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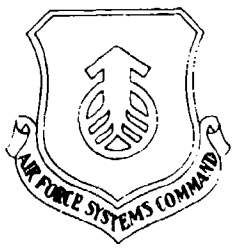

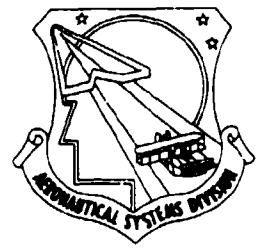

History of the
AERONAUTICAL SYSTEMS DIVISION

July—December 1963

Volume III

Termination of the X—20A Dyna-Soar (Narrative)

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HISTORY OF AERONAUTICAL SYSTEMS DIVISION

July - December 1963

VOLUME III

TERMINATION OF THE X-20A DYNA-SOAR

by

Clarence J. Geiger

Historical Division
Information Office
Aeronautical Systems Division

Air Force Systems Command

64ASE-39

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Frontispiece. The X-20 vehicle in orbit (artist's drawing).

TABLE OF CONTENTS

VOLUME III

VOLUME IV

[redacted]

CHRONOLOGY

1961	December	11	The Air Force eliminated suborbital launches of the Dyna-Soar vehicle and directed early attainment of orbital flight. The objectives of the program were to obtain research data on maneuverable re-entry and demonstrate conventional landing at pre-selected sites.
1962	February	23	The Secretary of Defense, R. S. McNamara, confirmed the redirection of the Dyna-Soar program and stated that the establishment of the necessary technology and experience for manned space missions were the immediate goals of the military space program.
1963	January	18	Secretary McNamara directed a review of the X-20 program.
		19	The Secretary of Defense instructed the Air Force to re-examine the Titan III program and the Gemini program of the National Aeronautics and Space Administration.
		21	The Department of Defense completed an agreement with NASA for Air Force participation in the Gemini program.
	March	15	Secretary McNamara directed the Air Force to conduct a comparison of the military potentials of the X-20 and Gemini programs.
	May	9	The Commander of the Air Force Systems Command, General B. A. Schriever, assigned the X-20 orbital test program to the Space Systems Division. The mission control center was to be located at the Satellite Test Center instead of Cape Canaveral.
		10	AFSC completed a report comparing the X-20 and Gemini and recommended the addition of military experiments to the Gemini program and possible further flights of the X-20.
		22	Major General O. J. Ritland, Deputy to the Commander for Manned Space Flight, AFSC headquarters, recommended to Air Force headquarters the continuation of the X-20 program and the limitation of Air Force participation in the Gemini program to a series of military experiments.

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1963	May	27	Based on an anticipated funding level of $135 million for fiscal year 1964 and firm contractor estimates of flight schedules, the X-20 office completed another revision of the system package program.
	June	1	The Dyna-Soar System Program Office completed a study concerning the use of the X-20 for anti-satellite missions.
		5	The Assistant Secretary of the Air Force for Research and Development, Dr. Brockway McMillan, recommended to the Secretary of Defense that the X-20 program be continued.
	July	3	AFSC headquarters informed the X-20 office that the defense department would only allow $125 million instead of $135 million for fiscal year 1964.
		12	The Secretary of the Air Force, E. M. Zuckert, directed that AFSC study the operational applications of the X-20 vehicle.
		22	Vice President Lyndon B. Johnson requested the Secretary of the Defense to prepare a statement on the importance to national security of a space station.
		31	The Commander of AFSC assigned the responsibility for the X-20 air-launch and pilot training programs to the Space Systems Division.
	August	9	In his reply to the Vice President, Secretary McNamara stressed the necessity of multi-manned orbital flights of long duration.
		30	The Director of Defense for Research and Engineering approved a study program for a military, orbiting, space station.
	September	3	The X-20 office completed a system package program based on a funding level of $125 million for fiscal year 1964, with the first multiorbital flight delayed from August 1967 to December 1967.
		12	The President's Scientific Advisory Committee requested a briefing from the Air Force on possible military space missions, biomedical experiments to be performed in space, and the

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1963	September	12	capability of Gemini, Apollo, and the X-20 vehicles to execute these requirements.
		23	The Dyna-Soar office completed Revision A to the system package program which detailed financial adjustments to the program if the mission control center remained at Cape Canaveral.
	October	7-8	Dr. A. C. Hall, Deputy Director for Space in the Office of the Director for Research and Engineering, and Dr. A. H. Flax, Assistant Secretary of the Air Force for Research and Development, visited the Boeing facilities in Seattle, Washington, for a status briefing on the X-20 program.
		23	Secretary McNamara was briefed on the Titan III and Dyna-Soar programs at the Martin Company facilities in Denver, Colorado.
	November	14	The Director of Defense for Research and Engineering recommended to the Secretary of Defense cancellation of the X-20 program and initiation of a space station program.
		18	With the assistance of the Boeing Company, the Minneapolis-Honeywell Regulator Company, and the Air Force Aerospace Medical Division, the X-20 office completed a report for SSD on the use of Dyna-Soar for satellite inspection missions.
		29	AFSC headquarters informed the X-20 office that USAF headquarters had approved three of the proposed four military capability studies relating to Dyna-Soar.
		30	Largely because of NASA objections to the space station proposal, Dr. Brown suggested to the Secretary of Defense an orbiting laboratory program, employing a Gemini capsule and a 1,500 cubic foot test module.
	December	4	In a memorandum to the Secretary of the Air Force, Dr. Flax disagreed with Dr. Brown's space station proposal and argued against the cancellation of the X-20.
		4	Secretary Zuckert informed the Secretary of Defense that he supported the position of Dr. Flax.

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1963 December	4	Major General J. K. Hester, Assistant Vice Chief of Staff, offered a space station program which employed the X-20.
	5	Secretary Zuckert forwarded General Hester's proposal to the Secretary of Defense and stated that there was no reason to omit the X-20 from consideration as part of a space station program.
	10	The Secretary of Defense announced the termination of the Dyna-Soar program and the initiation of the Manned, Orbiting, Laboratory program.
	10	The X-20 office directed the Dyna-Soar contractors and various Air Force agencies to stop all efforts involving X-20 funds.
	11	The Secretary of the Air Force directed that X-20 efforts important to other space programs be continued.
	13	The X-20 System Program Office completed the first phase-out plan, and the X-20 Engineering Office compiled a list of useful efforts for continuation.
	16	AFSC headquarters canceled two studies relating to the military applications of the X-20.
	19-20	Representatives from various government agencies met at the system program office to determine the allocation of X-20 hardware.
	20	Both the system program office and engineering office completed revisions to the termination plan and the list of efforts for possible continuation.
	27	The program office again revised its termination plan.
1964 January	3	Further revisions were made to the termination plan and the list of efforts for continuation.
	23	A final edition of the program office's termination plan was completed.
	23	USAF headquarters informed AFSC that the Secretary of the Air Force had approved 36 tasks for continuation.
	29	The X-20 Engineering Office completed a management plan for the continuation of useful X-20 efforts.

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TERMINATION OF THE X-20A DYNA-SOAR

In 1963 the Department of Defense was again seriously questioning the necessity for the Dyna-Soar program. It appeared that the alternatives for the X-20 had been severely narrowed: direct the program towards achieving military goals or terminate it in lieu of another approach to a manned, military, space system. During the Phase Alpha studies of 1960 and the Manned, Military, Space, Capability Vehicle studies of 1961 the re-entry approach of the Dyna-Soar glider was critically compared with other re-entry proposals and systems. On these two occasions, both the Air Force and the Department of Defense deemed the Dyna-Soar as the most feasible. The X-20 program, however, was not as fortunate in the 1963 evaluations.

In December 1961, Air Force headquarters had eliminated suborbital launches of the Dyna-Soar vehicle and had directed the early attainment of orbital flight. The objectives were to obtain research data on maneuverable re-entry and demonstrate conventional landing at a pre-selected site.[1] Secretary of Defense Robert S. McNamara later confirmed this redirection and identified the purposes of the military space program. He stated that the establishment of the necessary technology and experience for manned space missions were the immediate goals. The Secretary placed emphasis on acquiring the ability to rendezvous with uncooperative targets, to maneuver during orbital flight and re-entry, to achieve precise recovery, and to re-use the vehicles with minimum refurbishment. In order to realize these ends, Secretary McNamara offered three programs. The orbital, research, Dyna-Soar program would provide a necessary technological basis.

