Redstone were accelerated. The program is proceeding at optimum speed now; the future "roll on" of the program is half the level it should be.

People came down to see that the orders not to launch a satellite were followed.

Does he agree with General Gavin's view that satellites should be given greater priority than ballistic missiles? He would not want to limit it to satellites. Priority should always be on the furthest thing out. The priority should be on the attainment of a space capability at the earliest possible date.

Satellites and ballistic missiles have many basic techniques, they cannot be separated. Divorcement of the two impedes both. They were divorced in the Vanguard program. They were not divorced in their satellite program because Jupiter weapons hardware is being used to launch the satellite.

What is necessary for maximum progress in the missile and satellite field is to have a few long-range objectives that we would stay on and these must be 10 to 15 years ahead of things we believe we can do in 15 years. At the least we must have a year's program at a time. We will lose the race if we have short-term objectives.

If Project Orbiter had been approved, the satellite could definitely have been launched by now. It would not have interfered with the ballistic-missile program.

The Jupiter powerplant could be used successfully to launch a satellite.

Work on satellite, rather than impeding ballistic missile, would result in derivative information for both projects.

The same test vehicle, the same missile that we use to launch the test nose cone, requires only a return to its original state and the addition of a couple of minor components to become a satellite carrier. The difference is in how to use the guidance system.

You must take risks in research.

Basic research should be adequate to solve the problems 15 years away; the intermediate research is for tools we will use 6 to 10 years from now. The actual development of an end product is devoted to what you will need 2 or 3 years from now.

He does not agree with the recommendation for an independent agency. One individual must be charged with responsibility. If that individual is charged with setting up an organization we will impede the program. We already have too many committees and commissions.

There is an adequate staff for research in the DOD now.

Early and firm decisions are necessary and 3- to 5-year-project basis are needed.

Dr. Wernher Von Braun

(December 14, 1957)

The Russians are definitely ahead in the ballistic missile and satellite fields.

Unless we get an engine with a large thrust we will be behind in the general field of control of outer space. The Silberstein Committee recommended that such an engine be developed. The recommendation was not followed. "It disappeared in the Department of Defense,"

Many people think we should not build large ICBM's, inasmuch as the payloads are becoming lighter. Hence they think there is no need for a large engine. But if you want to establish control of outer space by manned vehicles you will need large engines. He joins in the belief that control of outer space is as importat, if not more so than the ballistic missile.

The great need is to put the program on an even keel. The lack of money has a great effect. Long lead times are involved.

He agrees that the U. S. S. R. has the means for sending an atomic or hydrogen warhead anywhere in the world. The reason is that Sputnik II weighs 1,280 pounds and that the "carrier" that brought it up there can carry about 4,000 or 5,000 pounds over an ICBM range with that same missile.

Why is it essential for the United States to control or at least be in outer space as quickly as the Russians or anyone else? A satellite of the weight of Sputnik II would be entirely capable of carrying a combination of optical and television equipment to use as a powerful reconnaissance instrument. You could store the pictures such as a reconnaissance satellite takes over enemy territory and you can play these pictures back while over friendly territory.

In addition there is a bombing capability from orbital vehicles. These may be vehicles capable of changing their orbital data or their orbital behavior so as to interfere with possible enemy countermeasures and "since planes can drop bomb on any point of the earth with a very high accuracy."

There will always be an optical line of sight between the guiding orbital vehicle from which the bomb is detached and the bomb itself and ultimately as both go around the earth, the target will also appear in view of that orbital vehicle so that at the end when it comes to homing in or aiming exactly at the target itself you have a line of sight between the bombing vehicle, the bomb and the target.

Such orbital bombing is even applicable to moving targets.

He agrees that if the Russians should control outer space with satellites before we do this country would be in mortal danger.

If you put a sufficient amount of orbital decoys into an orbit you can saturate a radar system.

The IRBM and ICBM programs deserve the highest priority. But with the teams we have available today we can get a space program going. Many of our guided-missile people are available. The whole Navaho team is standing by.

A National Space Agency could be set up either under the Secretary of Defense or as an independent agency. He is thinking of $1.5 billion a year additional. The job would be to get a man into space on a returnable basis in 5 years and to build a space station in 10.

The IGY effort could be incorporated into the National Space Agency he is suggesting. The space medical program would be transferred to the National Space Agency. The satellite could be used as an efficient communications carrier.

There would be no better or more reliable weather information service than from a satellite.

The weather could be influenced. The Space Agency should be a separate one. He fears the services will jockey for position again.

Cooperation between the services has been excellent. But irresponsible statements hurt. Some instigate service rivalry.

Curiosity should be the motivating power in research and it is curiosity that makes him want to go to the moon.

He can fire a satellite weighing many times the weight of the Vanguard or our Jupiter-C still within the IGY.

If the Russians chose, and they had the hydrogen warhead, they could put a hydrogen bomb on top of the Capitol.

The sputniks show a capability in the guidance area also.

In principle he approves bringing missile-satellite space program under an independent civilian commission. The question is whether things have not advanced to the point that there would be such delay and upheaval that we would hurt our IRBM and ICBM programs.

He agrees there is need for a permanent and competent staff in DOD to provide leadership to applied and basic research. Also that R. and D. should be on a 3- to 5-year basis. Also that contractors should have more leeway to plan technical decisions. Also that lead time be reduced by early and firm decisions. Also that overtime restrictions be eliminated.

The satellite stays up when the centrifugal force in its curved trajectories equal to the gravitational pull of the earth.

He guessed that the Russians will try to shoot at the moon. With their rocket they can probably carry a 100- to 300-pound payload to the moon.

The ICBM's have a basic capability of orbiting a 1,000-pound satellite but the vehicles have not been tested.

If the services approved he would be for putting IRBM's and ICBM's in a separate agency.

If a new space agency were set up you would not have one man over both space and missiles programs if the missiles program remained in DOD.

He agrees that ultimately the ideal setup would be the consolidation of all space and military effort under one man.

STATEMENT BY THE PRESIDENT OF THE UNITED STATES; SCIENCE ADVISORY COMMITTEE: INTRODUCTION TO OUTER SPACE

THE WHITE HOUSE, *March 26, 1958.*

STATEMENT BY THE PRESIDENT

In connection with a study of space science and technology made at my request, the President's Science Advisory Committee, of which Dr. James R. Killian is Chairman, has prepared a brief introduction to outer space for the nontechnical reader. This is not science fiction. This is a sober, realistic presentation prepared by leading scientists.

I have found this statement so informative and interesting that I wish to share it with all the people of America and, indeed, with all the people of the earth. I hope that it can be widely disseminated by all news mediums, for it clarifies many aspects of space and space technology in a way which can be helpful to all people as the United States proceeds with its peaceful program in space science and exploration. Every person has the opportunity to share, through understanding, in the adventures which lie ahead.

This statement of the Science Advisory Committee makes clear the opportunities which a developing space technology can provide to extend man's knowledge of the earth, the solar system, and the universe. These opportunities reinforce my conviction that we and other nations have a great responsibility to promote the peaceful use of space and to utilize the new knowledge obtainable from space science and technology for the benefit of all mankind.

INTRODUCTION TO OUTER SPACE

An explanatory statement prepared by the President's Science Advisory Committee

What are the principal reasons for undertaking a national space program? What can we expect to gain from space science and exploration? What are the scientific laws and facts and the technological means which it would be helpful to know and understand in reaching sound policy decisions for a United States space program and its management by the Federal Government? This statement seeks to provide brief and introductory answers to these questions.

It is useful to distinguish among four factors which give importance, urgency, and inevitability to the advancement of space technology.

The first of these factors is the compelling urge of man to explore and to discover, the thrust of curiosity that leads men to try to go where no one has gone before. Most of the surface of the earth has now been explored, and men now turn to the exploration of outer space as their next objective.

Second, there is the defense objective for the development of space technology. We wish to be sure that space is not used to endanger our security. If space is to be used for military purposes, we must be prepared to use space to defend ourselves.

Third, there is the factor of national prestige. To be strong and bold in space technology will enhance the prestige of the United States among the peoples of the world and create added confidence in our scientific, technological, industrial, and military strength.

Fourth, space technology affords new opportunities for scientific observation and experiment which will add to our knowledge and understanding of the earth, the solar system, and the universe.

The determination of what our space program should be must take into consideration all four of these objectives. While this statement deals mainly with the use of space for scientific inquiry, we fully recognize the importance of the other three objectives.

In fact, it has been the military quest for ultra-long-range rockets that has provided man with new machinery so powerful that it can readily put satellites in orbit, and, before long, send instruments out to explore the moon and nearby planets. In this way, what was at first a purely military enterprise has opened up an exciting era of exploration that few men, even a decade ago, dreamed would come in this century.

Why satellites stay up

The basic laws governing satellites and space flight are fascinating in their own right. And, while they have been well known to scientists ever since Newton, they may still seem a little puzzling and unreal to many of us. Our children, however, will understand them quite well.

We all know that the harder you throw a stone the farther it will travel before falling to earth. If you could imagine your strength so fantastically multiplied that you could throw a stone at a speed of 15,000 miles per hour, it would travel a great distance. It would, in fact, easily cross the Atlantic Ocean before the earth's gravity pulled it down. Now, imagine being able to throw the stone just a little faster, say about 18,000 miles per hour; what would happen then?

The stone would again cross the ocean, but this time it would travel much farther than it did before. It would travel so far that it would overshoot the earth, so to speak, and keep falling until it was back where it started. Since, in this imaginary example, there is no atmospheric resistance to slow the stone down, it would still be traveling at its original speed, 18,000 miles per hour, when it had got back to its starting point. So, around the earth it goes again. From the stone's point of view, it is continuously falling, except that its very slight downward arc exactly matches the curvature of the earth, and so it stays aloft, or, as the scientist would say, "in orbit," indefinitely.

Since the earth has an atmosphere, of course, neither stones nor satellites can be sent whizzing around the earth at treetop level. Satellites must first be lifted beyond the reach of atmospheric resistance. It is absence of atmospheric resistance, plus speed, that makes the satellite possible. It may seem odd that weight or mass has nothing to do with a satellite's orbit. If a feather were released from a 10-ton satellite, the 2 would stay together, following the same path in the airless void. There is, however, a slight vestige of atmosphere even a few hundred miles above the earth, and its resistance will cause the feather to spiral inward toward the earth sooner than the satellite. It is atmospheric resistance, however slight, that has set limits on the life of all satellites launched to date. Beyond a few hundred miles the remaining trace of atmosphere fades away so rapidly that tomorrow's satellites should stay aloft thousands of years, and perhaps indefinitely. The higher the satellite, incidentally, the less speed it needs to stay in orbit once it gets there (thus the moon's speed is only a little more than 2,000 miles per hour), but to launch a satellite toward a more distant orbit requires a higher initial speed and greater expenditure of energy.

The thrust into space

Rocket engineers rate rockets not in horsepower, but in thrust. Thrust is just another name for push, and it is expressed in pounds of force. The rocket gets its thrust or push by exhausting material backward. It is this thrust that lifts the rocket off the earth and accelerates it, making it move faster and faster.

As everyone knows, it is more difficult to accelerate an automobile than a baby carriage. To place satellites weighing 1,000 to 2,000 pounds in orbit requires a first-stage rocket engine or engines having a thrust in the neighborhood of 200,000 to 400,000 pounds. Rocket engines able to supply this thrust have been under development for some time. For launching a satellite, or other space vehicle, the rocket engineer divides his rockets into 2, 3, or more stages, which can be dropped one after the other in flight, thus reducing the total weight that must be accelerated to the final velocity desired. (In other words, it is a great waste of energy to lift one huge fuel tank into orbit when the tank can be divided into smaller tanks—each packaged in its own stage with its own rocket motor—that can be left behind as they become empty.)

To launch some of the present satellites has required rockets weighing up to 1,000 times the weight of the satellite itself. But it will be possible to reduce takeoff weights until they are only 50 to 100 times that of the satellite. The rocket's high ratio of gross weight to payload follows from a fundamental limitation in the exhaust velocities that can be achieved by chemical propellents.

If we want to send up not a satellite but a device that will reach the moon, we need a larger rocket relative to its payload in order that the final stage can be accelerated to about 25,000 miles per hour. This speed, called the escape velocity, is the speed with which a projectile must be thrown to escape altogether from the gravitational pull of the earth. If a rocket fired at the moon is to use as little fuel as possible, it must attain the escape velocity very near the beginning of its trip. After this peak speed is reached, the rocket will be gradually slowed by the earth's pull, but it will still move fast enough to reach the moon in 2 or 3 days.

The moon as a goal

Moon exploration will involve three distinct levels of difficulty. The first would be a simple shot at the moon, ending either in a hard landing or a circling of the moon. Next in difficulty would be a soft landing. And most difficult of all would be a soft landing followed by a safe return to earth.

The payload for a simple moon shot might be a small instrument carrier similar to a satellite. For the more difficult soft landing, the carrier would have to include, as part of its payload, a "retrorocket" (a decelerating rocket) to provide braking action, since the moon has no atmosphere that could serve as a cushion.

To carry out the most difficult feat, a round trip to the moon, will require that the initial payload include not only retrorockets but rockets to take off again from the moon. Equipment will also be required aboard to get the payload through the atmosphere and safely back to earth. To land a man on the moon and get him home safely again will require a very big rocket engine, indeed—one with a thrust in the neighborhood of 1 million or 2 million pounds. While nuclear power may prove superior to chemical fuels in engines of multi-million-pound thrust, even the atom will provide no shortcut to space exploration.

Sending a small instrument carrier to Mars, although not requiring much more initial propulsion than a simple moon shot, would take a much longer travel time (8 months or more), and the problems of navigation and final guidance are formidable.

A message from Mars

Fortunately, the exploration of the moon and nearby planets need not be held up for lack of rocket engines big enough to send men and instrument carriers out into space and home again. Much that scientists wish to learn from satellites and space voyages into the solar system can be gathered by instruments and transmitted back to earth. This transmission, it turns out, is relatively easy with today's rugged and tiny electronic equipment.

For example, a transmitter with a power of just 1 or 2 watts can easily radio information from the moon to the earth. And messages from Mars, on the average some 50 million to 100 million miles away at the time the rocket would arrive, can be transmitted to earth with less power than that used by most commercial broadcasting stations. In some ways, indeed, it appears that it will be easier to send a clear radio message between Mars and Earth than between New York and Tokyo.

This all leads up to an important point about space exploration. The cost of transporting men and material through space will be extremely high, but the cost and difficulty of sending information through space will be comparatively low.

Will the results justify the costs?

Since the rocket powerplants for space exploration are already in existence or being developed for military need, the cost of additional scientific research, using these rockets, need not be exorbitant. Still, the cost will not be small, either. This raises an important question that scientists and the general public (which will pay the bill) both must face: Since there are still so many unanswered scientific questions and problems all around us on earth, why should we start asking new questions and seeking out new problems in space? How can the results possibly justify the cost?

