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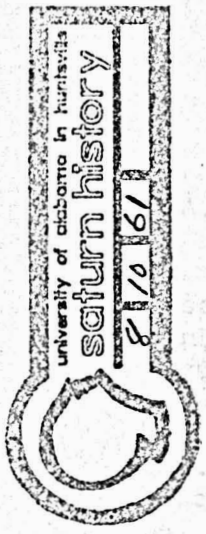

SATURN C-1 VEHICLE

PROJECT·DEVELOPMENT·PLAN

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SECTION III. (U) HISTORICAL SUMMARY AND RELATED WORK

A. VEHICLE SYSTEM

1. In April 1957, the Army Ballistic Missile Agency (ABMA) initiated studies of vehicles having payloads of 20,000 to 40,000 pounds (for orbital missions) or 6,000 to 12,000 pounds (for escape missions). It was determined that development of high-thrust boosters was urgently required to support missions of this type and for future programs. In December 1957, therefore, ABMA submitted to DOD a "Proposal for a National Integrated Missile and Space Vehicle Development Program". In this proposal, the need for a 1.5 million-pound thrust vehicle was proposed.

2. To secure this thrust, consideration was first given to clustering four 380,000-pound thrust Rocketdyne E-1 engines, which were in an early stage of development. In July, however, representatives of ARPA expressed interest in a clustered booster of 1.5 million pounds thrust that would use available engines already tested and of a proven reliability. On August 15, 1958, ARPA Order 14-59, formally initiated what was to become the SATURN project. The intent of this order was to demonstrate the feasibility of the clustered engine concept by means of a full-scale dynamic static firing. As an immediate step toward this demonstration, a contract was awarded Rocketdyne on September 11, 1958, to begin development and testing of the H-1 engine.

3. Studies had indicated that the tankage developed for the JUPITER and REDSTONE missiles could, with some modification, be used for both the oxidizer (LOX) and propellant (RP-1) tankage of the proposed booster. It was also found that an existing engine, the THOR-JUPITER, could be uprated to an estimated 188,000-pound thrust. (Later, after repackaging and simplification, this engine was designated the H-1.) Therefore, at the beginning of the booster development program, a number of important elements were already available. As an additional advantage, much of the tooling previously developed for the REDSTONE and JUPITER missiles could be used with comparatively little modification. It was possible, therefore, to begin booster development with hardware that had been long tested and was of proven reliability. This approach at once sharply compressed the amount of design and development time required prior to fabrication and the beginning of testing. For the same reason, the costs of hardware development and retooling were significantly reduced.

4. In October 1958, to enlarge previously stated program objectives, ARPA-Order 14-59 was amended to require the development of a reliable, high-performance booster to serve as the first stage of a multistage carrier vehicle capable of performing advanced space missions. ARPA also requested a complete vehicle system study so that upper stage selection and development could be initiated. Later, December 11, 1958, ARPA Order 47-59 authorized AOMC to begin design, modifications, and construction of an ABMA captive test tower and associated facilities to be used in this booster development program. In addition, AOMC was authorized to determine design criteria for SATURN launch facilities. At the end of the year, December 31, 1958, the program was further advanced by the first full power firing of an H-1 engine at a Rocketdyne facility, Canoga Park, California.

5. Construction of the ABMA test stand began January 10, 1959. On February 3, an ARPA memorandum officially renamed the Project SATURN cancelling the former identification of JUNO V.

6. A presentation of the proposed National Vehicle Program was given on March 2, 1959, by representatives of ARPA to the President and the National Aeronautics and Space Council. The program presented at this time included the SATURN B and SATURN C vehicle systems. On March 17, 1959, ABMA prepared and submitted to ARPA the results of the SATURN System Study. This study, which outlined various upper stage configurations, indicated that either an ATLAS or a TITAN could be acceptably used as the second stage of the proposed vehicle. ARPA responded to this study in May 1959 indicating that modified TITAN hardware would be used for the second stage and that the third stage would use the CENTAUR vehicle.

7. On April 28, the first H-1 production engine (H-1001) was delivered to ABMA on schedule. The first static test of this engine was performed successfully at Redstone Arsenal on May 26, 1959. This engine was later used in the first static test booster.