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A cooperative effort with the National Aeronautics and Space Administration in its Gemini program would give experience in manned rendezvous. Lastly the defense secretary stated that a manned space laboratory to conduct sustained tests of military systems could be useful.[2]

It was not until January 1963 that Secretary McNamara took another significant step in defining a military space program. He directed a comparison between the Dyna-Soar program and the Gemini program of NASA to determine which would be of more military value.[3] Gemini became even more important a few days later when the Department of Defense completed an agreement with the national aeronautics administration for Air Force participation. Following a review in the middle of March of the Dyna-Soar program, Secretary McNamara further clarified his directions concerning the Gemini and X-20 study. He considered that the Air Force had placed too much emphasis on controlled re-entry and not on the missions which could be performed in orbit. Inspection, reconnaissance, defense of space vehicles, and the introduction of offensive weapons in space were all significant. He suggested that the Air Force take as long as six months to determine the most practicable test vehicle for these military space missions. The Secretary of Defense then suggested that a space station serviced by a ferry vehicle could be the most feasible approach.[4] Air Force headquarters directed the Air Force Systems Command to organize studies concerning X-20 and Gemini contributions to these four missions.[5]

By 10 May, a committee, under the leadership of the Space Systems Division and composed of representatives from the Aerospace Corporation, Air Force Systems Command headquarters, and the Aeronautical Systems Division, completed a comparison of Gemini and the

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X-20. The committee considered that the current X-20 program could be rapidly, and with relative economy, adapted for testing of military subsystems and military operations. There were several reasons. The Dyna-Soar glider had a payload volume of 75 cubic feet, sufficient power, and enough cooling capacity to accomodate subsystems required for military missions. Furthermore, the orbital duration of the vehicle could be extended to 24 hours or longer.

Concerning reconnaissance missions, the committee thought that the X-20 program could develop low, orbital, operational techniques and ground recognition ability. The research data from the program would also be applicable for the verification of the feasibility, design, and employment of glide bombs. The fact that the X-20 would develop maneuvering techniques and quick return methods made the program valuable for the development of satellite defensive missions. Since deceleration occurred slowly during lifting re-entry, such an approach would provide a safe physiological environment for transfer of personnel from space stations and for other logistical missions. Lastly, significant information for the development of future maneuvering re-entry spacecraft would be obtained from the X-20 program.

The committee then detailed the necessary modifications to the X-20 glider in order to allow the incorporation of either reconnaissance or satellite inspection equipment. A test program of four X-20A flights, six reorientation flights for testing reconnaissance subsystems, and two demonstration flights, would total $206 million from fiscal years 1964

through 1968. The same type of program, this time for the testing and demonstration of inspection subsystems, would total $228 million.[6]

In contrast, the technology being developed by the Gemini program of NASA related to the ability to rendezvous and orbit for long durations. The committee estimated that to incorporate a series of military experiments into the current NASA program with only minor equipment and operational flight changes would total about $16.1 million from fiscal years 1964 through 1966. If the Department of Defense conducted two Gemini launches and employed the same booster as NASA, the Titan II, the cost for inspection and reconnaissance experiments would total $129 million from fiscal years 1964 through 1967. If six Department of Defense flights were conducted, the total would be $458 million. The committee then considered a series of Gemini launches conducted by the Department of Defense, this time using the Titan IIIC. Because the 5,000 pound Gemini capsule only had a limited payload capacity of 10 cubic feet, the committee considered the addition of a mission module, which would have to be discarded in space, to the Gemini capsule. The largest test module which was considered had a volume of 700 cubic feet. The committee then examined the applicability of such a test system to reconnaissance and inspection missions. Considering a six flight program beginning in July 1966, with the following flights at five month intervals, an inspection test flight program would total $509 million and a reconnaissance flight test program would cost $474 million.[7]

The committee concluded that the main advantage of the Gemini vehicle was that it was lighter than the X-20 and consequently could carry more fuel for orbital maneuverability or have a larger payload. The inherent advantage of the X-20 was its maneuverability during re-entry, which meant that it could land quicker and with more landing site options. The committee recommended that a series of military experiments should be implemented in the NASA Gemini program and that additional flights of the X-20 might be warranted. Both systems could be modified to perform reconnaissance, inspection, satellite defense, and logistical missions; however, neither would directly provide a means of introducing offensive weapons into earth orbit.[8]

On 22 May, Major General O. J. Ritland, Deputy to the Commander for Manned Space Flight, AFSC headquarters, forwarded the report to Air Force headquarters with the recommendation that the X-20 program be continued because of the contribution a high lift-to-drag ratio vehicle could make to future military systems. Air Force participation in the Gemini program should be limited to incorporating a series of military experiments into the NASA program.[9 *] A few weeks later, Brockway McMillan, the Assistant Secretary of the Air Force for Research and Development, summarized the report in a memorandum to the Secretary of Defense. The assistant secretary recommended that the X-20 program be energetically

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* Secretary McNamara approved the incorporation of Air Force experiments in the NASA Gemini program on 20 June 1963.

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continued. He suggested that further examination of the military applications of the X-20 and Gemini be extended under various study programs.[10]

At the request of AFSC headquarters, the program office then completed a study concerning the use of the X-20 in anti-satellite missions. The Dyna-Soar office proposed an X-20B which would have an interim operational capability of satellite inspection and negation. The program office suggested that the last six flights of the current X-20A program be altered to carry inspection sensors and additional fuel for space maneuver demonstration. Two additional flights would be added to demonstrate an interim operational capability. This would necessitate a weight reduction to the X-20 glider of 700 pounds which could be achieved through a series of design changes. Such a program would total $227 million from fiscal years 1964 through 1968. To conduct a 50 flight operational program following the completion of the two demonstration flights would cost $1.229 billion from fiscal years 1965 through 1972.[11]

Near the end of June 1963, the Space Systems Division requested the X-20 office to conduct, as part of the 706 Phase 0 studies, an analysis which would show the capability of the Dyna-Soar vehicle and modified versions to fulfill satellite inspection missions.[12] With the assistance of the Boeing Company, the system contractor, the Minneapolis-Honeywell Regulator Company, an associate contractor, and the Air Force Aerospace Medical Division, the Dyna-Soar office completed its report by the middle of November. This study offered an inspection vehicle, the X-20X, which could have provisions for a one or two-man crew,

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permit orbital flight for 14 days, and be capable of inspecting targets as high as 1,000 nautical miles. The Dyna-Soar office estimated a first flight date of the X-20X in September 1967 and a probable funding requirement, depending upon the extent of modifications, ranging from $324 million to $364.2 million for fiscal years 1965 through 1971.[13]

Since the completion of the Step IIA and IIB studies by Boeing in June 1962, the Dyna-Soar office had on several occasions, requested funds for intensive military application studies, and, on 8 July 1963, W. E. Lamar, Director of the X-20 Engineering Office, reiterated this request during a presentation to the Secretary of the Air Force, E. M. Zuckert.[14] A few days later, Secretary Zuckert, attending a meeting of the Designated Systems Management Group, directed studies of the operational applications of Dyna-Soar. He stated that the X-20 program would probably prove to be invaluable to the national military space program.[15]

Before the purpose of these studies was clarified, the future of the Dyna-Soar became tied to a projected space station program. On 22 July, Vice President Lyndon B. Johnson raised the question of the importance of space stations to national security and requested the Secretary of Defense to prepare a statement on this subject.[16] Secretary McNamara replied a few days later and stressed a factor which the Air Force now had to consider: multi-manned orbital flights of long duration. The Secretary outlined some premises upon which America's manned, military,

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space program was to be based. He stated that the investigation of the military role in space was important to national security. Because there was no clearly defined military space mission, present efforts should be directed towards the establishment of the necessary technological base and experience in the event that such missions were determined. The Secretary of Defense pointed out that Air Force participation in the Gemini program would provide much of this technological base. He considered that an orbital space station could prove useful in conducting experiments to improve capability in every type of military mission. Such a system could even evolve into an operational military vehicle. Secretary McNamara informed Vice President Johnson that he hoped to have the characteristics of an orbital space station delineated by early 1964.[17]

In September, a subcommittee of the President's Scientific Advisory Committee Space Vehicle Panel was formed to review the available data relative to a manned orbiting station. The President's Office of Science and Technology requested the Air Force to brief the subcommittee on possible military space missions, biomedical experiments which could be performed in space, and the capability of Gemini, Apollo, and the X-20 vehicles to execute these possible future requirements.[18]