Scientific research, of course, has never been amenable to rigorous cost accounting in advance. Nor, for that matter, has exploration of any sort. But if we have learned one lesson, it is that research and exploration have a remarkable way of paying off—quite apart from the fact that they demonstrate that man is alive and insatiably curious. And we all feel richer for knowing what explorers and scientists have learned about the universe in which we live.

It is in these terms that we must measure the value of launching satellites and sending rockets into space. These ventures may have practical utility, some of which will be noted later. But the scientific questions come first.

The view from a satellite

Here are some of the things that scientists say can be done with the new satellites and other space mechanisms. A satellite in orbit can do three things: (1) It can sample the strange new environment through which it moves; (2) it can look down and see the earth as it has never been seen before; and (3) it can look out into the universe and record information that can never reach the earth's surface because of the intervening atmosphere.

The satellite's immediate environment at the edge of space is empty only by earthly standards. Actually, empty space is rich in energy, radiation, and fast-moving particles of great variety. Here we will be exploring the active medium, a kind of electrified plasma, dominated by the sun, through which our earth moves. Scientists have indirect evidence that there are vast systems of magnetic fields and electric currents that are connected somehow with the outward flow of charged material from the sun. These fields and currents the satellites will be able to measure for the first time. Also, for the first time, the satellites will give us a detailed three-dimensional picture of the earth's gravity and its magnetic field.

Physicists are anxious to run one crucial and fairly simple gravity experiment as soon as possible. This experiment will test an important prediction made by Einstein's general theory of relativity, namely, that a clock will run faster as the gravitational field around it is reduced. If one of the fantastically accurate clocks, using atomic frequencies, were placed in a satellite and should run faster than its counterpart on earth, another of Einstein's great and daring predictions would be confirmed. (This is not the same as the prediction that any moving clock will appear to a stationary observer to lose time—a prediction that physicists already regard as well confirmed.)

There are also some special questions about cosmic rays which can be settled only by detecting the rays before they shatter themselves against the earth's atmosphere. And, of course, animals carried in satellites will begin to answer the question: What is the effect of weightlessness on physiological and psychological functions? (Gravity is not felt inside a satellite because the earth's pull is precisely balanced by centrifugal force. This is just another way of saying that bodies inside a satellite behave exactly as they would inside a freely falling elevator.)

The satellite that will turn its attention downward holds great promise for meteorology and the eventual improvement of weather forecasting. Present weather stations on land and sea can keep only about 10 percent of the atmosphere under surveillance. Two or three weather satellites could make a cloud inventory of the whole globe every few hours. From this inventory, meteorologists believe they could spot large storms (including hurricanes) in their early stages and chart their direction of movement with much more accuracy than at present. Other instruments in the satellites will measure for the first time how much solar energy is falling upon the earth's atmosphere and how much is reflected and radiated back into space by clouds, oceans, the continents, and by the great polar icefields.

It is not generally appreciated that the earth has to send back into space, over the long run, exactly as much heat energy as it receives from the sun. If this were not so, the earth would either heat up or cool off. But there is an excess of income over outgo in the tropical regions, and an excess of outgo over income in the polar regions. This imbalance has to be continuously rectified by the activity of the earth's atmosphere which we call weather.

By looking at the atmosphere from the outside, satellites will provide the first real accounting of the energy imbalances, and their consequent tensions, all around the globe. With the insight gained from such studies, meteorologists hope they may improve long-range forecasting of world weather trends.

Finally, there are the satellites that will look not just around or down, but out into space. Carrying ordinary telescopes, as well as special instruments for recording X-rays, ultraviolet, and other radiations, these satellites cannot fail to reveal new sights forever hidden from observers who are bound to the earth. What these sights will be, no one can tell. But scientists know that a large part of all stellar radiation lies in the ultraviolet region of the spectrum, and this is totally blocked by the earth's atmosphere. Also blocked are other very long wavelengths of light of the kind usually referred to as radio waves. Some of these get through the so-called radio window in the atmosphere and can be detected by radio telescopes, but scientists would like a look at the still longer waves that cannot penetrate to earth.

Even those light signals that now reach the earth can be recorded with brilliant new clarity by satellite telescopes. All existing photographs of the moon and nearby planets are smeared by the same turbulence of the atmosphere that makes the stars twinkle. Up above the atmosphere the twinkling will stop, and we should be able to see for the first time what Mars really looks like. And we shall want a really sharp view before launching the first rocket to Mars.

A closeup of the moon

While these satellite observations are in progress, other rockets will be striking out for the moon with other kinds of instruments. Photographs of the back or hidden side of the moon may prove quite unexciting, or they may reveal some spectucular new feature now unguessed. Of greater scientific interest is the question whether or not the moon has a magentic field. Since no one knows for sure why the earth has such a field, the presence or absence of one on the moon should throw some light on the mystery.

But what scientists would most like to learn from a closeup study of the moon is something of its origin and history. Was it originally molten? Does it now have a fluid core, similar to the earth's? And just what is the nature of the lunar surface? The answer to these and many other questions should shed light, directly or indirectly, on the origin and history of the earth and the surrounding solar system.

While the moon is believed to be devoid of life, even the simplest and most primitive, this cannot be taken for granted. Some scientists have suggested that small particles with the properties of life—germs or spores—could exist in space and could have drifted onto the moon. If we are to test this intriguing hypothesis we must be careful not to contaminate the moon's surface, in the biological sense, beforehand.

There are strong scientific reasons, too, for avoiding radioactive contamination of the moon until its naturally acquired radioactivity can be measured.

** * and on to Mars*

The nearest planets to earth are Mars and Venus. We know quite enough about Mars to suspect that it may support some form of life. To land instrument carriers on Mars and Venus will be easier, in one respect, than achieving a "soft" landing on the moon. The reason is that both planets have atmospheres that can be used to cushion the final approach. These atmospheres might also be used to support balloons equipped to carry out both meteorological soundings and a general photo survey of surface features. The Venusian atmosphere, of course, consists of what appears to be a dense layer of clouds so that its surface has never been seen at all from earth.

Remotely controlled scientific expeditions to the moon and nearby planets could absorb the energies of scientists for many decades. Since man is such an adventurous creature, there will undoubtedly come a time when he can no longer resist going out and seeing for himself. It would be foolish to try to predict today just when this moment will arrive. It might not arrive in this century, or it might come within 1 or 2 decades. So much will depend on how rapidly we want to expand and accelerate our program. According to one rough estimate it might require a total investment of about a couple of billion dollars, spent over a number of years to equip ourselves to land a man on the moon and to return him safely to earth.

The satellite radio network

Meanwhile, back at earth, satellites will be entering into the everyday affairs of men. Not only will they be aiding the meteorologists, but they could surely—and rather quickly—be pressed into service for expanding worldwide communications, including intercontinental television.

At present all transoceanic communication is by cable (which is costly to install) or by shortwave radio (which is easily disrupted by solar storms). Television cannot practically be beamed more than a few hundred miles because the wavelengths needed to carry it will not bend around the earth and will not bounce off the region of the atmosphere known as the ionosphere. To solve this knotty problem, satellites may be the thing, for they can serve as high-flying radio relay stations. Several suitably equipped and properly spaced satellites would be able to receive TV signals from any point on the globe and to relay them directly—or perhaps via a second satellite—to any other point. Powered with solar batteries, these relay stations in space should be able to keep working for many years.

Military applications of space technology

The development of military rockets has provided the technological base for space exploration. It will probably continue to do so, because of the commanding military importance of the ballistic missile. The subject of ballistic missiles lies outside our present discussion. We ask instead, putting missiles aside, what other military applications of space technology can we see ahead?

There are important, foreseeable, military uses for space vehicles. These lie, broadly speaking, in the fields of communication and reconnaissance. To this we could add meteorology, for the possible advances in meteorological science which have already been described would have military implications. The use of satellites for radio relay links has also been described, and it does not take much imagination to foresee uses of such techniques in long-range military operations.

The reconnaissance capabilities of a satellite are due, of course, to its position high above the earth and the fact that its orbit carries it in a predictable way over much of the globe. Its disadvantage is its necessarily great distance, 200 miles or more, from the surface. A highly magnifying camera or telescope is needed to picture the earth's surface in even moderate detail. To the human eye, from 200 miles away, a football stadium would be a barely distinguishable speck. A telescopic camera can do a good deal better, depending on its size and complexity. It is certainly feasible to obtain reconnaissance information with a fairly elaborate instrument, information which could be relayed back to the earth by radio.

Much has been written about space as a future theater of war, raising such suggestions as satellite bombers, military bases on the moon, and so on. For the most part, even the more sober proposals do not hold up well on close examination or appear to be achievable at an early date. Granted that they will become technologically possible, most of these schemes, nevertheless, appear to be clumsy and ineffective ways of doing a job. Take one example, the satellite as a bomb carrier. A satellite cannot simply drop a bomb. An object released from a satellite doesn't fall. So there is no special advantage in being over the target. Indeed, the only way to "drop" a bomb directly down from a satellite is to carry out aboard the satellite a rocket launching of the magnitude required for an intercontinental missile. A better scheme is to give the weapon to be launched from the satellite a small push, after which it will spiral in gradually. But that means launching it from a moving platform halfway around the world, with every disadvantage compared to a missile base on the ground. In short, the earth would appear to be, after all, the best weapons carrier.

This is only one example; each idea has to be judged on its own merits. There may well be important military applications for space vehicles which we cannot now foresee, and developments in space technology which open up quite novel possibilities. The history of science and technology reminds us sharply of the limitations of our vision. Our road to future strength is the achievement of scientific insight and technical skill by vigorous participation in these new explorations. In this setting, our appropriate military strength will grow naturally and surely.

A space timetable

Thus we see that satellites and space vehicles can carry out a great variety of scientific missions, and a number of military ones as well.

Indeed, the scientific opportunities are so numerous and so inviting that scientists from many countries will certainly want to participate. Perhaps the International Geophysical Year will suggest a model for the international exploration of space in the years and decades to come.

The timetable on the following page suggests the approximate order in which some of the scientific and technical objectives mentioned in this review may be attained.

The timetable is not broken down into years, since there is yet too much uncertainty about the scale of the effort that will be made. The timetable simply lists various types of space investigations and goals under three broad headings: "Early," "Later," "Still Later."

Scientific objectives

Early	Later	Still later
1. Physics	1. Astronomy	1. Automated lunar exploration.
2. Geophysics	2. Extensive communications	2. Automated planetary exploration.
3. Meteorology	3. Biology	3. Human lunar exploration and return.
4. Minimal Moon contract	4. Scientific lunar investigation	And much later still:
5. Experimental communications.	5. Minimal planetary contact	Human planetary exploration.
6. Space physiology	6. Human flight in orbit	

In conclusion, we venture two observations. Research in outer space affords new opportunities in science, but it does not diminish the importance of science on earth. Many of the secrets of the universe will be fathomed in laboratories on earth, and the progress of our science and technology and the welfare of the Nation require that our regular scientific programs go forward without loss of pace, in fact at an increased pace. It would not be in the national interest to exploit space science at the cost of weakening our efforts in other scientific endeavors. This need not happen if we plan our national program for space science and technology as part of a balanced national effort in all science and technology.

Our second observation is prompted by technical considerations. For the present, the rocketry and other equipment used in space technology must usually be employed at the very limit of its capacity. This means that failures of equipment and uncertainities of schedule are to be expected. It therefore appears wise to be cautious and modest in our predictions and pronouncements about future space activities—and quietly bold in our execution.

Dr. JAMES R. KILLIAN, Jr., *Chairman.*
Dr. ROBERT F. BACHER.
Dr. WILLIAM O. BAKER.
Dr. LLOYD V. BERKNER.
Dr. HANS A. BETHE.
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O

AOMC INTERNAL INFORMATION RELEASE

Public Information Office
U. S. Army Ordnance Missile Command
Redstone Arsenal, Alabama

JUPITER NOSE CONE RECOVERY

A full-scale JUPITER IRBM nose cone was successfully recovered intact by the U. S. Navy one hour and 30 minutes after the missile was launched from Cape Canaveral, Florida at 4:05 A.M., EST, on 17 July 58.

It was the second recovery of an undamaged JUPITER IRBM cone. The Army Ballistic Missile Agency achieved the feat first on 18 May 58, repeating the success of August 1957 when a scale model cone carried by a JUPITER C was recovered.

Three recoveries confirm the adequate protection afforded the weapon system's warhead by the cone developed by ABMA with assistance of the Cincinnati, Ohio Testing and Research Laboratories. The recovery package installed in the cone was provided by Cook Electric Co., Evanston, Ill.

On hand to witness the historic launching by the ABMA Missile Firing Laboratory were Brig. Gen. J. M. Colby, Deputy Commander, AOMC; Brig. Gen. J. A. Barclay, ABMA Commander and Dr. Wernher von Braun, Director, Development Operations Division, ABMA.

The Navy's cooperation was again outstanding. The USS Escape, guided by Navy aircraft which saw the cone as it reentered the atmosphere, hoisted it aboard and returned it to the San Juan, P. R. Naval Base from which it will be airlifted to the Arsenal.

JUPITER was flown over the approximate full range of the IRBM.

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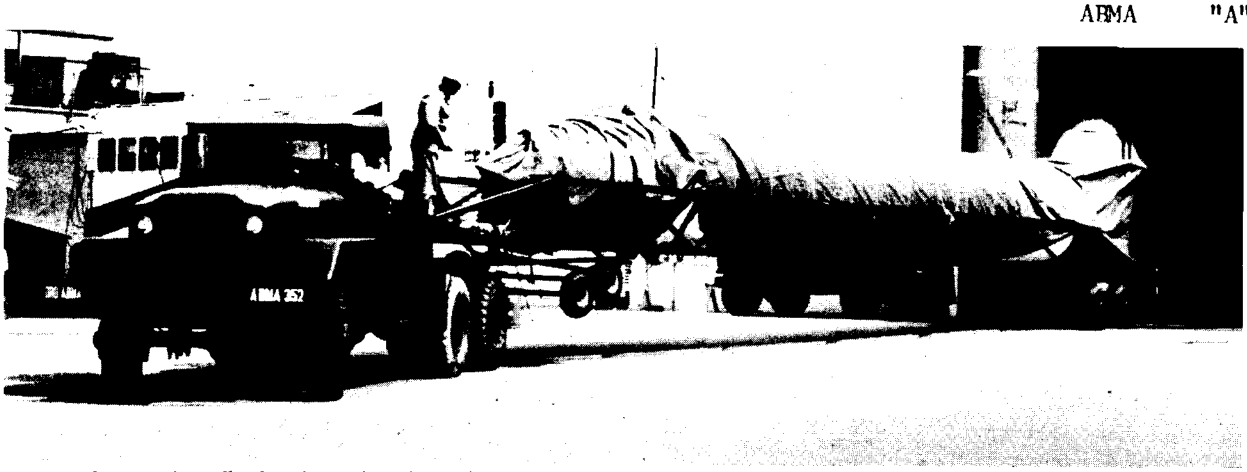


JUPITER-C, satellite launching vehicle for Explorer, is backed into Army Ballistic Missile Agency shop at Cape Canaveral, Fla.