8. In June, construction of the SATURN blockhouse began at Cape Canaveral.

9. On July 27, 1959, the date that the last JUPITER airframe was completed at Redstone Arsenal, retooling of the Arsenal shops began to support the SATURN project. On the same day, the Director of Defense Research and Engineering sent the Secretary of the Air Force and the Director of ARPA a memorandum indicating that the requirements for the second stage of SATURN and the booster for the proposed DYNA SOAR vehicle were quite similar and, therefore, ARPA and the Air Force should consider a common development of these projects. Until this review was completed, neither agency was to make firm commitments for the redesign of existing boosters or the development of new ones. On July 29, 1959, immediately

after issuing this memorandum, ARPA ordered that all AOMC in house and contract work, and other expenditures relating to the TITAN second stage, cease immediately. However, permission was granted to continue preliminary work that was not directly connected with the stage diameter.

10. While studies of the proposed SATURN-DYNA SOAR combination continued, ARPA, on August 1, authorized ABMA to proceed with captive firings of the SATURN booster early in 1960. In September, a series of presentations on SATURN and TITAN C, was made by representatives of AOMC, ARPA, and the Air Force, respectively, to the Booster Evaluation Committee of the Office of the Secretary of Defense. On the basis of these presentations to Dr. York (Director of Research and Engineering, Department of Defense, and Chairman of the Booster Evaluation Committee), the SATURN program was continued because it offered the most immediate advantages of the systems presented. Shortly after this decision, on September 24, 1959, ARPA requested that a study be performed to determine the two best configurations for increasing SATURN capabilities for NASA payloads.

11. From 1958 through September 1959, responsibility for the SATURN project had been assigned to ARPA. In October 1959, however, the President proposed to the Administrator of NASA that responsibility for the SATURN be transferred to NASA. After study, this proposal was amended to include the transfer of certain ABMA technical facilities and experienced personnel, including the majority of ABMA's Development Operations Division, headed by Dr. von Braun. The President approved the proposed DOD-NASA transfer plan, and on November 25, 1959, NASA assumed technical direction of the project, pending formal transfer from the Army while administrative direction was retained by ARPA. To provide the necessary technical assistance to NASA, committees composed of representatives from ARPA, ABMA, NASA, and the Air Force were established.

12. During the month of October 1959, planning for the configuration of the SATURN vehicle also continued, and, on October 29 and 30, ABMA presented a second SATURN System Study to ARPA and NASA, proposing various upper stages studies offering increased payload capability and growth potential.

13. In December 1959, after evaluation of previous presentations, NASA and ARPA requested that AOMC prepare an engineering study for a three-stage SATURN configuration (later identified as C-1).

14. On December 15, 1959, after consideration of all aspects of the SATURN upper stage configuration, the SATURN Vehicle Evaluation Committee, composed of representatives of NASA, ARPA, DOD, AF and chaired by Dr. Silverstein, recommended a long range development program for SATURN including use of hydrogen-oxygen engines for all upper stages. The C-1

configuration was selected as the initial vehicle to be developed as a stepping stone to the C-2 vehicle. It was also recommended that a high thrust (150,000 to 200,000 pounds) hydrogen-oxygen engine be developed for use on advanced configurations. A building-block concept was recommended, as this would yield a variety of SATURN configurations, each using previously proved developments as far as possible. On December 31, 1959, these recommendations were accepted by the NASA Administrator and a 10-vehicle R&D program was established. The C-1 vehicle configuration included the S-I (8 H-1's 1.5M pounds thrust LOX/RP) the S-IV (4 LR-115's 80,000-pounds thrust LOX/LH_2 engines) and the S-V (modified CENTAUR).

15. The SATURN project was approved as a program of the highest national priority (DX rating) on January 18, 1960. A bidder's conference on the newly designated S-IV stage was held at Huntsville, Alabama, on January 26, 1960.

16. By 1960, the formal test program to prove out the clustered-booster concept was well under way at Redstone Arsenal. On January 4, 1960, a mockup of the SATURN booster had been installed in the ABMA test stand to check mating of the booster and stand and to prove out servicing methods. After structural assembly of the SA-T test booster was completed January 29, the booster was moved to checkout. The mockup was removed from the test stand on February 1 and SA-T was installed in the test tower by February 21, 1960.

17. While preparations for the first series of booster static tests were being made, ABMA received ARPA Order 14-60, Amendment 17, on February 19, 1960, which formulated the NASA authorization to proceed with the preliminary steps leading to contracts for the upper stages of the C-1 configuration. During March 1960, the executive order transferring the SATURN Program to NASA became effective.

18. On April 29, 1960, all eight engines of the test booster were successfully fired on the first attempt for an eight-second test.

19. Douglas Aircraft Corporation was selected for negotiation for the S-IV contract on April 26, 1960, and was awarded a preliminary study contract for the S-IV stage.