Additional instructions concerning the briefing to the President's Scientific Advisory Committee were relayed from the Director of Defense for Research and Engineering by Air Force headquarters to the Aeronautical Systems Division. Considerations such as modifications of the X-20 and

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discussion of an orbital space station should be emphasized. Air Force headquarters pointed out that the Department of Defense was not convinced that an orbital space station was needed. Rather a study of the requirements to test military equipment in space was necessary to answer questions such as equipment characteristics and the usefulness of man in space.[19]

A few days later, Dr. Lester Lees, chairman of the subcommittee, gave additional information to Mr. Lamar about the coming presentation. Emphasis was to be on specific, meaningful experiments which the Air Force could conduct with either Gemini, Apollo, or the X-20, in order to provide a technological basis for future military space missions. Dr. Lees pointed out that it was necessary to convince a number of governmental officials that military man had a definite mission in space. The usual arguments for manned space flight such as decision-making and flexibility were inadequate. The subcommittee chairman stated that more specific reasons must be given or it was unlikely that extensive funds would be available for the development of manned space systems.[20]

The briefings to the President's Scientific Advisory Committee on 10 October essentially covered the findings concerning Gemini and the X-20 in the earlier 10 May report of the Air Force to Secretary McNamara. More detail, however, was presented on the use of the X-20 as a shuttle vehicle capable of rendezvous and docking. A configuration of the X-20 with an orbital development laboratory was also considered.[21] After completion of the presentations, Dr. Lees commented to Mr. Lamar that

although he had previously been against the continuation of the Dyna-Soar program he now saw a definite need for the X-20. He would no longer oppose the program.[22]

By the end of October, the purposes of the Dyna-Soar capability studies, which Secretary Zuckert had agreed to in July, were clarified. Following the instructions of Air Force headquarters, Lieutenant General H. M. Estes, AFSC Vice Commander, informed Major General R. G. Ruegg, ASD Commander, that the purpose of the first study was to formulate a program of military space experiments involving only engineering changes to the X-20 subsystems. The Vice Commander added that this program of experiments should be compared to a similar one employing the Gemini vehicle to insure that the Dyna-Soar approach offered the most economical and effective means of accomplishment. A second study would integrate the findings of various other studies and establish a series of mission models for reconnaissance, surveillance, satellite inspection, and also logistical support of a space station. A third study was to examine the future operational potential of re-entry vehicles having a lift-to-drag ratio greater than the X-20. A final study would examine the economic implications of various modes of recovering space vehicles from near-earth orbit.[23] At the end of November, AFSC headquarters informed the X-20 office that Air Force headquarters had approved all but the second proposal which had just been submitted.[24 *]

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* On 16 December, AFSC headquarters canceled the first two studies, both of which dealt directly with the Dyna-Soar program.

Early in October 1963, General B. A. Schriever, AFSC Commander, informed ASD and SSD that the Secretary of Defense intended to visit the Martin Company facilities at Denver, Colorado, to receive briefings on the status of the X-20 and Titan III programs.[25] Colonel W. L. Moore, X-20 program director, later noted that the directions were somewhat in error because it became apparent during these presentations that Secretary McNamara desired far more than a status briefing.[26]

Prior to these briefings, there were numerous indications that the future of the Dyna-Soar program was uncertain. Several X-20 displays and activities had been planned for the Air Force Association convention which was to be held in the middle of September. One of the proposed events involved the continuous showing of a brief film on the nature and objectives of the Dyna-Soar program. Although this film was an updated version of one previously unclassified and released, the Office of the Secretary of Defense refused its clearance for the convention.[27] Furthermore, neither Dr. A. C. Hall, Deputy Director for Space in the Office of the Director of Defense for Research and Engineering, nor Dr. A. H. Flax, now Assistant Secretary of the Air Force Research and Development, indicated agreement to a briefing by the Air Force Plant Representative at Boeing on the necessity for manned, military, space flight.[28] It was reported that some X-20 Boeing officials became concerned over the future of the program after this visit.[29] In addition, the Director of Defense for Research and Engineering,

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Dr. Harold Brown, had not approved the release of funds for X-20 range requirements. The AFSC Vice Commander was concerned and considered that the range operational date of October 1965 for the Dyna-Soar program was certainly in jeopardy.[30] Lastly, Dr. Brown, in a speech before the United Aircraft Corporate Systems Center at Farmington, Connecticut, appeared critical of the Air Force, manned, space programs. He stated that both the Gemini and X-20 programs had very limited ability to answer the question of what man could do in space. Unless an affirmative answer were found, there would be no successor to these programs.[31]

A few days later, on 23 October, Secretary McNamara, accompanied by R. L. Gilpatric, Deputy Secretary of Defense, Harold Brown, and Brockway McMillan, now Under Secretary of the Air Force, were briefed by Titan III and X-20 officials. At the conclusion of his presentation, Colonel Moore stated that it would be desirable to have the Department of Defense publicly state its confidence in the Dyna-Soar program. The X-20 director then asked if there were any questions.[32]

Both Secretary McNamara and Dr. Brown asked a series of questions directed towards obtaining information on the necessity of manned, military, space systems. Secretary McNamara stated that the X-20 office had been authorized to study this problem since March 1963. He emphasized that he considered this the most important part of the X-20 program. The Secretary of Defense wanted to know what was planned for the Dyna-Soar program after maneuverable re-entry had been demonstrated.

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He insisted that he could not justify the expenditure of about $1 billion for a program which had no ultimate purpose. He was not interested in further expenditures until he had an understanding of the possible space missions. Only then would the department give a vote of confidence to the X-20 program. Secretary McNamara then directed Dr. McMillan to get the answers.[33]

Some of the participants arrived at varying conclusions concerning the reaction of Secretary McNamara to the briefing. Mr. J. H. Goldie, Boeing's X-20 chief engineer, thought that the Secretary of Defense did not appear to be firmly against the X-20 nor in favor of Gemini. Rather, Secretary McNamara seemed willing to allow the Air Force to use the X-20 as a test craft and a military system if a case could be adequately made for a manned, military, space system.[34] Mr. Lamar concluded that the Secretary of Defense was not satisfied with the response and that "drastic consequences" were likely if an adequate reply were not made.[35] Colonel Moore prophetically stated that Secretary McNamara "probably will not ask us again."[36]

Just as serious as Secretary McNamara's reception of the X-20 briefing was the refusal of the Department of Defense to sanction a revision of the system package program. From May through September 1963, several changes involving the test organization and funding were made to the X-20 program. On 9 May 1963, General Schriever had directed that the Dyna-Soar orbital test program be assigned to the Space Systems Division. The AFSC commander further ordered that the mission control center be located at the Satellite Test Center in Sunnyvale, California,

instead of the Air Force Missile Test Center.[37] The 27 May 1963 system package program reflected this change in the test program and registered a requirement of $135 million for fiscal year 1964.

While Air Force headquarters approved this system package program in June, the Department of Defense would only allow $125 million for fiscal year 1964. On 3 July, the Air Force Systems Command headquarters informed the X-20 office that attempts to obtain the higher funding level had failed.[38] The Director of Defense for Research and Engineering considered that the primary purpose of the program was to acquire data on maneuverable re-entry. Incorporation of multiorbital flight was only of secondary importance, and the X-20 office could defer the first multiorbital flight date to remain within budget limitations.[39] AFSC headquarters then directed that a revised system package program be completed by early September.[40] Before this could be accomplished, General Schriever transferred not only orbital test direction to the space division but also responsibility for the air-drop program and the training of X-20 pilots.[41] These additional changes would also have to be incorporated into the revised system package program.