Army Gaining Vital Space Assignments

On Jan. 31, 1958, the Army Ballistic Missile Agency put the first United States satellite into orbit and thereby filed its claim to space research and development. Since then, ABMA has been given important assignments in the nation's space program such as:

- Mar. 5, Agency launched Explorer II. Mechanical failure in ignition system of last stage rocket prevented satellite from going into orbit after good initial trajectory.
- Mar. 26, ABMA launched Explorer III, successfully placing third U. S. satellite in orbit (Vanguard went into orbit March 17).
- Mar. 27, Advanced Research Projects Agency authorized ABMA "to undertake one, and possibly two, lunar probes" and "to launch two, and possibly three, earth satellites." Satellites will be continuation of Explorer program with some modifications in both the satellites and in the carrier rockets.
- May 2, Army awarded $2,850,000 contract to California Institute of Technology for research on moon project. Rear Admiral John E. Clark, deputy director of ARPA, said he hoped to see satellite orbiting the moon before end of 1958.

Satellite will be carried by Juno missile, probably a combination of ABMA's Jupiter and components of the Vanguard, or other missiles.

Project Orbiter

The Army actually began its preparations for the space age long before the first Explorer took to the air. It was during the first part of 1954 that the initial plan began to take shape.

Soon after the Redstone had proven itself in flight tests, Dr. Wernher von Braun, now director of ABMA's Development Operations Division, started toying with the idea of using the 200-mi. ballistic missile as the first stage of a satellite carrying rocket. On top of the Redstone, according to von Braun, could be placed a rotating, cylindrical launcher, containing three clusters of small, solid propellant Loki rockets.

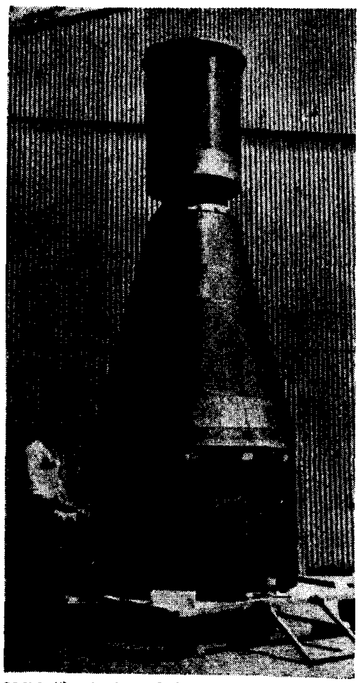
The Lokis, then under development, were desired because of their short burning time, about 0.8 sec. The plan was for the Redstone to start the vehicle on its trajectory. After two minutes, the Redstone engine would be cut off as the propellant tanks started to go dry. A few seconds later, the Redstone would be separated, and the last three stages plus the satellite would continue to coast upward.

Aligned by Air Jet

Just before the final stages reached the apex of their trajectory, compressed air jets would align the vehicle horizontally. At apex, about 200 mi. up, the spin-stabilized clusters of Lokis would be fired, in order, to bring the vehicle from a speed of around 6,000 mph. to orbital velocity of 18,000 mph. At this point, the vehicle has no guidance, and it was believed that the incremental velocity would have to be produced almost instantaneously for the satellite to go into a circular orbit.

This was the reason von Braun wanted the Lokis with their very short burning times. Further analysis, however, showed that the firing time wasn't as critical a factor as first believed. So when the larger, more powerful Sergeant rocket engine came along, it was used in place of the Loki. Adoption of the Sergeant significantly reduced the number of solid propellant rockets needed. This, in turn, meant an easier engineering job and increased reliability, i.e. fewer chances for failure in flight.

While the idea was still in the planning stage, von Braun was introduced to Cmdr. George Hoover of the Office of Naval Research. ONR wanted to initiate a satellite projects based on existing hardware. It liked von Braun's ideas and offered to put up the necessary money. Maj. Gen. H. N. Toftoy, at that time commanding general of Red-



SPIN "bucket" and first-stage nose for Explorer vehicle at Reynolds Metals plant.

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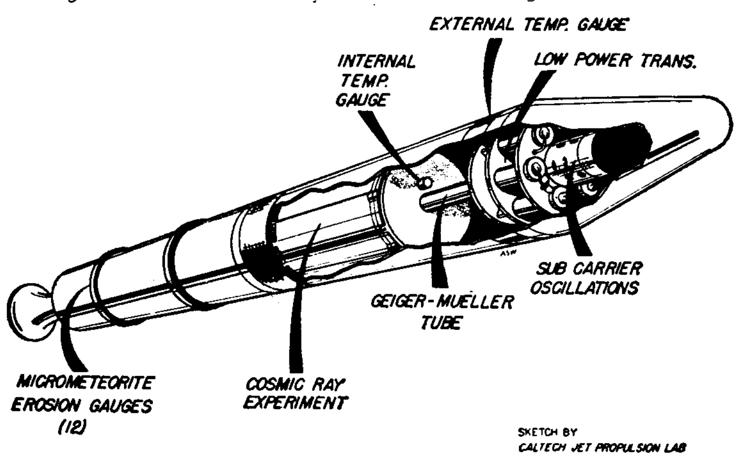
EXPLORER is prepared for spin test. Upper stages are rotated to 700 rpm. in check-out.

sisted of two main parts: the body unit which held the guidance and control equipment in addition to the warhead, and the thrust unit which contained the propellant tanks and rocket engine.

To get the additional velocity required for re-entry, the engineers lengthened the thrust unit and inserted larger propellant tanks. This increased the burning time by almost 50%. Then, two, spin-stabilized clusters of scaled-down Sergeant rockets were sub-



EXPLORER III instruments measure cosmic ray intensity, temperature, meteor particles.

AOMC INTERNAL INFORMATION RELEASE

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● SPACE AGENCIES

Army's Mission in Space Is Expanding

Army, which put the first U.S. satellite into orbit, has been authorized by Advanced Research Projects Agency to undertake one, and possibly two, lunar probes and also to launch two, and possibly three, earth satellites. The satellites will be Explorers or variations thereof and the rockets used will be modified Jupiter-Cs.

The Army's proposal to place a man in a capsule atop the Redstone missile and send him up to an altitude of 150 mi. is still under consideration by the Defense Department. But this experiment is not tied in with the Army's space work, declares Maj. Gen. John Medaris, Chief of Army Ordnance Missile Command. Rather, it will be part of a separate series of experiments concerned with transporting men by missile—not through space, but from one point on earth to another.

This "men-by-missile" program would be more closely associated with special forces operations. The idea is to get a small number of specialists such as a medical aid or demolition team to a key point at a specific time "with the assurance that they won't be clobbered by the enemy on the way in."

Separation Impossible

Actually, it is impossible to separate missile or weapons work from space projects, Gen. Medaris declares. Technical problems for both are closely interlocked; there are many fruitful opportunities for cross-pollination of ideas; variety makes the work of the researchers more challenging.

Army has no intention of trying to keep space and weapons projects distinct, either in its own facilities or among outside contractors. The recent placement of the Pershing contract with the Martin Co., contrary to some speculation, does not signify any change in the Army's arsenal concept nor is it part of any plan to give weapons work to private industry in order to keep Army scientists free for space work, says Gen. Medaris. As an ordnance manager, he is interested in maintaining a reasonable workload balance between industry and government. At present, the balance in the Army's missile work runs about 70% to industry and about 30% in-house. The average division is closer to 82% for industry to 18% in-house.

Right now, the Army is running about 80 static firings a month at Redstone Arsenal. Most of these are part of weapons programs. Space programs constitute only a very small percentage of current work. From here on in, Gen. Medaris expects to see an increase in both the over-all missile work and the percentage represented by space projects.

To better handle its rapidly expanding missile work, the Army recently reorganized its Redstone Arsenal complex. Effective Mar. 31, 1958, the Army Ordnance Missile Command came into being after about 15 months in the gestation period.

The creation of this new command (see chart, p. 92) is designed to enable the Army to exploit its missile capabilities as fast and as fully as possible by placing all the resources in this area under one commander along with the responsibility for all the decision-making required to bring a missile from an idea to a field-proven weapons system.

This new command extends from California to Cape Canaveral, Fla. with the management headquartered in Huntsville, Ala. Commanding general of AOMC, Gen. Medaris, reports directly to the Chief of Ordnance on routine research and development projects. For special priority—weapons or space projects, there are direct access lines between Medaris on one end and, on the other, the Secretary of the Army, the Army Missile Committee, and the Advanced Research Projects Agency.

Under Medaris and his command headquarters staff come Redstone Arsenal, Army Ballistic Missile Agency, Army Rocket and Guided Missile Agency, White Sands Proving Ground, and Jet Propulsion Laboratory.

Non-Ballistic Responsibility

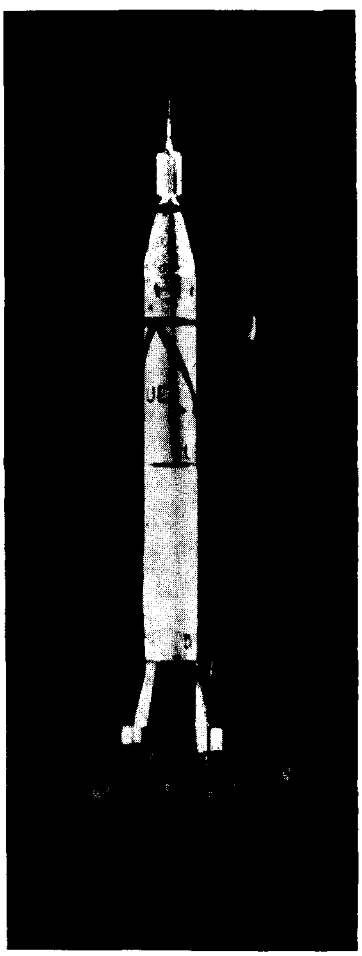
ARGMA, which is the new group, has taken over the responsibility for non-ballistic weapons formerly held by Redstone Arsenal. These weapons include Sergeant, Corporal, Honest John, Little John, Nike Ajax, Nike Hercules, Nike Zeus, Lacrosse, land-based Talos, Dart, Plato and Hawk. At present, ARGMA, which is under the command of Brig. Gen. John G. Shinkle, has the largest budget of all AOMC subgroups. In 1959, for example, ARGMA will spend approximately $180 million on research and development and perhaps another $800 million on production and procurement.

Redstone Arsenal, the physical home base of AOMC, is now essentially a post command. Under the direction of Col. Keith T. O'Keefe, it is responsible for the housekeeping of the 40,000-acre arsenal reservation and for providing support to ARGMA, ABMA and the Ordnance Guided Missile School. Besides OGMS, other tenants on the base who are not part of the AOMC table of organization are Rohm & Haas and Thiokol, which do work on solid propellants for ARGMA. Combined support for all AOMC groups will cost about $137 million next year.

White Sands

White Sands Proving Ground, commanded by Maj. Gen. W. E. Laidlaw, is located in south central New Mexico. Its main mission is providing integrated range facilities for flight testing of missiles under development by all three services. In addition, it conducts laboratory tests of Army missile components and carries out independent engineered testing of complete Army missile systems before they are released for field use. AOMC estimates White Sands will spend $70 million next year.

Jet Propulsion Laboratory, located



JUPITER-C, carrying Explorer, takes off from Cape Canaveral, Fla.

Remove from bulletin boards after 15 August 1958

Dr. Wernher von Braun
Director, Development Operations Division
U. S. Army Ballistic Missile Agency
Redstone Arsenal, Alabama

THE EXPLORERS
Ninth Annual Congress
International Astronautical Federation
Amsterdam, The Netherlands
25-30 August 1958

Events of the past ten months since this Congress last convened in Barcelona have given special meaning to these meetings of the International Astronautical Federation. History-making demonstrations of advancing rocket technology have focused the attention of people everywhere on the International Geophysical Year and the concerted effort of scientists from all over the globe to obtain more information about our home planet and the open spaces around it.

It is therefore a propitious time for this assembly, which is broadly representative of the scientific and engineering programs of many nations interested in the limitless areas beyond the earth. I believe I speak for all of us assembled here in this room when I say that for many months we felt a deep regret that the International Geophysical Year will be concluded all too soon. We knew in our hearts that it would indeed be tragic if we failed to continue the world-wide research program initiated under the IGY which has rendered mankind such convincing and heartening proof that even in times of tension and crises the world's scientific community can work together for the mutual good. And as protagonists of the grandiose concept of flight into outer space we all knew that it would be an incorrigible mistake and a severe setback for all astronautical endeavors and programs if we failed to make further use of the world-wide network of observation stations established for the IGY effort. It was thus with a feeling of infinite relief and gratitude that we learned that during the recent meeting of the national representatives of the International Geophysical Year in Moscow it was resolved to continue the most important phases of the IGY program through the coming calendar year. I strongly recommend that this assemblage exert its good influence to ensure the vigorous continuance of this effort with the objective of providing a continuous permanent basis for a close international cooperation not only in spirit but also in the practical phases of astronautical projects.

As a preamble to my discussion of one portion of the space programs of the United States of America, I quote a statement by President Eisenhower on March 26, 1958. On that date the President made public a presentation by his Science Advisory Committee entitled "Introduction to Outer Space." In doing so, Mr. Eisenhower said:

"This statement of the Science Advisory Committee makes clear the opportunities which a developing space technology can provide to extend man's knowledge of the earth, the solar system, and the universe. These opportunities reinforce my conviction that we and other nations have a great responsibility to promote the peaceful use of space and to utilize the new knowledge obtainable from space science and technology for the benefit of all mankind."

I think all of us will heartily subscribe to that statement of principles. It is within that context that the United States Army has provided the launching vehicles which placed the EXPLORER earth satellites in orbit with the primary objective of obtaining useful scientific data about the spatial environment. That data has been made available, without restriction, to the scientific community by elements of the Army Ordnance Missile Command, the U. S. National Academy of Sciences and the International Geophysical Year Committee. We are continuing our cooperative effort to explore space with interested segments of the scientific fraternity.

I want also to use this opportunity to extend my congratulations to the representatives of the Soviet Union for the technological feats they achieved in recent months, beginning with the launching of Sputnik I on the 4th of October, 1957, and culminating in the launching of Sputnik III on May 15, 1958. We all appreciate the derivative values of competition which can be extremely beneficial in wholly peaceful scientific endeavors such as the launching of satellites for the exploration of the environment of outer space. And I should like to say to our Soviet colleagues that we shall certainly continue to be up there with you, collecting all the data we can in preparation for even more ambitious undertakings which will follow in due course.

My presentation concerns the scientific earth satellites of the EXPLORER series and their launching vehicles, and will be illustrated with a number of slides. In this effort we received major assistance from two sources: the Jet Propulsion Laboratory of California Institute of Technology and the State University of Iowa. The Air Force Cambridge Research Center also participated. So did many other individuals and agencies, including the Vanguard Project of the United States Navy, primarily in tracking and data reduction aspects.

Let me first talk about the carrier rockets for our EXPLORER satellites. We call these carrier rockets JUPITER-C, because we have used these rockets in support of the development of a bigger rocket called the JUPITER. As Figure 1 indicates, the JUPITER-C rocket consists of a modified REDSTONE rocket serving as first stage and a three-stage cluster of solid propellant rockets placed in a spinning tub which was mounted in the nose of the first stage. The entire JUPITER-C thus has four stages.

The standard REDSTONE Missile operates with a thrust of 75,000 pounds and burns alcohol with liquid oxygen as the oxidizing element. For the EXPLORER missions we enlarged the first-stage propellant tanks and selected another fuel, known as hydyne, to replace alcohol. Hydyne is a development of the Rocketdyne Division of North American Aviation Company, our power plant contractor. It yields from 10 to 15 per cent more specific impulse than does alcohol and can be used in an engine designed for alcohol and liquid oxygen without major modification. We actually increased burning time as well as thrust, boosting the latter to 83,000 pounds or 8,000 pounds above the usual REDSTONE thrust.

The total weight of the high-speed clusters in the nose of the JUPITER-C is substantially less than the payload weight of the REDSTONE Missile. As a with some extra propellants for the first stage.

The instrument compartment sits atop the tank section and is separated from the latter after first-stage power cutoff. It accommodates the guidance and control equipment for the first-stage flight phase and a spatial attitude control system for horizontal alignment of the separated nose section with the spinning tub when it passes through the apex of its trajectory. The objective is to aim and fire the high-speed clusters prior to apex so that at injection the satellite would be traveling in exactly horizontal direction.

The firing procedure for the JUPITER-C was as follows:

The missile takes off vertically under its thrust of 83,000 pounds. During the 155 seconds burning time of the first stage, it is tilted into a trajectory which is approximately 40 degrees inclined to the horizon at cutoff. A few seconds after cutoff, the booster - with that I mean the combined tank and engine section of the first stage - is separated from the instrument compartment. This is done by igniting six explosive bolts which secure the compartment to the front end of the tank section of the first stage. Wrapped around these bolts are six coil springs which have been pre-loaded during the assembly procedure. At the moment the tiny powder charges destroy the bolts, the springs exert a gentle push on the instrument compartment and separate it cleanly from the booster. The velocity increment imparted to the instrument compartment by sudden expansion of the coil springs is in the order of 2.6 fps.

We did not apply a refined cutoff for the first stage of EXPLORER I. Instead we used the so-called depletion technique. This means simply that shortly before the expected burn-out time we energized two contacts. These contacts sensed the pressure in the fuel and the liquid oxygen pump discharge lines. Whichever of these two pressures dropped to zero first triggered a relay which, in turn, closed both propellant main valves controlling the flow into the combustion chamber. In other words, we simply used the instant at which one of the two propellant components depleted to shut the engine down and get a clean cutoff. Cutoff occurred after 157 seconds in EXPLORER I, two seconds later than expected. Simultaneously a timer was triggered which activated the separation mechanism 5 seconds later. This prevented the runup of the booster into the instrument compartment as a result of gradual thrust decay.

In a near-perfect vacuum such as the missile encounters at a cutoff point 58 miles above earth's surface there is no abrupt thrust decay. While the thrust drops quite abruptly to a fraction of its original level, further thrust decay is slow because all the gas in the combustion chamber, plus whatever fuel and liquid oxygen is trapped between the valves and the combustion chamber will expand or after-burn. This will exert a small but noticeable post-cutoff impulse on the booster. Since only the weak spring forces separated the instrument compartment from the booster, we had to ensure that the booster would not collide with the instrument compartment after separation due to this residual thrust. For this reason we allowed the complete missile to coast about 5 seconds and permitted the thrust to decay completely down to zero before actual separation occurred.

From the point of separation, the two portions of the missile coasted through a vacuum trajectory until approximately 404 seconds from take-off. The apex was nearly attained at this time. During the free coasting period, between 157 and 404 seconds, the spatial attitude control system aligned the instrument compartment into an exactly horizontal position with respect to the earth's surface.

This was accomplished as follows:

The same gyroscopes which had controlled the missile up to the cutoff point by means of jet vanes now (after separation) would control a system of compressed air nozzles which were mounted in the tail of the instrument compartment. The reaction thrust of these air nozzles tilted the entire nose section, complete with the spinning cluster of high-speed rockets, into the horizontal direction. The tilt actually occurred substantially faster than the tilt of the trajectory itself. We turned the nose section into the horizontal position relatively fast in order to give the residual errors sufficient time to decay. Thus we obtained the highest possible degree of accuracy in the horizontal alignment by the time apex was finally reached.

Due to our relatively crude cutoff technique, based only on propellant depletion, it was impossible to predict exactly the time at which the apex would be attained prior to takeoff. It was for the same reason impossible to determine exactly and in advance the horizontal distance the missile would have traversed between takeoff point and apex. Because of the curvature of the earth and because the high-speed rocket launcher must be in exactly horizontal position over the local horizon, it was necessary to introduce some auxiliary tracking means to furnish additional data during the flight. Only by catching the moment of apex and by accurate alignment of the spinning tub would it be possible to ignite the high-speed stages in the right direction necessary to obtain orbital flight.

Three independent methods were employed to determine the instant of apex as precisely as possible. First, the missile was tracked by radar. The radar plot was used to predict the instant and point in space at which apex would be reached. Second, we had an accelerometer in the missile which, by means of telemetry, relayed to the ground the velocity build-up of the first stage. Cutoff velocity was then fed into a simple ground computer which predicted the instant of apex transit. Third, standard Doppler tracking network furnished the same information.

The results obtained with these three independent apex prediction methods were introduced into a small calculator which enabled us to evaluate the quality of the three inputs. For example, if one prediction was based upon readings of poor quality, it could be disregarded or its value in determining the average would be reduced to about 20 per cent of the weight of the other methods. We could thus determine a rather reliable average of the apex predictions. The average was then employed to set a timing device which dispatched a radio signal to the missile. It was this signal which fired the second stage. All this had to be accomplished in the four-minute interval between cutoff and apex, of course.

We did not want to fire the second stage exactly at apex but slightly prior to this instant. The second, third and fourth stage had burning times of about 5 seconds each and several seconds elapsed between firing one stage and burnout of the previous stage. Total elapsed time between firing the second stage and fourth stage cutoff was about 24 seconds. Firing of the second stage, therefore, had to occur prior to the predicted apex point. With this lead time the vertical velocity component of the high-speed cluster would be exactly zero at fourth stage cutoff.

The fourth stage appears at the right side of Figure 1. This is the stage which orbits. It consists of a single 6-inch solid rocket loaded with high energy propellant. The black-and-white striped unit on top of it is the instrumented satellite itself. The entire EXPLORER unit; that is, the empty shell plus the instrumented satellite, weighed 30.8 pounds. The forward portion alone weighed 18.8 pounds and the empty shell weighed 12 pounds. The EXPLORER fourth stage assembly is 80 inches long and 6 inches in diameter. Similar rockets but with a slightly different propellant were used in the second and third stages. The second stage consisted of a ring of 11 of them. Inserted into this ring was the third stage consisting of three rockets. The single rocket making up the fourth stage sat atop the third stage.

Figure 1 also shows the orbit obtained with EXPLORER I. The perigee altitude of 225 miles and apogee of 1594 miles corresponds to a period of revolution of 114.78 minutes. From post-launch tracking data, we learned that the angle under which the fourth stage entered orbit was, in respect to the local horizon, as little as 0.81 degrees off, which we thought was a remarkable accuracy in view of the many factors contributing to this error. However EXPLORER I would still have orbited had the error been as high as 4 degrees. Thus a comfortable safety margin was available so far as accuracy requirements for apex attitude alignment were concerned.

The satellite carried two transmitters. The low-powered transmitter in the nose is the same kind as the high-powered one located further aft, but it operates on one-sixth of the power level, radiating only 10 milliwatts instead of 60. It is fed by the same type mercury batteries but since they have about the same capacity in terms of ampere hours as those connected to the high-powered transmitter, they were expected to furnish about six times more lifetime. The high-powered transmitter thus had an expected lifetime of two weeks, while the battery power supply for the low-powered transmitter was expected to last for 2 to 3 months.

The first task of both transmitters was to provide signals for the tracking of the EXPLORER; to prove, that is, that the satellite was in orbit. The high-powered transmitter could be received with any customary VHF receiver but the low-powered one required more sophisticated, narrow band-width receiving equipment. Specifically, the latter could be received only by the microlock ground stations developed by the Jet Propulsion Laboratory for the Army and by the minitrack network established by the Navy, consisting of a long string of stations stretching from North to South approximately along the 65 longitude west of Greenwich. The stations provide a line across the North and South American continents which must be passed by any object orbiting at any moderate inclination to the equatorial plane. The minitrack network will receive any satellite transmission, provided it employs the right frequency, once per orbit and record the time of passing.

In addition to the task of providing a tracking tool, the transmitters also telemeter to the ground scientific information collected by the satellite. The telemetered data from EXPLORER I consisted of measurements of temperature, micrometeorites, and cosmic rays in space.

Three temperature gauges were carried in the nose and the cylindrical portion of the outer shell to determine outer skin temperatures, and one inside the instrument compartment, behind the high-powered transmitter, to measure the temperature of the heat-insulated instrument package as compared to the outer skin.

For its second test objective EXPLORER I carried several instruments designed to determine the abundancy of micrometeorites in space and to determine how they, or tinier particles commonly referred to as cosmic dust, affect the satellite's surface. Three different instruments were employed. One was a microphone amplifier mounted in the satellite's hull. This would register the impact of a micrometeorite and amplify it. A scale of two circuits was used to switch the frequency of a subcarrier oscillator. Meteorite impact was observed through frequency changes. Dr. Bohn of the Research Institute of Temple University in Philadelphia developed this piece of equipment.

In addition to the microphone there was a micrometeorite erosion gauge, consisting of two instruments in one. A portion of it consisted of 11 wires of extremely brittle metal which were imbedded in an insulating surface. A voltage was applied to the 11 wires in parallel. Each time a micrometeorite struck and broke a wire, the total number of wires connecting the plus and minus busbar would be reduced from 11 to 10, or 10 to 9, or 9 to 8, and so on that the resistance would increase in distinct steps. This change in resistance would be indicated on a sub-carrier oscillator.

Two wires were put out of commission on the first orbit of EXPLORER I. We believe now that they went out during the vehicle's ascent through the atmosphere. Apparently the density of micrometeorites in outer space, at least outside of recurrent meteor swarms is not as high as anticipated. The rosion gauge was prepared by Dr. M. Dubin of the Air Force Cambridge Research Center.

Final results of the micrometeorite tests will be issued by the Air Force Research Center while Iowa State University will publish the results of cosmic ray measurements.

The third, and most important experiment, was performed by a Geiger counter, compactly packaged and assembled, which was developed by the State University of Iowa under Dr. James Van Allen. The purpose of this counter was to determine the intensity of cosmic primary radiation in outer space.

You will recall that the diameter of the EXPLORER cylinder is only six inches. The total weight of the instrumentation performing all three experiments in EXPLORER I was a mere 10.83 pounds. From this inauspicious springboard there developed a major scientific discovery in physics, which was completely confirmed by the data collected with EXPLORER III.

The first analysis of the results of Dr. Van Allen's cosmic ray probe proved fascinating and bewildering. EXPLORER I's radiation counts ran about 30 to 40 per second some 200 to 300 miles above southern California, as had been predicted.

But the count climbed to more than 35,000 per second at the highest altitudes of both EXPLORER I and EXPLORER III when they were over South America and adjoining waters. This figure could possibly have been higher -- it was impossible to tell, because the instruments were completely overwhelmed at this extremely high and unexpected cosmic ray count.

Due to existing weight limitations the EXPLORER I counter could report only the number of impinging cosmic primary particles within the counter's sensitivity level. Unable to differentiate between the energy levels, it could not catalog the total into heavier and lighter, or faster and slower cosmic particles.

Moreover, with EXPLORER I we could record impingments only while the transmitter was in direct line of sight with at least one receiving ground station. Since the major portion of the earth is covered with water, or not covered by microlock or minitrack receiver stations, we lost most of the telemetered information over areas where no receiving stations existed.

For more complete data gathering EXPLORER III carried a tape recorder which stored information acquired throughout the entire orbit and reported it, on command, when the satellite passed over a suitably equipped receiving station. This is a small magnetic tape recorder driven by a spring with a little battery-powered electric step motor which wound the spring continuously. A coded radio signal flashed to the satellite from the ground triggered a relay which unlatched the tape reel so that the spring drove the tape through the playback pickup within about 5 seconds. Within this period the transmitter, turned on by the same relay, played back to the ground whatever had been recorded on tape during the last orbit. To conserve power the transmitter was turned off after relaying the tape information. Since the little step relay continued winding the spring, the unit would again play back two hours or so later, after the next orbit. Each time the tape was played back, it was simultaneously cleaned for new information. Consequently the process of recording, storing and playback continued as long as the battery lasted. The system functioned perfectly.

The presence of an exceptionally high particle impingment rate was indirectly concluded from a rather sudden, and complete absence of telemetered pulses while near the apogee of the orbits. The instruments were carried out to altitudes in excess of 1100 kilometers. As it was inconceivable that there existed an area void of any cosmic ray count, this temporary absence of any pulses was interpreted as signifying a blanketing of the Geiger tube by a very dense radiation field. Calibration of the equipment in the laboratory indicated that such complete blanketing of the Geiger tube would require a counting rate of at least 35,000 impacts per second.

It was further concluded that only a small portion of these rays could be of high energy classification, identified as cosmic rays, and that most of the count was made up of a little-known low-energy type, presumably either electrons or protons. There was no way to determine their source, whether the particles came from the sun, or from interstellar space.

The instrumentation in EXPLORERS IV and V was designed to investigate this exciting radiation phenomenon more closely. To permit the maximum exploitation of our relatively small carrier, the micrometeorite and temperature experiments carried in EXPLORERS I and III were eliminated. Even the tape recorder in EXPLORER III, that permitted the storage of information gathered throughout orbit for release in toto at a single receiving station, was sacrificed.

Weight reductions in the upper two stages of the JUPITER-C launching vehicle, combined with the use of more powerful propellants, permitted an addition of seven pounds of instrumentation in EXPLORERS IV and V, bringing the total satellite instrumentation weight up to 18.26 pounds.

All the instrumentation, devoted to this one experiment, was designed to break down the radiation count into levels of intensity. Four separate radiation counters were carried instead of the single counters in EXPLORERS I and III. Two Geiger-Mueller tubes, similar to the one each flown in the earlier satellites, were complemented by two scintillation counters. One each of the tubes and scintillators was shielded with lead to eliminate data below certain energy levels.

The shielded counters would respond only to high-energy particles, while the unshielded counters were expected to detect everything. Also, the unshielded scintillation counter had special pickups which could further differentiate between energy levels.

The new instruments in EXPLORERS IV and V were capable of detecting radiation accurately up to the range of 60,000 particles per square centimeter per second, which is several thousand times greater than the capacity of the equipment used in EXPLORERS I and III.

The satellite instrumentation for EXPLORERS IV and V was designed, assembled and tested under the supervision of Mr. Josef Boehm of the Army Ballistic Missile Agency. Dr. Van Allen's institute again furnished the counters and, for telemetry, we used Jet Propulsion Laboratory's proven microlock system.