The 3 September program package presented the adjusted financial estimates and flight schedules. Considering that $125 million had been authorized for fiscal year 1964 and a total of $339.20 million had previously been expended, the program office estimated that $139 million would be required for 1965, $135.12 million for 1966, $93.85 million for 1967, $31.85 million for 1968, and $3 million for 1969. The total cost for the Dyna-Soar program would amount to $867.02 million. The reduction

of fiscal year 1964 funds was absorbed by delaying the necessary modifications for multiorbital flight and deferring the date of the ninth ground-launch (the first multiorbital flight) from August 1967 to December 1967. The 20 air-launches were to occur from May 1965 through May 1966, and the two unmanned ground-launches were to take place in January 1966 and April 1966. The first piloted ground-launch was to occur in July 1966, and the last piloted flight was to be conducted in February 1968.[42]

Soon after the issuing of this program package, there was some concern over the expense involved in locating the mission control center at Sunnyvale. Colonel Moore estimated that this relocation would increase program costs by several million dollars.[43] Major General L. I. Davis, a special assistant to the AFSC Vice Commander, supported this argument by stating to General Schriever that many of the functions necessary for launch control were also necessary for mission control. It would be less expensive to keep both control centers at the Air Force Missile Test Center.[44]

At the request of AFSC headquarters, the X-20 office forwarded, on 23 September, a revision of the 3 September system package program which detailed adjustments to program costs if the mission control center remained at Cape Canaveral. The X-20 office estimated that $138.13 million would be required for fiscal year 1965, $130.66 million for 1966, $88.34 million for 1967 and $31.09 million for 1968. The total program cost would amount to $853.23 million instead of the previously

estimated $867.02 million.[45] On 17 October 1963, AFSC headquarters forwarded the system package program to the Air Staff, informing them that it was more feasible to locate the mission control center at the missile test center.[46] This program package did not receive the endorsement of either headquarters. As late as 21 November, the X-20 assistant director, J. B. Trenholm, reminded AFSC headquarters that it would be beneficial to the program if the systems command would approve of the program package.[47]

It had been reported that, on the day following the 23 October 1963 briefing to Secretary McNamara, Dr. Brown had offered a manned, orbiting, laboratory program to the Air Force in exchange for Air Force agreement to terminate the X-20 program. General C. E. LeMay, the Air Force Chief of Staff, did not agree and directed an Air Force group to prepare a rebuttal to such a proposal.[48] Previously, in August, Dr. Brown had approved an Air Force request to conduct a study of an orbital space station. He authorized the expenditure of $1 million for fiscal year 1964. The Air Force was to focus on the reconnaissance mission with the objective of assessing the utility of man for military purposes in space. In determining the characteristics of such a station, the Air Force should consider the use of such programs as the X-15, the X-20, Mercury, Gemini, and Apollo. This study had to be concluded by early 1964.[49]

Before the completion of this space station study, however, Dr. Brown recommended a program for such an effort to Secretary McNamara in a 14 November 1963 memorandum. The Director of Defense for Research and Engineering analyzed varying sizes of space station systems which would

incorporate either the Gemini or Apollo capsules as ferry vehicles and would employ either the Titan II, the Titan IIIC, or the Saturn IB booster. Two of the approaches were suitable. One would involve the use of the Lunar Excursion Module (LEM) adapter as a space station and the Saturn IB as the booster. The Apollo command module and the Titan IIIC would perform the logistics function. Dr. Brown estimated that this approach would cost $1.286 billion from fiscal years 1964 through 1969. The first, manned, ferry launch could take place in late 1966, and active station tests could be conducted by late 1967.

The alternative which the Director of Defense for Research and Engineering preferred was to develop a space station with provisions for four men, use the Gemini capsule as a ferry vehicle, and separately launch both the station and capsule with a Titan IIIC booster. From fiscal years 1964 through 1968, this approach would total $983 million. The first, manned, ferry launch could occur in the middle of 1966, and active space station tests could begin in the middle of 1967.

Dr. Brown, however, was concerned because both of the recommended approaches would employ primitive landing methods, and, consequently, he suggested the development of a low lift-to-drag ratio vehicle which could perform maneuverable re-entry and conventional landing. The Director of Defense for Research and Engineering suggested that models of such a craft be tested in the Aerothermodynamic, Structural Systems, Environmental, Test program (ASSET) during 1964 and 1965, and he estimated that an improved ferry vehicle could be available for later station tests.

The total for this more sophisicated vehicle program would amount to $443 million for fiscal years 1964 through 1968.

Dr. Brown's recommendation to Secretary McNamara was brief: cancel the X-20 program and initiate the Gemini approach to a manned, military, space station. Management of the Gemini program should be transferred from NASA to the Department of Defense by October 1965.[50]

Discussions between National Aeronautics and Space Administration and Department of Defense officials made it clear that the space agency would agree to a coordinated, military, space program, but it was not prepared to support a space station program. Instead NASA suggested a program for an orbiting military laboratory which did not involve ferrying, docking, and resupplying. On 30 November, Dr. Brown, in another memorandum to Secretary McNamara, analyzed an approach more agreeable to NASA. This alternative would involve the orbiting by a Titan IIIC booster of a Gemini capsule and a 1,500 cubic foot test module, capable of supporting two to four men for 30 days. Dr. Brown maintained that such an approach could easily be converted into the Gemini alternative he had recommended on 14 November. This simplified approach would total $730 million from fiscal year 1964 through 1968, and the manned, orbital, test program could be conducted in late 1967. Dr. Brown, however, advised the Secretary of Defense that the space station proposal of 14 November was still the most feasible and should be initiated.[51]

While NASA had suggested a simplified Gemini approach, it by no means concurred with the proposed termination of the X-20 program.

The Associate Administrator for Advanced Research and Technology, Dr. R. L. Bisplinghoff, pointed out that advanced flight system studies had repeatedly shown the importance of developing the technology of maneuverable hypersonic vehicles with high-temperature, radiation-cooled, metal structures. Test facilities were unable to simulate this lifting re-entry environment, and, consequently, X-20 flights were necessary to provide such data. NASA had always supported the Dyna-Soar program and should it be canceled the space agency would have to initiate a substitute program.[52]

In order to achieve the objective of obtaining data on re-entry, Dr. Bisplinghoff recommended some changes to the Dyna-Soar program. After completion of an adequate air-drop program and a satisfactory unmanned ground-launch flight, a piloted orbital flight should be conducted.[53] Dr. Brown requested Dr. Flax to examine such an alternative for the X-20.[54] With the assistance of the X-20 program office and AFSC headquarters, Dr. Flax completed his reply on 4 December. He estimated that such a curtailed program would reduce the total cost by $174.4 million through fiscal year 1969. He pointed out, however, that such an approach would result in the loss of technical data which would be disproportionate to the financial savings.[55]

On the same day, in another memorandum to the Secretary of the Air Force, Dr. Flax firmly disagreed with the recommendations of Dr. Brown's 14 November memorandum. The Assistant Secretary pointed out that the X-20 had not been given serious consideration as an element in any of

the space station proposals. He emphasized that major modifications were necessary to both the Gemini and the X-20 if either were to be employed in an orbital station program. Furthermore, the Dyna-Soar approach possessed several advantages: the vehicle could make emergency landings without the costly deployment of air and sea elements and there would be a more tolerable force of vehicle deceleration during re-entry. Dr. continued by emphasizing the importance of the X-20 program. I technology not only supported the development of re-entry vehicles, including Dr. Brown's improved ferry vehicle, but also an entire class of hypersonic winged-vehicles. Since about $400 million had already been expended on the X-20 program, the Assistant Secretary severely questioned the proposal to cancel Dyna-Soar and initiate a new program with similar objectives. While he endorsed the purposes of the space station program, Dr. Flax believed that the decision to begin such a program was independent of the question to terminate the X-20.[56]

On the same day, Secretary of the Air Force Zuckert forwarded Dr. Flax's memorandum to Secretary of Defense McNamara with the statement that it represented the best technical advice available in the Air Force. The Secretary of the Air Force added that both he and Dr. Brockway McMillan were in accord with Dr. Flax's position. Secretary Zuckert further stated that he did not wish to see the Air Force abandon a program such as Dyna-Soar and start a new program which perhaps had been projected upon optimistic schedules and costs.[57] (MOL)

As an Air Force reply to Dr. Brown's 14 November memorandum, Major General J. K. Hester, the Assistant Vice Chief of Staff, suggested to the Secretary of the Air Force several alternatives for varying sizes of space stations, all of which employed the X-20 vehicle. The first alternative offered an extended X-20 transition section which would provide a module of 700 cubic feet. This would be a two-man station employing an X-20 launched by a Titan IIIC. The second approach comprised a separately launched two-room station by the Titan II. This would have 1,000 cubic feet of volume and would be serviced by an X-20 shuttle vehicle boosted with a Titan IIIC. The third alternative, recommended by General Hester as the most feasible, involved a five-man station, launched by Titan IIIC and capable of orbiting for one year. This approach would require $978.4 million from fiscal years 1964 through 1969 for the development of a space station and the X-20 ferry vehicle. The Assistant Vice Chief of Staff considered that the first space station launch could take place by the middle of 1967. With an X-20 approach to a space station program, it was not necessary to have a separate program for an improved ferry vehicle. Rather, only an annual funding level of $6.4 million for the ASSET program was necessary to advance space technology. General Hester, therefore, recommended the initiation of a space station program employing the X-20 and, if economy were essential, the cancellation of the Gemini program.[58]