The highly elliptical orbits bands planned for EXPLORERS IV and V were calculated to cover most of the earth's surface. Their orbital inclination with respect to the equator was 50 degrees compared to the 35 degrees of EXPLORERS I and III. When I was preparing this paper, EXPLORER IV was still sitting on its launching pad, and EXPLORER V was still in the checkout hangar. In the meantime, you will have learned from the newspapers whether or not they have been successful.

This much about our scientific objectives. Other speakers will cover the scientific data obtained from the EXPLORERS more fully.

Let me now return to the firing operations proper.

Figure 2 shows an elongated REDSTONE booster mounted on a flatbed trailer as it is loaded into a Douglas Globemaster aircraft. The first stage was shipped in two pieces to the launching site in Florida; booster and instrument compartment separately. Both were carried on the same flight. The slide indicates how the booster was protected by tarpaulin.

Figure 3 reveals the loading of the instrument compartment.

Figure 4 shows the booster in the Army flight preparation hangar at Cape Canaveral, site of the Atlantic Missile Test Range. Note the fins, to which the air rudders have not been attached. This also shows the nozzle exit of the rocket motor for the first stage and the mounts for the jet vanes which control the missile during first-stage flight.

The jet vanes for the JUPITER-C caused us some concern for a while. Most of the testing of the rocket engine with the hydyne fuel had been conducted by Rocketdyne at its own California facility while the testing of the jet vanes to determine compatibility was conducted by our Army Agency in Huntsville, Alabama. We were concerned about the combined effect of extended burning time and higher exhaust velocity upon the vanes, since erosion might have reduced our control below the minimum level. It developed that the new fuel eroded the standard jet vanes far less than alcohol.

The extended burning time achieved by using hydyne also required an enlargement of the hydrogen peroxide tank for the engine, simply to keep the turbine running for that extra period. This modification was provided by Rocketdyne.

Figure 5 shows the instrument compartment of the first stage, which is bolted to the top flange of the booster by six explosive bolts. Numerous cables and tubes connect the instrument compartment and booster. All have quick-disconnect couplings so that at separation the plugs separate and the lines part quickly and easily.

For a research project such as EXPLORER I, with its relatively simple guidance system, access doors were eliminated and the entire cover had to be lifted to service the instrument compartment....

AOMC EXECUTIVE BRIEFING

editorial

missiles and rockets, October 6, 1958

Ahead of Schedule

The politics of an election, of defense streamlining, and of big industries dependent for survival on Government contracts, are beginning to affect our missile programs in a dangerous way.

The Administration—interested in balancing the budget—is trying hard to find ways and means of cutting defense expenditures. Already there has been some talk about killing the *Titan* ICBM as a weapons system.

The President himself has been led to believe that some of our missile programs actually are *ahead of schedule,* and this thinking has been relayed to the public in recent months.

With an apparent record of semi-successful ICBM and IRBM test shoots, with a series of small satellites in orbit, and with a vast hunk of glamorous publicity about the X-15 and other sophisticated Air Force projects, the Administration might succeed in convincing the tax-payers that the nation has caught up with our potential enemies.

A short while ago, Dr. Simon Ramo was quoted as having said we already *have* caught up with the Russians in the ICBM field.

The current feud between advocates of the *Nike Hercules* and the *Bomarc* as our standard anti-aircraft weapon also has added to the confusion and has made the public think we are wasting money on duplicate systems. It becomes obvious to the taxpayer that the *Nike-Bomarc* "duplication" is bad for the country and for our defense planning.

It is too bad this idea has become so firmly fixed in the public mind. Of course, the *Bomarc* and the *Nike Hercules* are different systems designed for different defense tasks; one for long-range area defense, the other for close-in city defense. It is good that Defense Secretary McElroy has had the foresight and courage, despite political pressure, to make the decision to continue both of these programs.

It is obvious that we have taken the wrong approach to many missile programs. It is equally obvious that such an approach has produced little operational hardware, but that it has—nevertheless—created a vast knowhow and sound engineering experience which will help us advance rapidly in the future. Today, however, we cannot afford to think that any of our missile programs are ahead of schedule.

We must realize that while the best technical approach might not always be the best policy, those who make the policy must know the best technical answer. So far, very few of our policy makers have known the best technical answers, simply because the entire field of missilery is too new and unexplored. This means that a great deal of industrial research and development—and sometimes what may appear to be duplicating research and development—must take place before we can expect to get any up-to-date systems into truly operational status.

For example, to many defense planners it now appears crystal-clear that the *Atlas* and *Titan* weapons systems are being outdistanced by the *Polaris*-type system, and that the latter is the logical one to be pushed to the extreme. But two years ago it just wasn't so. At that time the liquid-propellant ICBM was termed the ultimate weapon. We now know that the complex underground bases required for the ICBMs cannot possibly be built and operated in secrecy, while a submarine is very difficult to detect. Furthermore, permanent ICBM bases, which are vulnerable, cannot be constructed for the amount of money and effort that are required for the equivalent in nuclear submarine missile striking power. This has become a controversial issue and certainly one that the Air Force doesn't like. Even many conservative Navy planners still don't quite understand the soundness of the *Polaris* concept.

We must face the fact, however, that such change-overs in science and engineering breakthroughs will continue until missilery becomes a science that we have mastered fully. Until then, we cannot afford to cut expenditures and we certainly cannot afford to assume that we are ahead of schedule, because our planners have no means of knowing the best technical answers.

The only thing that we can think of that might be ahead of schedule is the *Russian* missile program—ahead of *our* schedule.

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AOMC EXECUTIVE BRIEFING

In My Opinion . . .

. . . The U.S. Army now faces the greatest space age challenge yet, lunar space construction. But unless Army leaders do something about it soon, the role of the Army is likely to fade away quickly in the space era.

Many Washington officials now admit we must begin to think sincerely about establishing lunar bases. This kind of research and construction task—traditionally and logically—is a job for the U.S. Army Corps of Engineers. With its vast experience and with the backing of the Signal Corps and the Missile Ordnance Command, the Corps of Engineers should establish a special research group for space base development. Working closely with industries in the architectural-engineering area, plans should be made now for our first automatic military lunar stations.

These, obviously, will be small packages in the beginning, but within ten years they will become bigger and will contain manned observers. It should not be necessary at this point to repeat anything about how hard Russia is pushing her lunar base program. In this base research area, in spite of great enthusiasm on the part of such outstanding planners as Brig. Gen. Homer A. Boushey, who repeatedly has stressed the importance of the use of lunar bases for retaliatory purposes in a future war.

The Corps of Engineers must act now to get the blessing of Lt. Gen. Arthur G. Trudeau, Chief, Research and Development, and move ahead, possibly funded by ARPA.

The Army has suffered badly from poor public relations in the missile program. Army's loss to the USAF in the IRBM roles and mission battle was mainly a result of poor public relations planning. McElroy's modification of Wilson's stubborn ruling limiting the distance of Army missiles is proof enough. The old-time Army conservatism will not get the soldiers anywhere in the space race. The Air Force now is advancing at full speed to become the No. 1 service in the space age. One year ago a directive was circulated among top AF officials ordering them not to imply in speeches, press releases, etc. that the USAF was pushing space flight. The word space flight was not to be mentioned. Today,—three-star USAF generals hint the Air Force some day will become the U.S. Space Force.

This should convince Army leaders that change-overs and breakthroughs constantly will take place. What was good yesterday may not be so good tomorrow. The Army certainly must show more vigor and foresight if it expects to take an active part in our conquest of space. We do need the Army in this big struggle. But Army leaders must wake up and do something about it. A lunar base research and development program must be started now. And industry must be invited to participate.

Erik Bergaust

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STATEMENT BY SENATOR SPARKMAN TO THE PRESS 15 OCTOBER 1958

I have been greatly concerned with the reports out of Washington relating to the proposed shift of a part of the famed Redstone team to the new space agency. This team consists of both military personnel and civilian personnel which has demonstrated to the world its efficiency and its effectiveness in research and development in the missile field, the anti-missile field and in space exploration. To break it up now as it seems this proposal would do, could have serious effects on our total defense program and in our determined effort to overcome our lag in the missile field. Not enough authentic information has been made available to determine just what would be done but from what has come out it seems not to have been well planned and to hold many serious and dangerous implications.

I stand ready to do what I can in this continuing fight to protect the program that has been so well developed here at Redstone Arsenal and to maintain the world's greatest team in the type of research and development that has been carried on here.

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AOMC INTERNAL INFORMATION RELEASE

WASHINGTON, D. C.-- The Department of Defense issued the following statement this morning:

"In response to press inquiries today, the Department of Defense said that no decision has been made to stop production of either the THOR or JUPITER Intermediate Range Ballistic Missiles. Both are being produced at present to meet early deployment schedules.

"No decision between the two IRBM weapons systems will be made until the completion of intensive studies which are now in progress."

The JUPITER IRBM was developed by the Army Ballistic Missile Agency, Huntsville, Ala., an element of the Army Ordnance Missile Command. It is in production at the Michigan Ordnance Missile Plant operated by the Chrysler Corporation for the Army.

The 864th Strategic Missile Squadron (JUPITER), first Air Force unit activated to operate the giant missile in the field, is in training now at Redstone Arsenal, Alabama.

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Remove from bulletin boards after 15 Oct.

AOMC INTERNAL INFORMATION RELEASE

15 October 1958

This is not the first occasion when rumors and distortions have affected the Army's missile activities. Our people are becoming inured to this sort of thing as an unfortunate but seemingly recurrent annoyance.

I believe the position taken by the President, as reported by the press today, clarifies the present situation. It is apparent that any proposal involving the Army missile team will receive careful study and evaluation before any decision is reached. I am satisfied that analysis of all the factors will not result in action detrimental to the best interests of our people and the nation.

We will continue work as usual to advance the military and scientific programs assigned to us and to insure their successful accomplishment. That is what is expected of us. We have no intention of doing anything less.

J. B. MEDARIS
Major General, USA
Commanding

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STATEMENT 15 October 1958

Dr. Wernher von Braun, Director, Development Operations Division, Army Ballistic Missile Agency, issued the following statement this morning in answer to press queries:

"I believe that the missile development team organized under the U.S. Army's sponsorship and direction has won recognition as a national asset through demonstrated capabilities in the weapons and space fields.

"The only question which should be asked is how can this team best serve the nation? Under the present Army management the team develops weapons systems for defense and utilizes military hardware to conduct scientific space programs. I believe that the dual effort has been entirely successful--the results speak for themselves.

"It would seem something less than prudent to risk the dissolution of such an asset at a time when national security and prestige demand a unified effort to achieve and maintain supremacy in rocket and space technologies."

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AOMC INTERNAL INFORMATION RELEASE

ST. LOUIS POST DISPATCH
October 17, 1958

The Army's concern over a report that the crack ballistic missile staff at Huntsville, Alabama should be split up is understandable even though President Eisenhower says a decision has not been made. The talk of transferring Army experts to the NASA is bound to cause anxiety. The experts at Huntsville possess an unequaled record and have produced three of the four earth satellites and several missiles including the Jupiter.

About 85 percent of the staff is working on missile weaponry of advanced and urgent character and the rest are engaged in outer space projects. The new Space Administration which is concerned with almost entirely non-military projects is accused by the Army of trying to carry out a raid that would wreck the Army missile, satellite and space ship program.

The Army also believes that its government-owned arsenal system, which is contrasted to the Air Force system of contracting with private firms, is likely to be wiped out or crippled. This feeling is not an unreasonable one.

History and some circumstances give credence to the Army feelings that the Air Force motives are wrapped up in the plans to transfer some of the staff at Huntsville.

Certainly men like the famous Dr. von Braun, who is first in everything in regard to plans for manned satellites, would be of just as much value to the NASA as he is to the Army and because there are no experienced astronautics engineers, it is the scientists and engineers working in rocketry techniques and such fields that are going to have to staff NASA.

What has to be done is to find a way by which NASA may be built up without putting out of business the missile agency of just one service. To wreck the Huntsville work with its splendid record while leaving the Air Force and Navy agencies intact is no solution.

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AOMC INTERNAL INFORMATION RELEASE

ST LOUIS GLOBE DEMOCRAT
October 18, 1958

WEAPONS COME FIRST

Many Americans welcome the decision to set up a civilian agency to undertake basic research into the exploration and conquest of space. On paper it seems that none of the branches of the Armed Forces could do this job as well as a new civilian science and space group. Any research that the Air Force, the Army, or the Navy might do should be directed toward the development of military weapons. The exploration of space, as such, plainly lay outside their assigned duties. Thus, there seems a definite place in the picture for the new civilian National Aeronautics and Space Administration. There are many valuable fields of aeronautical research which would be hard to justify as a military expenditure. No responsible person was suggesting however, that NASA space ship or moonrockets should have a higher priority than a military hardware that this nation needs for defense in this dangerous age. Now NASA comes up with a request that the Army's highly successful team of missile and rocket experts at Redstone Arsenal in Huntsville, Ala. be turned over to it lock, stock and barrel. The Army has about 4100 workers at the Redstone Arsenal, of whom some 1200 are civilians. Redstone Arsenal scientists produce the highly successful 1500 mile JUPITER missile and launched America's first earth satellites EXPLORER I.

Dr. Wernher von Braun; Director of the Army's ballistic missile program there, is one of the scientists who has protested against the NASA attempted raid. He said "I believe that the missile's development team organized under the U. S. Army sponsorship and direction has won recognition as a national asset thru demonstrated capabilities in the weapons and space field. The only question to be asked is how can this team best serve the nation. Under the present Army management the team developed weapons systems for defense and utilized military hardware to conduct scientific space programs. I believe the results speak for themselves."

President Eisenhower says that NASA's bold attempt to take over the Army's entire missile branch has not been approved and won't be until he makes the decision personally. This would be nothing short of a national calamity to take the weapons team that the Army has successfully assembled and turn it over to this space ship and lunar marching society. If NASA can't take close-up of the man in the Moon without stripping the Army scientific cupboard bare it would be better if NASA closed up shop. Weapons come first.

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ABMA NEWS FOR YOU

missiles and rockets, October 27, 1958

In My Opinion . . .

. . . the nation's missile and space flight progress is in grave danger of being slowed down again. Once more the spirit and morale at Redstone is at a rock bottom low. Once more Wernher von Braun has been forced to tell his scientists to keep up the good work, to ignore the political footballing, to avoid any let-down—in spite of the fact that the axe is again being lowered over their heads.

It will take weeks, and more probably months, for the Administration to finalize the decision to transfer the ABMA rocket science team to NASA, although the decision probably will be made before the end of the year. This is the statutory time limit and the only way the President can take such action without approval of Congress. But in the meantime—while the future of the nation's greatest rocket development team is being determined by election-minded Washington politicians—this same team is expected to advance successfully a major share of our most important missile and astronautics work.

In addition to the accelerated *Explorer* program, which represents this country's only worthwhile satellite program so far, the ABMA team is preparing two lunar shoots which the entire world is awaiting anxiously—a series of *Juno* IV communications satellites, the *Pershing* ballistic missile, ballistic freight and manned rocket carriers, an anti-ballistic missile, and other highly secret and crucial projects—projects that play an important role in this nation's cold-war struggle with Russia.

For many years, the Army missilemen have been given one blow after another—in fact, we cannot think of any other defense development group that has had better reason to become discouraged, disillusioned and distressed in their efforts. Yet this team, under the brilliant leadership of von Braun, has continued to pursue the goal of putting this nation ahead. The progress of this team is unparalleled—ranging from development of the first IRBM to this country's first satellite. And there have been other important break-throughs—less publicized—such as the ballistic missile nose cone development for less than $4 million (other missile builders spent $400 million doing the same thing later).

At the present time—since we do not know the details of the proposal to transfer the ABMA team to NASA—we cannot voice an opinion as to whether the proposal is good or bad. However, it can be stated that every effort must be made to back up the ABMA morale and spirit. This team must know that every man and woman in the Free World is thankful for the team's efforts. The ABMA scientists must be told that the nation will demand that only the very best decision is good enough for them. They should also be reminded that the current Administration has only a short time to go—and that in the end, free men and women will have the final voice in electing better people if the right decisions are not made.

Finally, let us appeal to Army Secretary Brucker to show his old vigor in this battle! The ABMA team needs your support, Mr. Brucker. Why not show them that you are determined not to let Army technology go without a fight?

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ABMA "PIO"

Army-Redstone Arsenal, Ala.

[redacted]

I. INTRODUCTION

A. Historical Background

The launching of SPUTNIK I on 4 October 1957 demonstrated clearly the Soviet capability in the field of long range rockets and orbital techniques. At the same time it was realized that the United States satellite capabilities, both from the standpoint of payload weight and schedule, were inadequate. With this in mind the Army Ballistic Missile Agency now an element of the Army Ordnance Missile Command, in December 1957 submitted to the Department of Defense a "Proposal for a National Integrated Missile and Space Vehicle Development Program." This proposal reviewed all United States missile programs in the light of known Soviet space flight capabilities and proposed an integrated national missile and space program that would insure maximum security through appropriate expenditure of manpower, facilities, and money. The proposal outlined a feasible plan whereby the United States could catch up and ultimately overtake the Soviets in the race for scientific and military space supremacy without upsetting the nation's economic stability, disrupting the manpower balance, and draining the national resources.

Implementation of the program was based on the assumption that the immediate development of an orbital carrier employing a booster stage of at least 1.5 million pounds thrust would be initiated without delay.

The realization of a need for this type of program led to the establishment by the National Advisory Committee on Aeronautics in early 1958 of a Special Committee on Space Technology whose several working groups were charged collectively with the responsibility of developing a plan for a national integrated missile and space development program. In July 1958, the Working Group on Vehicular Program submitted a plan for "A National Integrated Missile and Space Vehicle Development Program," the third in a series of reports by that group. This plan was prepared by personnel of the Army Ordnance Missile Command. Once again, full implementation of the program was dependent upon the early development of a booster of 1.5 million pounds thrust.

B. Statement of Mission

On 15 August 1958, by Order Nr 14-59, the Advanced Research Projects Agency directed the Army Ordnance Missile Command to initiate a development program to provide a large space vehicle booster of approximately 1.5 million pounds thrust based on a cluster of available rocket engines, with the immediate goal of demonstrating a full scale captive dynamic firing by the end of Calendar Year 1959. Further studies

[redacted]

27

E X C E R P T

From

DEVELOPMENT AND FUNDING PLAN

FOR

THE JUNO V BOOSTER PROGRAM (U)

ARPA ORDER 14-59

13 October 1958

of the extension of the large booster program past the feasibility demonstration resulted in the signing of an ARPA-AOMC Memorandum of Agreement on 23 September 1958. This memorandum provided for an extension of the program to include four booster test flights, the latter two of which would employ unsophisticated second stages and have a limited orbital capability. The first of the four booster test flights is to be accomplished approximately September 1960.

C. State of the Art versus Requirements

The present state of the art in the field of orbital carriers in the United States is represented by vehicles which require 1000 to 2000 pounds of takeoff weight per pound placed in orbit. The satellite carriers presently being produced will reduce this factor gradually to 100 pounds takeoff weight per pound placed in orbit.

A vehicle employing the JUNO V 1.5 million pound thrust Booster described in this plan will reduce this factor to 50 initially, then to 25, and ultimately 10 by the use of various high performance upper stages.

The maximum payload capability of the orbital carriers now being produced, without the use of high performance upper stages, will be limited to 3000 pounds during the next two years. Use of high performance upper stages will extend the payload capability of these carriers to 10,000 pounds in mid 1961.

A United States satellite payload capability of at least 20,000 pounds and an escape payload capability of at least 5000 pounds are urgent requirements for space missions in the near future, if Soviet technological advancements are to be surpassed.

A vehicle employing the JUNO V 1.5 million pound thrust Booster and appropriate upper stages will provide the desired capability by 1963.

D. Potential Uses

The potential uses of the JUNO V Space Vehicle employing the 1.5 million pound thrust Booster for both military and scientific missions are manifold. Among those most prominent are the following:

An orbital carrier vehicle for space defense missions against offensive enemy space vehicles.

An orbital carrier vehicle for large communication, meteorological, reconnaissance, and navigation satellites.

A manned orbital carrier vehicle in support of the Man-in Space Program.

A carrier vehicle for research and development of offensive and defensive space weapons.

A logistics carrier for earthbound operations.

An IRBM and ICBM for special missions with multiple nuclear, chemical, and conventional warheads and/or for transportation of propaganda material.

An orbital carrier for scientific research by means of large instrumented satellites.

An orbital carrier for the establishment and maintenance of space stations.

A vehicle for the preliminary exploration of space, by means of large space probes.

A flight test bed for advanced chemical engines, nuclear engines, and other high performance upper stages.

The potential uses outlined above are not exhaustive but rather representative of the possibilities inherent in a system that employs the JUNO V 1.5 million-pound thrust booster.

INDEX

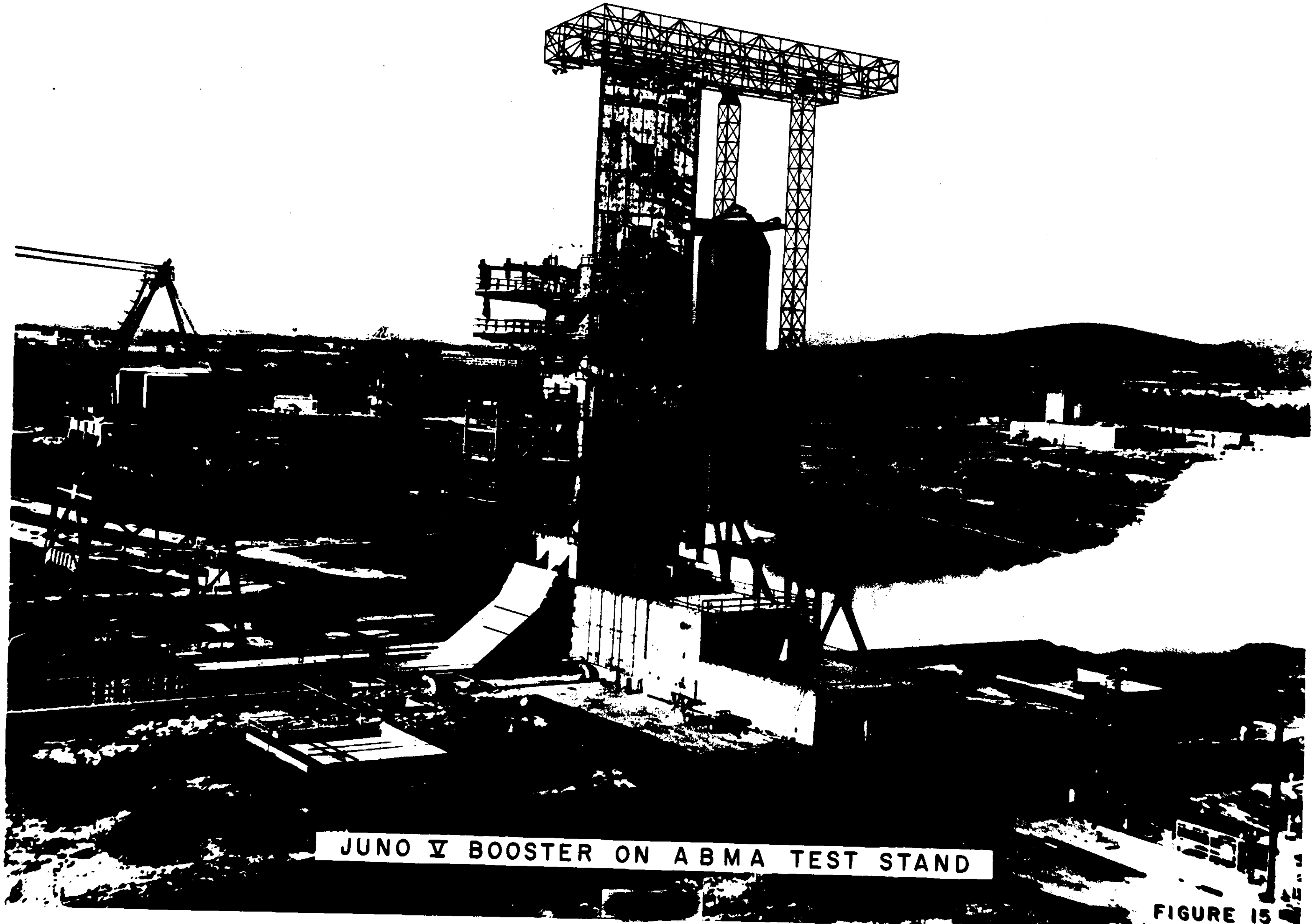
PARACHUTE RECOVERY OF JUNO V BOOSTER

AIR-TRANSPORTABLE BOOSTER
JUNO V

FIG 7

[redacted]

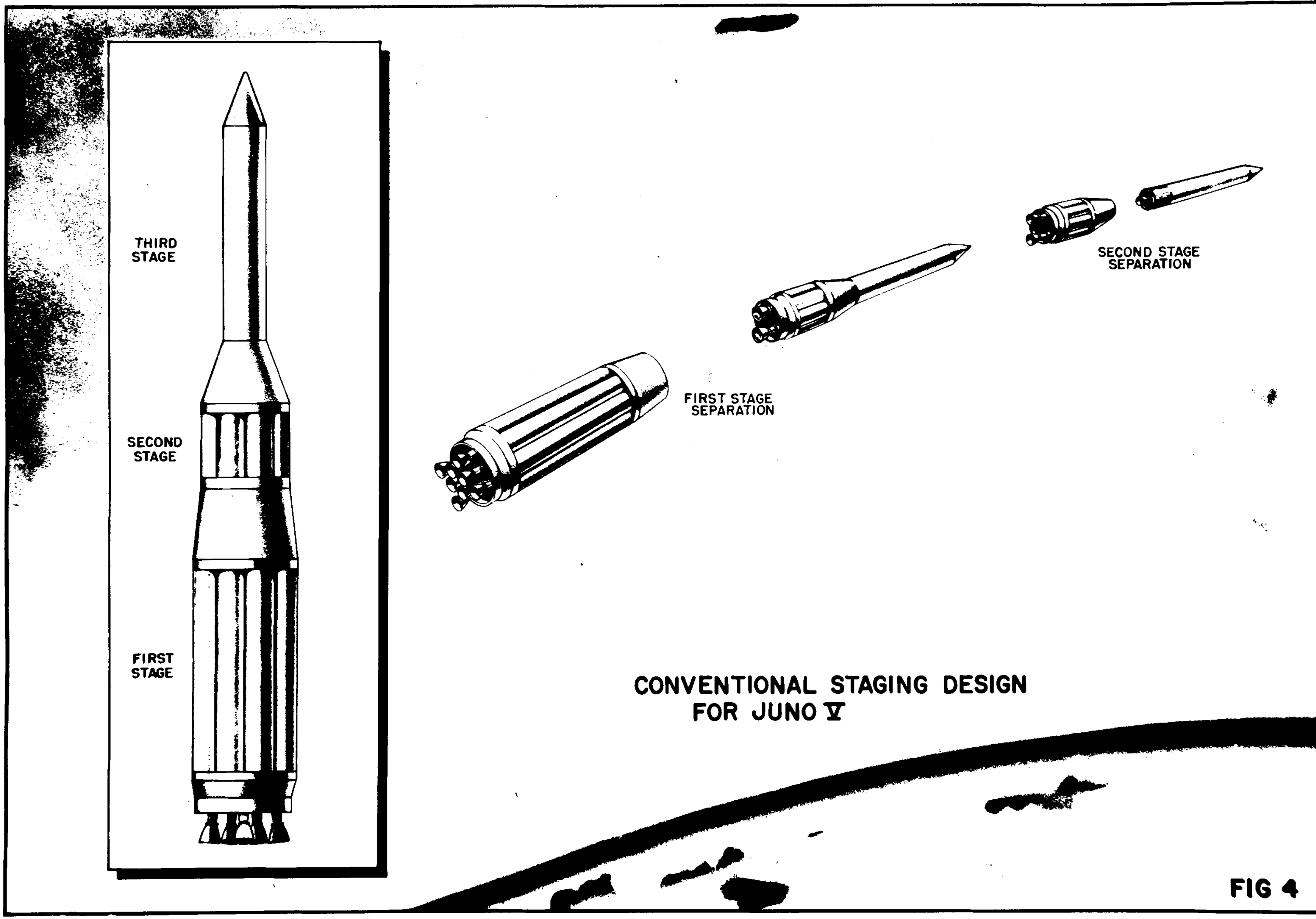
UNCLASSIFIED



JUNO V BOOSTER ON ABMA TEST STAND

FIGURE 15

UNCLASSIFIED



CONVENTIONAL STAGING DESIGN FOR JUNO V

FIG 4

UNCLASSIFIED

[redacted]