On the next day, Secretary Zuckert forwarded General Hester's memorandum to Secretary McNamara. The Air Force Secretary stated that the Air Staff study clearly indicated that there was no definite reason

for omitting the X-20 from consideration as a re-entry vehicle for an orbital space station or orbital laboratory program. This was particularly important because of safety and cost advantages which the X-20 offered for long duration orbital missions. Secretary Zuckert believed that the X-20 alternative deserved serious consideration.[59]

On 8 December, a rumor circulated in Air Force headquarters that the Defense Department had reduced X-20 fiscal year 1964 funds from $125 million to $80 million and had not allocated any money for fiscal year 1965.[60] The next day, defense officials conferred with President Johnson. Apparently, Secretary McNamara recommended the termination of Dyna-Soar, and the President agreed.[61] On 10 December, the Secretary of Defense announced the cancellation of the X-20 project. The program had been reviewed, alternatives studied, and the decision made. In its place would be a manned orbital laboratory (the NASA proposal which Dr. Brown explained in his 30 November 1963 memorandum). The Secretary of Defense also stated that there would be an expanded ASSET program (the improved ferry vehicle program which Dr. Brown offered in his 14 November memorandum) to explore a wide range of re-entry shapes and techniques. By taking the Gemini approach to a space program, Secretary McNamara estimated that $100 million would be saved in the following 18 months.

The Secretary of Defense explained his reasons for canceling the X-20. He stated that the purpose of the program had been to demonstrate maneuverable re-entry and landing at a precise point. The Dyna-Soar vehicle was not intended to develop a capability for carrying on space logistics operations. Furthermore, the X-20 was not intended to place

substantial payloads into space, nor fulfill extended orbital missions. The Secretary of Defense stated that about $400 million had already been expended on a program which still required several hundred million dollars more to achieve a very narrow objective.[62]

A few days after the termination announcement, Dr. Brown, in a memorandum to the Secretary of the Air Force, replied to the arguments of Dr. Flax and General Hester. Dr. Brown stated that before reaching a decision the Air Force alternatives were carefully considered. There were three objections. The Air Force recommended program involved construction of a space station and a new and larger X-20. The Department of Defense considered that such a large step was not justified and a test module and Gemini vehicle were chosen as the logical first step. Furthermore, the Air Force suggestion to cancel Gemini was not within the power of the Department of Defense since this was a NASA program. Lastly, the Air Force recommendation involved a greater degree of schedule risk than the chosen program. The Air Force proposal could not be accepted as a feasible substitute for the Manned, Orbiting, Laboratory program.[63]

Following Secretary McNamara's news conference on 10 December, Air Force headquarters informed all of its commands of the termination of the X-20 and the initiation of an orbital laboratory program.[64] On the same day, General Schriever met with some of his staff to discuss the new space approach. He stated that both the orbiting laboratory and the expanded ASSET programs would be placed under the management of

the Space Systems Division.[65] Later, General Schriever requested the Commander of the Research and Technology Division, Major General Marvin C. Demler, to aid the space division in the preparation of a new ASSET development plan. The objective of this program as first announced by Dr. Brown remained unchanged: the development of an advanced ferry vehicle.[66]

Although official instructions were not received from AFSC headquarters until 17 December, the X-20 program office instructed the Dyna-Soar contractors and various Air Force agencies on 10 December to stop all activities involving the expenditure of X-20 funds.[67] On the next day, Secretary Zuckert authorized the Air Force to terminate the X-20 program; however, it was to continue certain X-20 efforts which were deemed important to other space programs. A preliminary report was due no later than 16 December.[68] The day following this direction, the ASD program office recommended the continuation of ten activities: studies of pilot control of booster trajectories, fabrication of the Dyna-Soar heat protection system, construction of the full pressure suit, fabrication and testing of the high temperature elevon bearings, final development testing of the nose cap, flight testing on the ASSET vehicle of coated molybdenum panels, final acceptance testing of the test instrumentation subsystem ground station, development of the very high frequency (VHF) search and rescue receiver and transmitter, employment of existing Boeing simulator crew station and flight instruments for further research, and development of certain sensoring and transducing equipment for telemetry instrumentation.[69] On 18 December, Air Force headquarters informed the program office that

the Secretary of the Air Force had approved the ten items, and funding for continuation of these contracts would be limited to $200,000 a month.[70]

The X-20 engineering office, however, had recommended a list of several items for reinstatement which were in addition to the ten efforts continued by the program director. The X-20 Program Director had not supported the engineering office items either because he did not consider them of sufficiently wide applicability or he could not adequately establish their merit.[71] This list, however, was revised on 14 December by representatives from AFSC headquarters, the Space Systems Division, the Aeronautical Systems Division, and the Research and Technology Division. The officials decided to identify the items not only by technical area, as originally presented by the engineering office, but also by four categories. Category A involved efforts whose cost for completion would be equal to the termination expense. Category B comprised items which were applicable to various space programs. Category C included items which would contribute to the advancement of the state-of-the-art. The final classification, Category D, contained efforts which possessed a potential future use.[72]

On 20 December 1963, a revision of this list had been completed and coordinated with the laboratories of the Research and Technology Division. The items were classified both by technical area and the suggested categories. At the end of the month, officials from USAF headquarters, AFSC headquarters, ASD, and RTD again reviewed proposed items for continuation, and this time a new classification was suggested. Category I included items which would advance the state-of-the-art. Category II

involved items which only required feasibility demonstration or design verification. Category III comprised equipment which was nearly completed, and Category IV were efforts which necessitated further justification.[73]

By 3 January 1964, a last revision of the proposed useful efforts had been completed. A Category V was added which included items that had been suggested for continuation by various organizations but were considered unacceptable by the X-20 engineering office. Essentially, the engineering office recommended for continuation the 38 efforts which comprised Categories I, II, and III. Included in these were the ten items which were being continued by the program office itself. A few days later, General Estes requested from USAF headquarters authority to retain sufficient funds for program termination, which would include $3.1 million for the completion of the first three categories.[74] On 23 January, USAF headquarters informed AFSC that the Secretary of the Air Force had approved, with the exception of two items, all the efforts listed under the first three categories. The Air Force would allow an expenditure of $70 million from fiscal year 1964 funds for the Dyna-Soar program, $2.09 million of which would be directed towards completing the three categories.[75] * The Research and Technology Division was then assigned authority to formulate a management plan for completion of this work.[76] The X-20 engineering office completed a plan at the end of January, recommending that separate contracts be negotiated for the three categories

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* For a list of the 36 items which were continued, see document 107.

of items which had not been already reinstated. These contracts would be administrated by the Research and Technology Division except for two which were to be transferred to the Air Force Missile Development Center and the Air Force Flight Test Center.[77] While Air Force headquarters did not give an official approval, this plan was put into operation.

The Air Force calculated that Boeing had completed 41.74 percent of its tasks. The Minneapolis-Honeywell Regulator Company, the associate contractor for the primary guidance subsystem, had finished 58 percent, and the Radio Corporation of America, the associate contractor for the communication and tracking subsystem, had completed 59 percent of its work. At the time of Secretary McNamara's announcement, Boeing had 6,475 people involved in the X-20 program, while Minneapolis-Honeywell had 630 and RCA, 565. The governmental expenditure for these contracts amounted to $410 million.[78]

While it had only approximately reached mid-point, the Dyna-Soar program definitely advanced the technology of radiation-cooled structures. Thirty-six X-20 tasks were continued and would directly contribute to other Air Force space efforts. Also significant was the initiation of an expanded ASSET program directed towards the development of a lifting, re-entry, shuttle vehicle. Paradoxically, the cancellation of X-20 development apparently made the maneuverable re-entry concept far more acceptable to the Department of Defense and some elements of the Air Force than it had been during the existence of the Dyna-Soar program.

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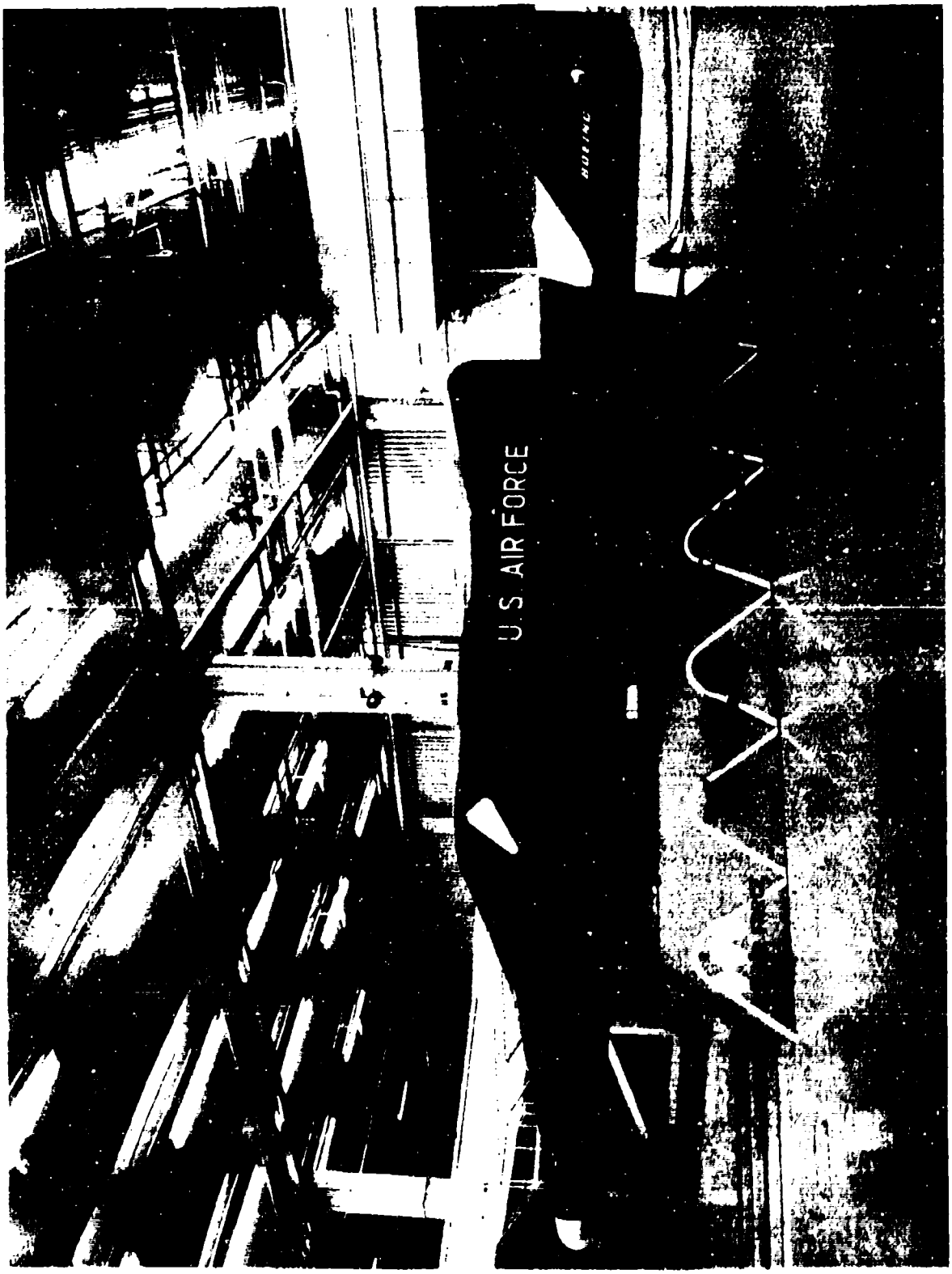

Figure 1. A mock-up of the X-20 glider in April 1963.

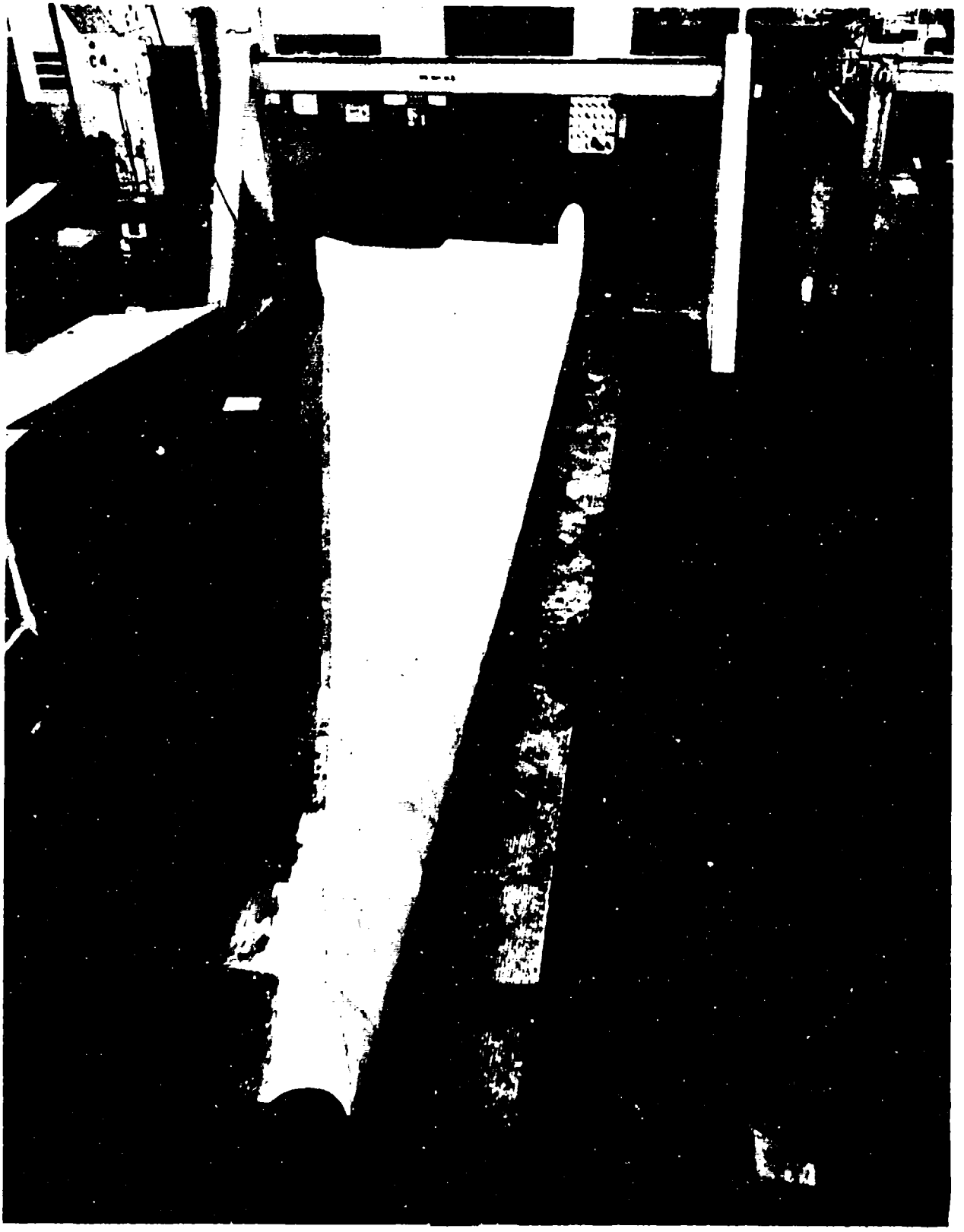

Figure 2. An X-20 right wing model in June 1963.