PARALLEL STAGING DESIGN FOR JUNO V

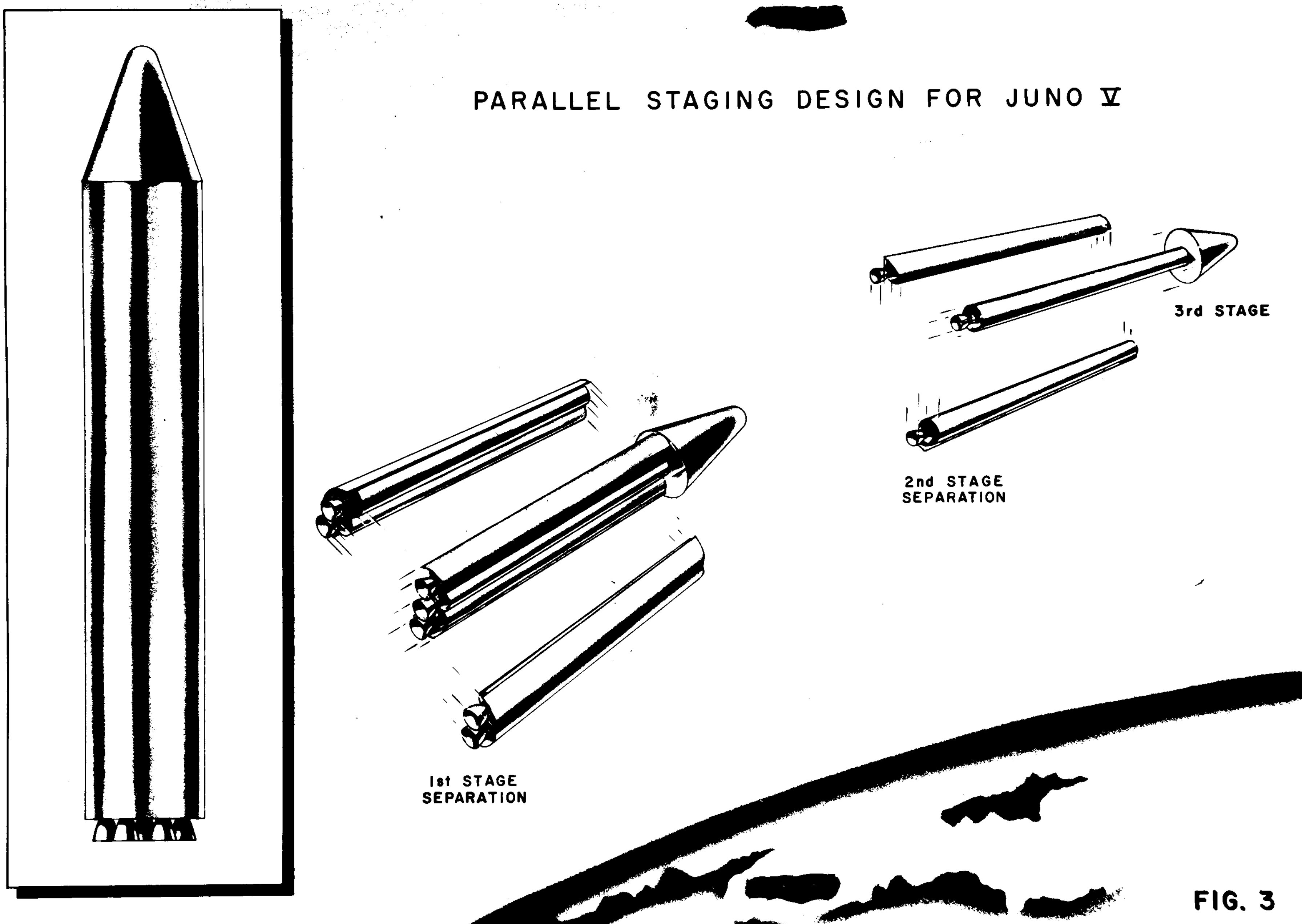
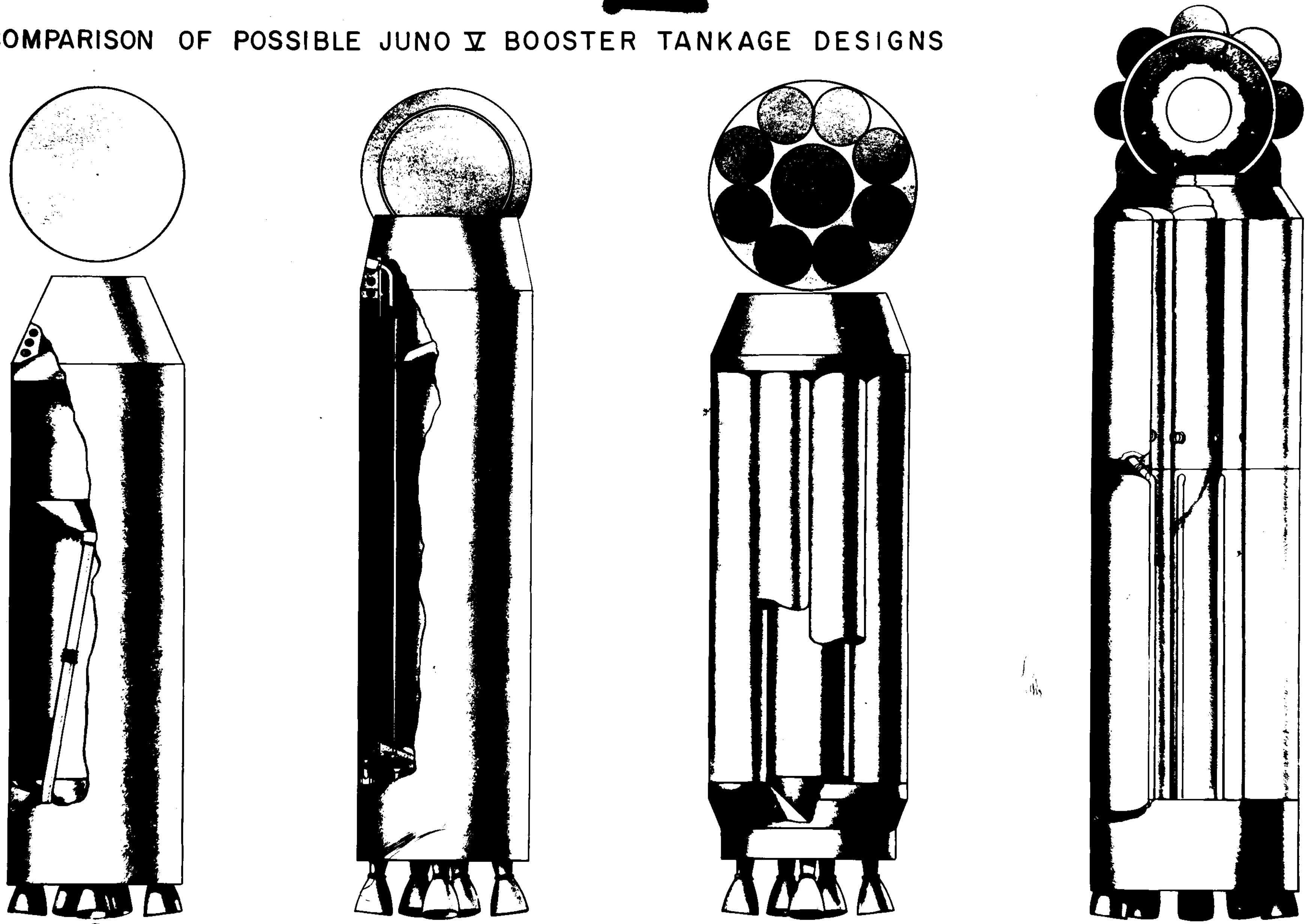


FIG. 3

[redacted]

COMPARISON OF POSSIBLE JUNO V BOOSTER TANKAGE DESIGNS

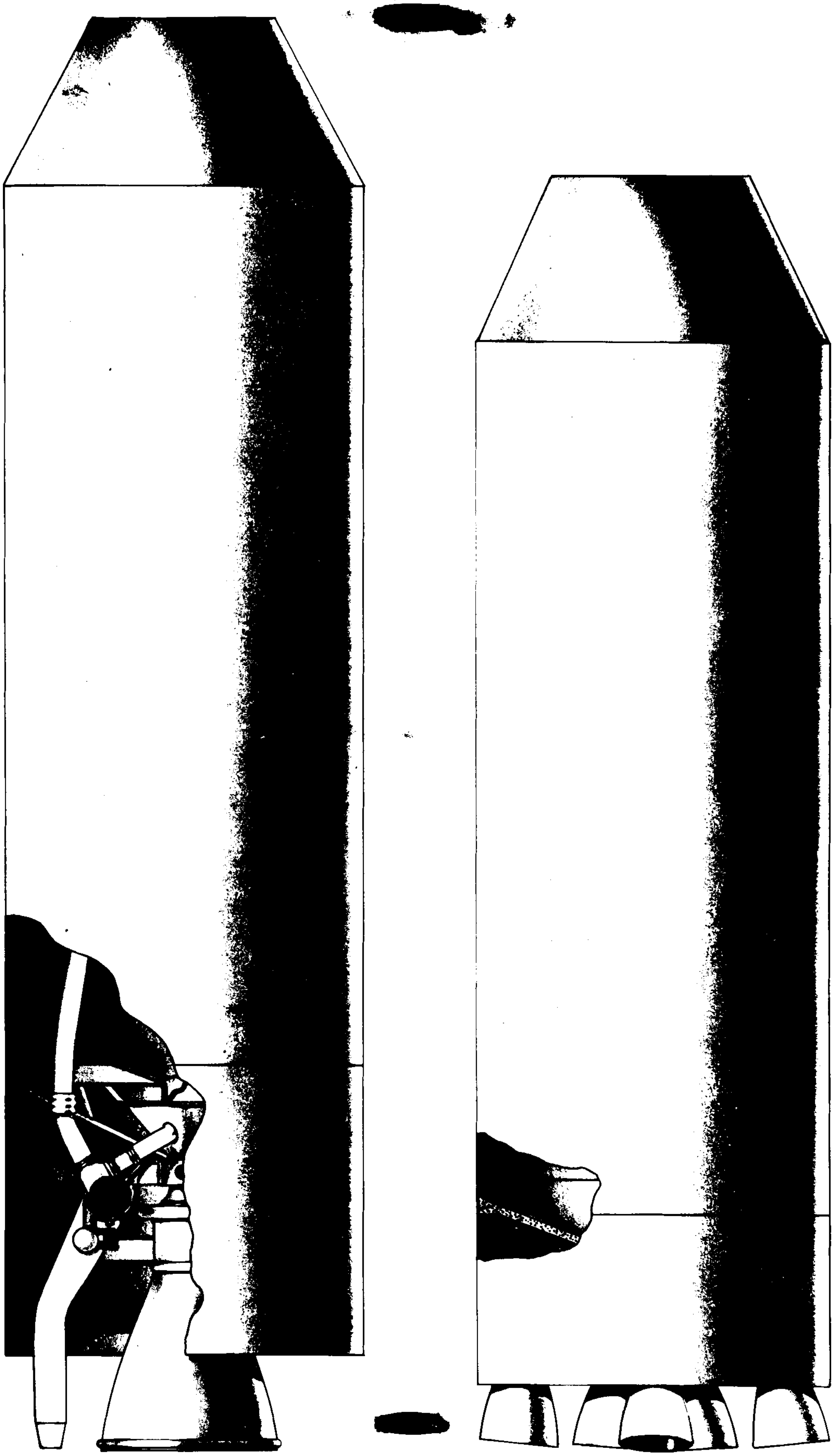


① ② ③ ④

FIG. 2

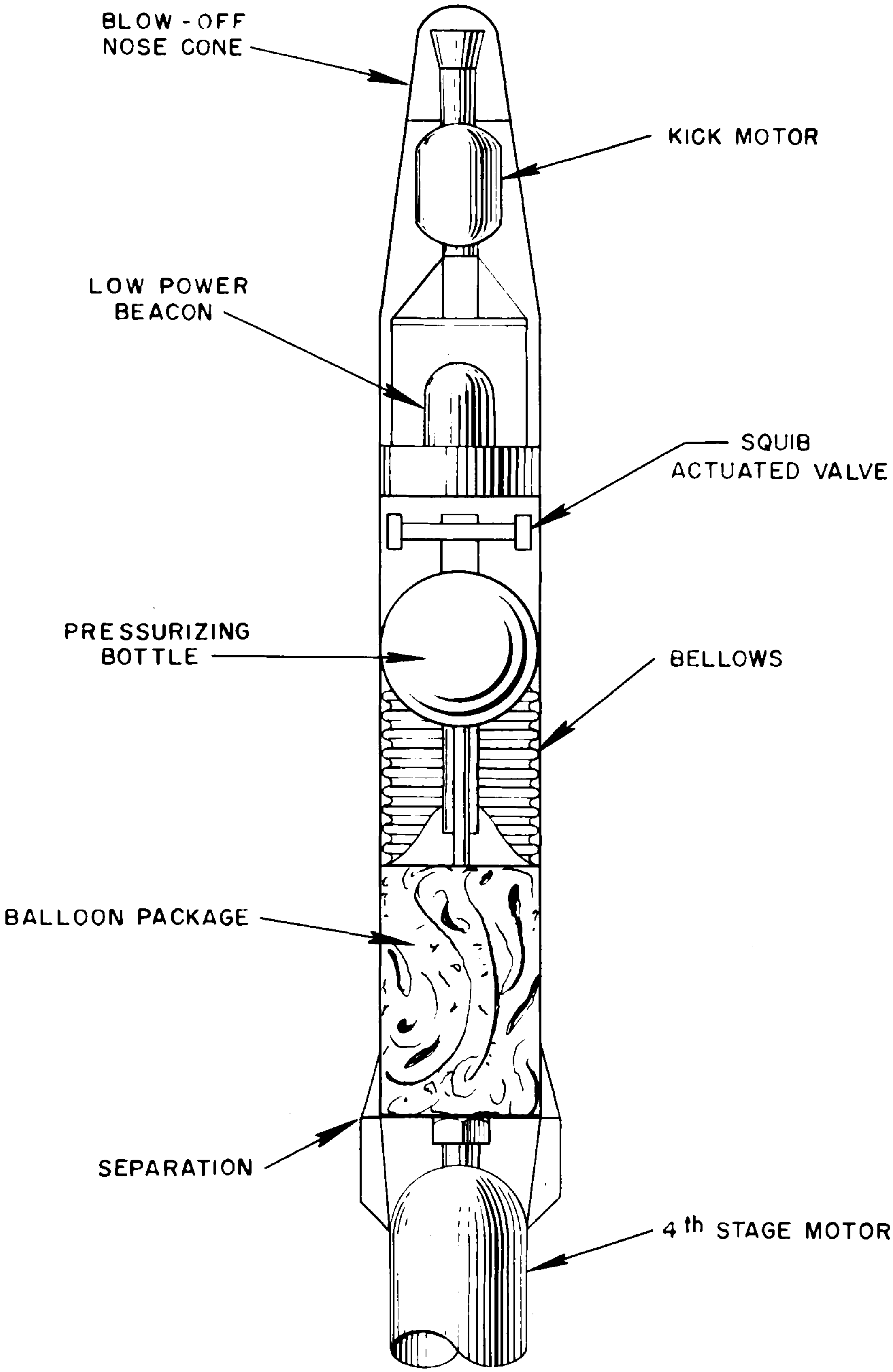
[redacted]

[redacted]