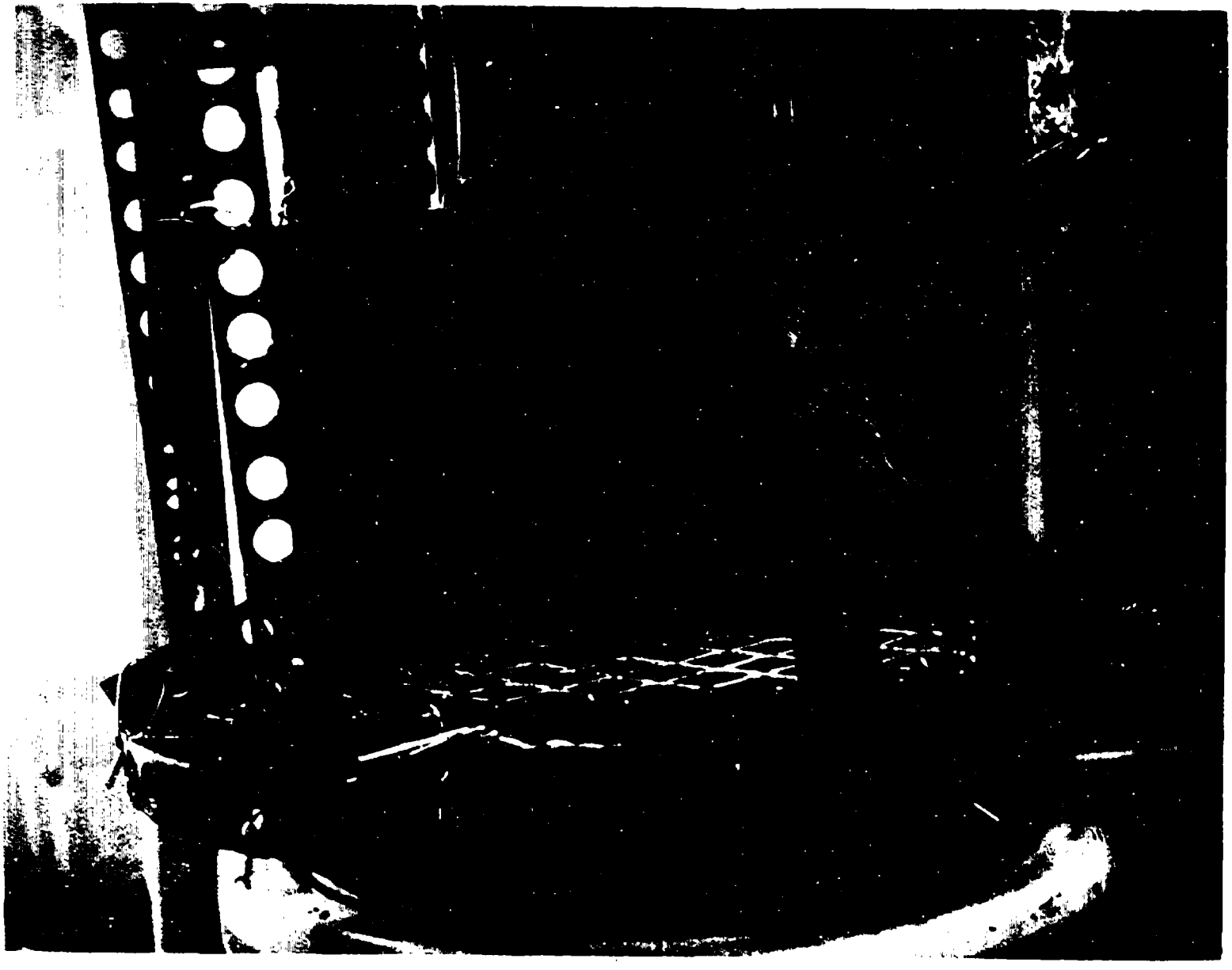

Figure 3. A leading edge segment being fabricated in July 1963.

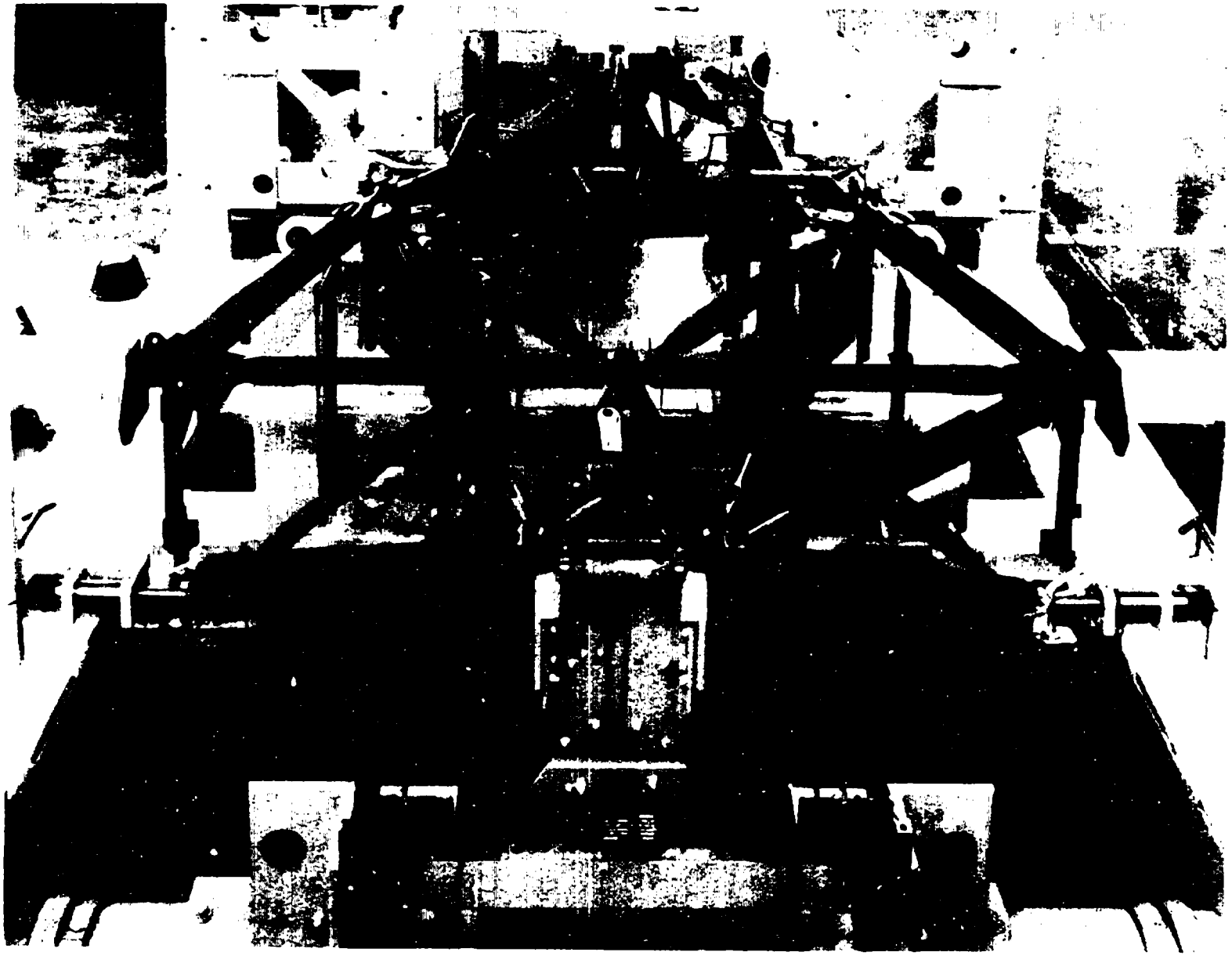

Figure 4. A weld assembly of the X-20 pilot's compartment in September 1963.

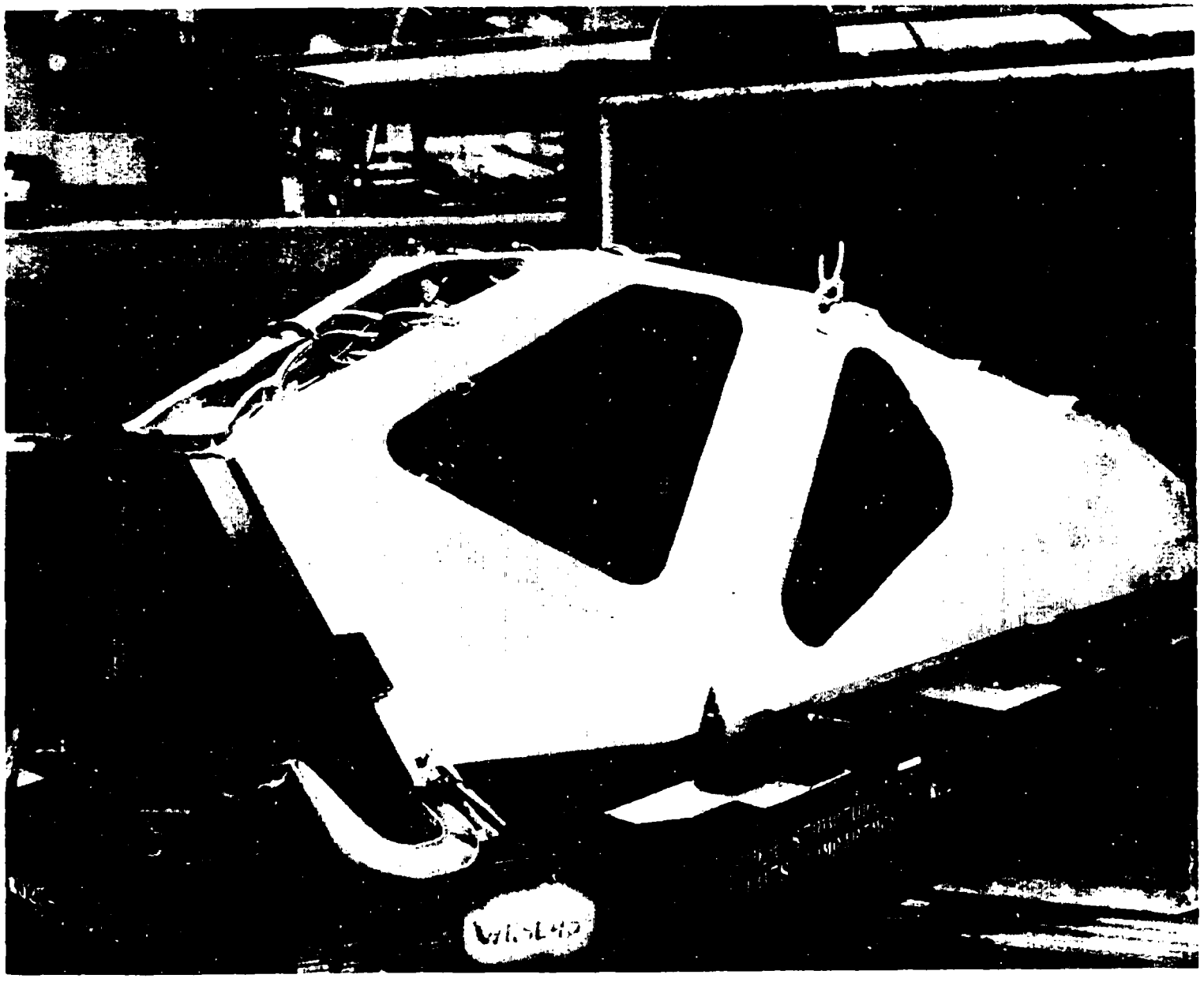

Figure 5. The fuselage structure assembly of the X-20 in December 1963.

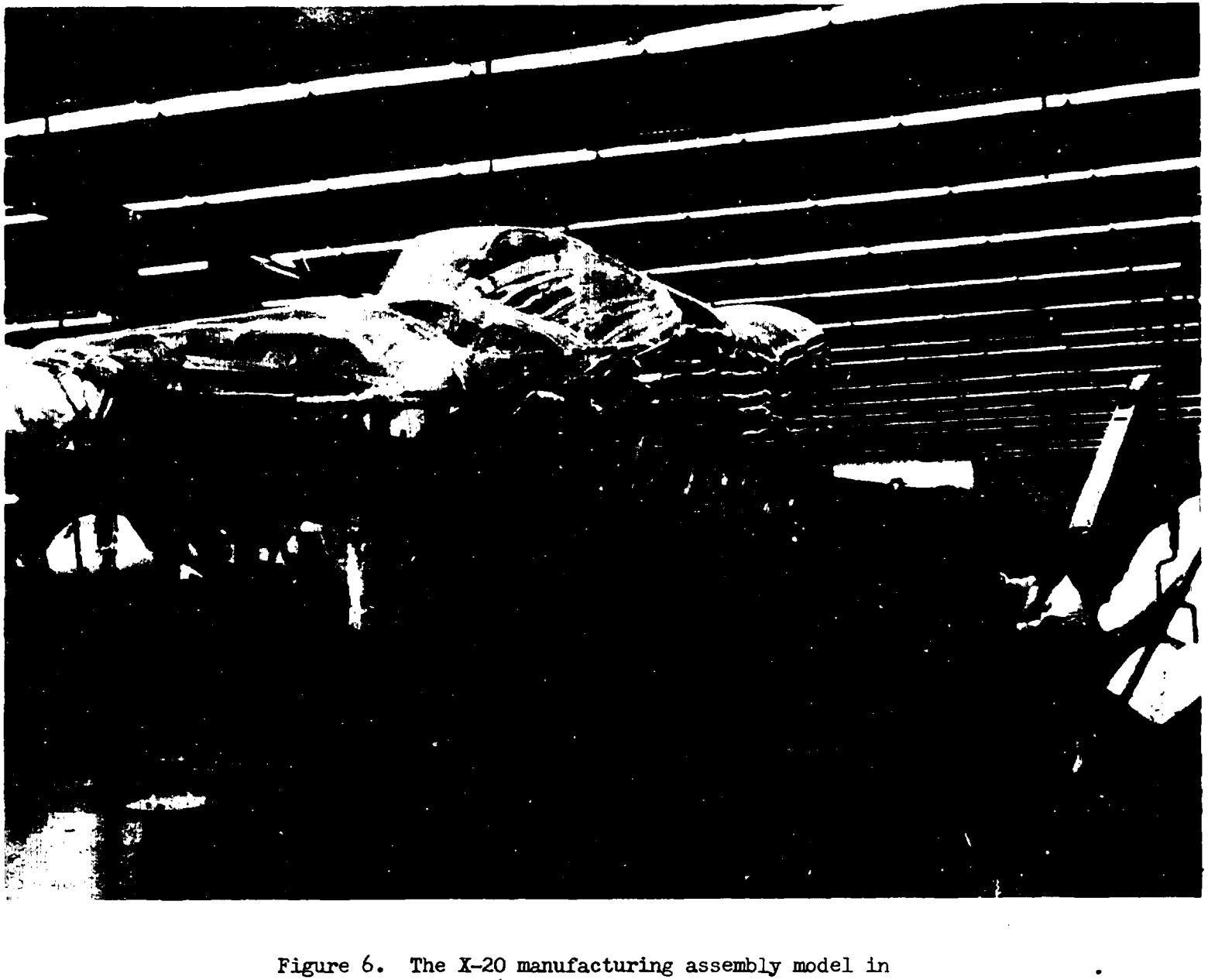

Figure 6. The X-20 manufacturing assembly model in July 1963.

GLOSSARY OF ABBREVIATIONS

Adm.	Administrator
Adv.	Advanced
AF	Air Force
AFFTC	Air Force Flight Test Center
AFMDC	Air Force Missile Development Center
AFMTC	Air Force Missile Test Center
AFPR	Air Force Plant Representative
AFSC	Air Force Systems Command
ASAF	Assistant Secretary of the Air Force
ASD	Aeronautical Systems Division
ASSET	Aerothermodynamic, Structural Systems, Environmental Test
Assoc.	Associate
Asst.	Assistant
Cmdr.	Commander
Co.	Company
Col.	Colonel
CS	Chief of Staff
DCS	Deputy Chief of Staff
DDR&E	Director of Defense for Research and Engineering
Def.	Defense
Dep.	Deputy
Dev.	Development
Dir.	Director(ate)
Div.	Division
Doc.	Document
DOD	Department of Defense
DSMG	Designated Systems Management Group
Engg.	Engineering
Exec.	Executive
Fig.	Figure
FY	Fiscal Year
Gen.	General

Hist.	Historical
Hq.	Headquarters
LEM	Lunar Excursion Module
Log.	Logistics
Lt.	Lieutenant
Ltr.	Letter
Maj.	Major
Memo.	Memorandum
MMSCV	Manned, Military, Space, Capability Vehicle
MOL	Manned, Orbiting Laboratory
Msl.	Missile
NASA	National Aeronautics and Space Administration
N. D.	No Date
No.	Number
Ofc.	Office
P., PP.	Page, Pages
Pres.	President
Presn.	Presentation
Prog.	Program
PSAC	President's Scientific Advisory Committee
RCA	Radio Corporation of America
R&D	Research and Development
RDT&E	Research, Development, Testing, and Evaluation
Res.	Research
Rpt.	Report
RTD	Research and Technology Division
SAF	Secretary of the Air Force
SAFUS	Under Secretary of the Air Force
Secy.	Secretary
SPD	System Program Directive
Spec.	Special
SPO	System Program Office

SSD	Space Systems Division
Subj.	Subject
Sys.	System(s)
Tech.	Technology
TWX	Teletypewriter Exchange Message
U. S.	United States
USAF	United States Air Force
VCS	Vice Chief of Staff
VHF	Very High Frequency
Vol.	Volume

INDEX