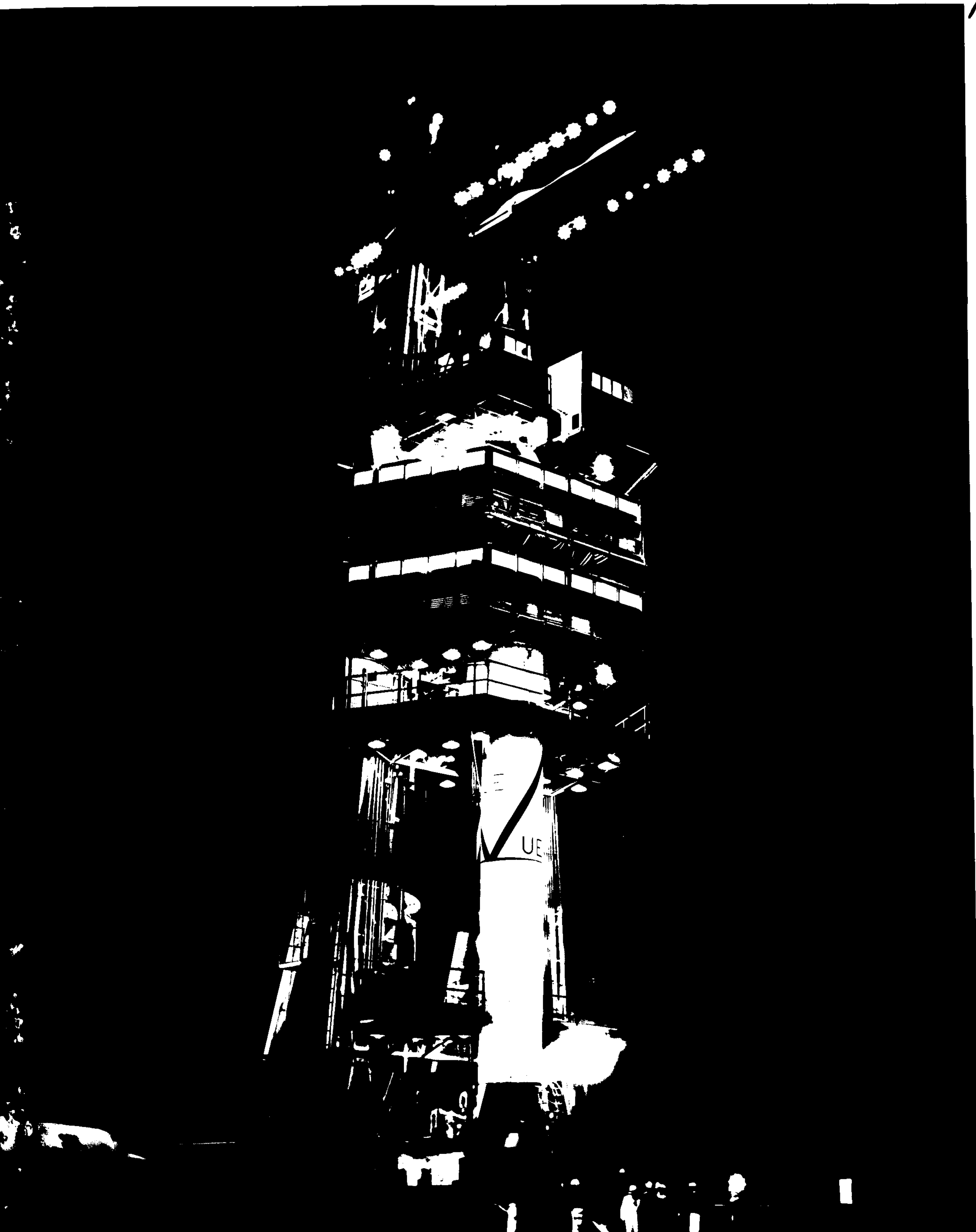


COMPARISON OF 1.5 MILLION LB THRUST CLUSTERED
AND SINGLE ENGINE DESIGNS

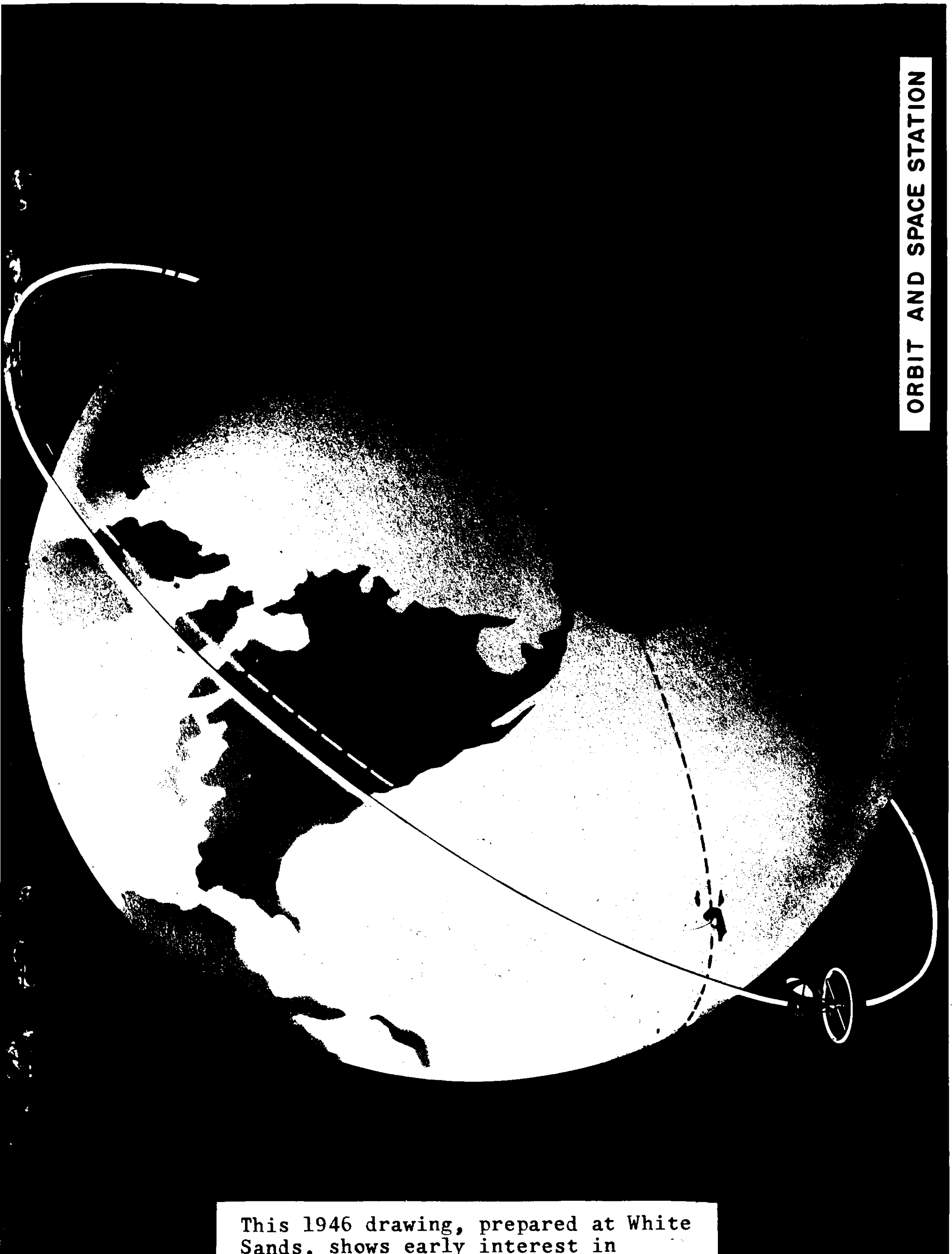
FIG. 1



JUNO I Missile 49 Payload



EXPLORER I
Final preparations on launching night of first U. S. satellite, 31 January 1958.



This 1946 drawing, prepared at White Sands, shows early interest in satellite trajectories.

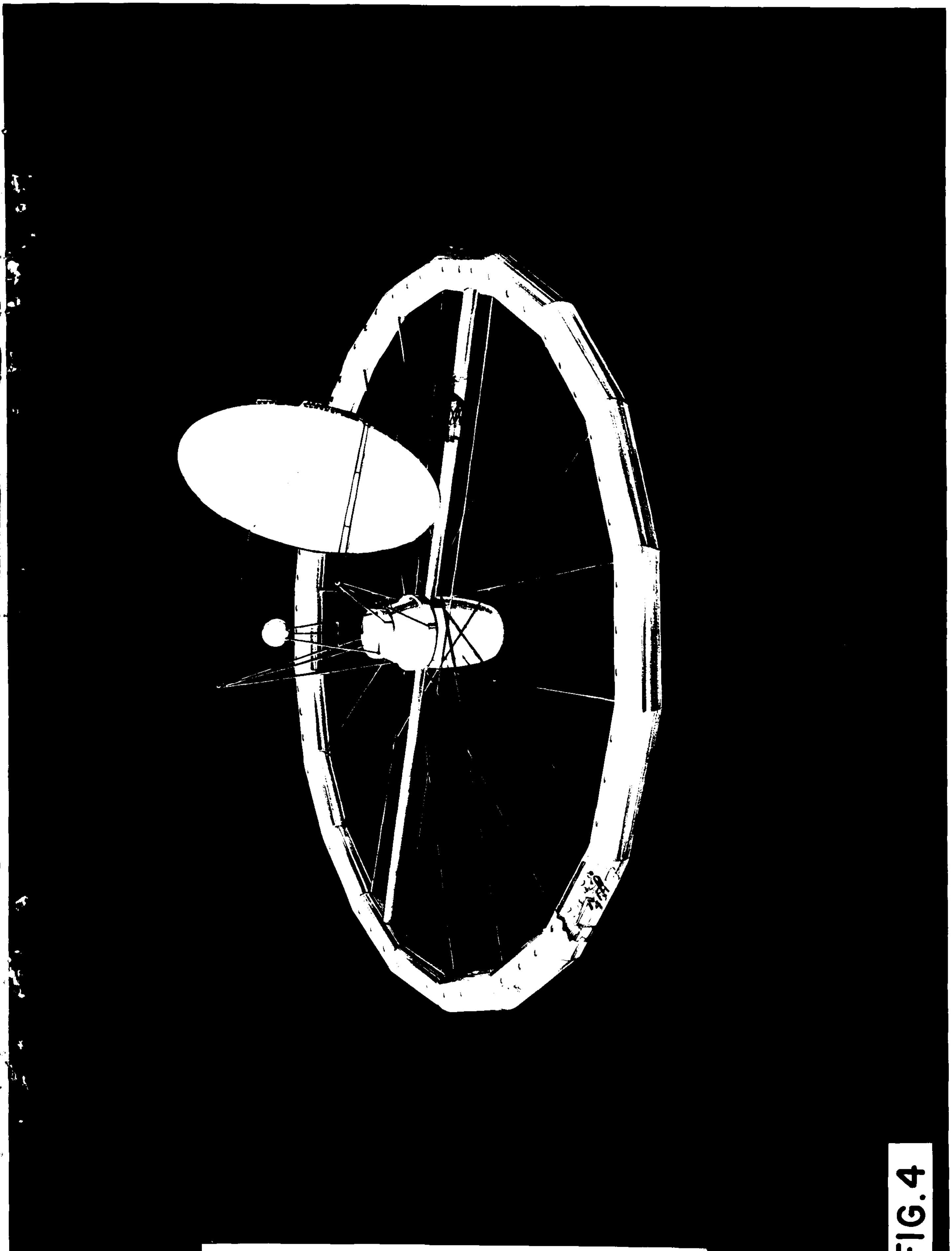


FIG. 4

Sketch of a space station, White Sands, 1946.

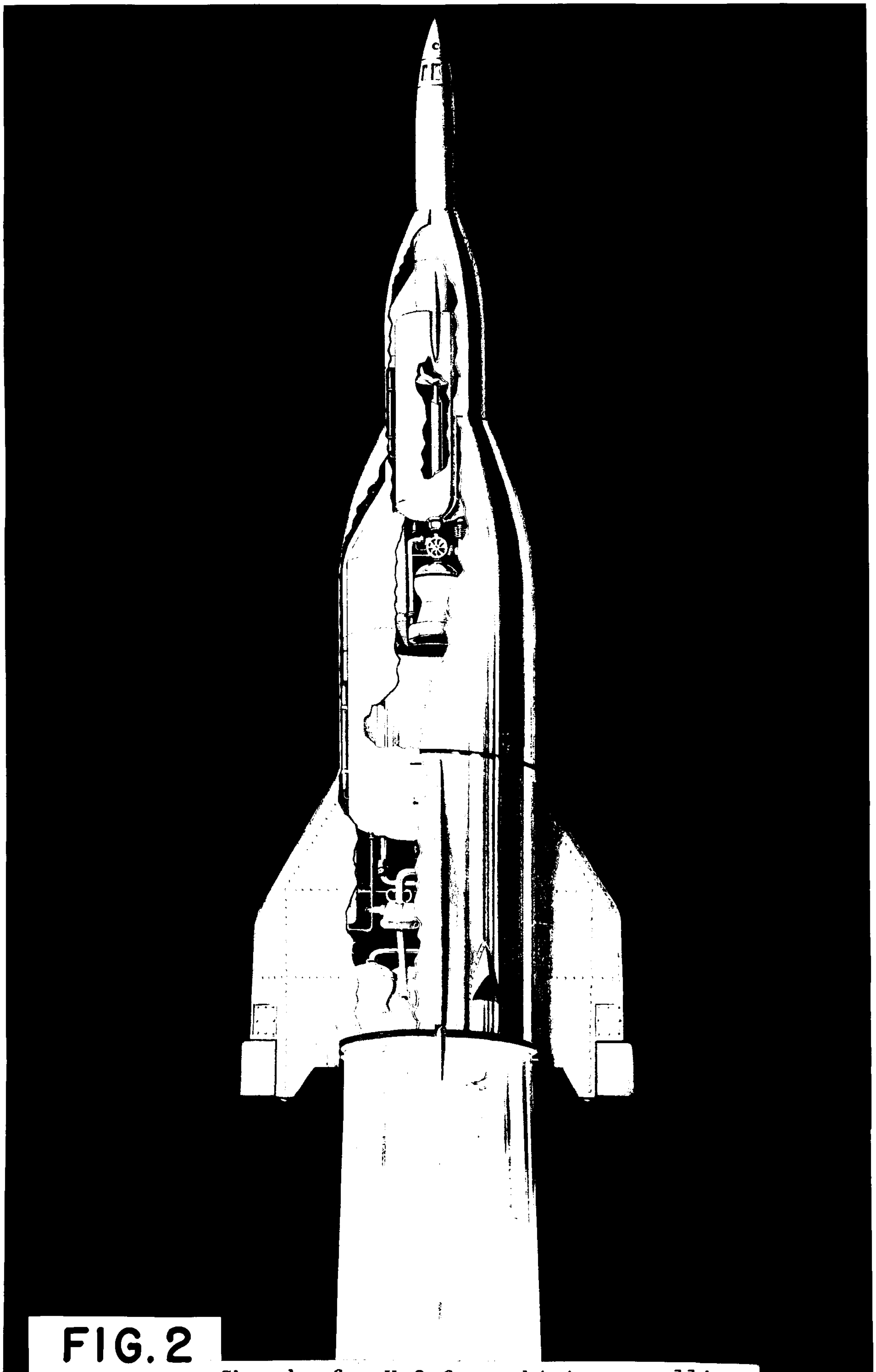


FIG. 2

Sketch of a V-2 for orbiting satellite, White Sands, 1946.

HISTORICAL MONOGRAPH

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