20. On May 26, assembly of the first stage of the SA-1 began. On June 15, 1960, the final test of 121.48 seconds successfully concluded the first series of booster tests.

21. On July 1, 1960, the SATURN program was formally transferred from ABMA to the George C. Marshall Space Flight Center.

22. Formal procurement of the S-IV stage had been initiated July 28, 1960 when NAS7-1 Supplemental Agreement was signed with DAC. This contract required that DAC design, develop, and fabricate the S-IV stage for the C-1 vehicle configuration. Contracts were also let on August 5, 1960, with P&W to develop and produce LR-119 engines for the S-IV and S-V stages of the C-1 vehicle. The LR-119 engine was planned as an uprated version of the LR-115, generating 17,500 pounds of thrust.

23. As a result of a request made by the Air Force on August 15, 1960, for NASA assistance in planning the application of SATURN to DYNA SOAR, a meeting was held October 6, 1960, between representatives of MSFC and the Air Force. It was agreed that MSFC would provide the Air Force with a preliminary study of the application of SATURN to this program.

24. On October 21, a study contract for the S-V stage (C-1 vehicle) was awarded to Convair Astronautics.

25. The second series of static firing tests of the test booster (updated to the flight configuration and designated SA-T1) was initiated December 2, 1960. The series of booster tests was successfully concluded on February 14, 1961.

26. On December 6, contract negotiations were initiated with the Packard Bell Co. for the development of an automatic checkout system for the SATURN booster.

27. By January 9, 1961, a preliminary study for the SATURN-DYNA SOAR presentation to the Air Force was completed. On January 16, 1961, the S-I stage for the SA-1 vehicle was moved from assembly to checkout. It was planned that this stage be installed on the static test stand as soon as one additional series SA-T1 had been completed.

28. On February 28, Convair was requested to perform studies to define the use of a minimumly modified CENTAUR vehicle for the C-1 configuration escape mission, in lieu of a man rated S-V stage. Soon after this request, on March 8 through 10, MSFC proposed a change from four LR-119 engines (17,500-pounds thrust) to six LR-115 engines (15,000-pounds thrust) for the S-IV stage. This change was necessary in order to provide engines to DAC on schedule and desirable to provide engine out capability for the S-IV stage. On March 23, 1961, MSFC presented a report to NASA Headquarters indicating that use of six engines was feasible and that P&W should discontinue development of the LR-119 engine and concentrate on a common engine (RL10-A-3) for use in the CENTAUR and SATURN programs. Approval for this change was received from NASA Headquarters on March 29, 1961.

29. On March 6, 1961, the SA-1 booster had been installed in the static test stand and preparations began for the first firing test of the flight stage.

30. In May, NASA Headquarters accepted a MSFC proposal to incorporate design changes in the S-I stage of the C-1 vehicle which would permit its use as a two-or three-stage vehicle with satisfactory safety requirements for the two-stage manned mission. This change eliminated the requirement for an S-V stage to be used with the C-1, except for possible special missions. NASA Headquarters also authorized use of the C-2 vehicle for the three-stage escape mission and indicated that MSFC should proceed with a two-phase procurement of an S-II stage development contract.

31. In April, studies performed by DAC indicated the feasibility of air transport for the S-IV stage. A Phase I Bidder's conference for S-II stage capability proposals was held in Huntsville on April 18, 1961. The SA-1 booster was successfully static tested for the first time on April 29 in a firing of 30 seconds duration. On May 5, 1961, a second static firing was performed, which was terminated after 44 seconds due to a leaking pressure pickup in the static test equipment. On May 11, a final successful 111-second static test of the booster was performed, after which the booster was removed from the test stand and forwarded for additional installation work and checkout prior to shipment to Cape Canaveral.

B. SPACECRAFT SYSTEM

1. The APOLLO program is the next development effort in the manned space flight program as announced by NASA at the Industry Conference of July 28-29, 1960. The objective of the APOLLO program is to develop a versatile spacecraft system which will ultimately be capable of a manned lunar landing. The APOLLO project has been in a study phase for the past year with systems studies being conducted by industry and the Space Task Group, and advanced research studies being conducted by the NASA centers. The feasibility of the project has been established to an extent that allows proceeding to the next step of the program, engineering study and design, and research and development flight testing.

2. Consideration of APOLLO development spacecraft for SATURN C-1 tests has been underway for some time. The results of these considerations are incorporated in this plan. Data derived from these "boilerplate" tests will provide information related to space vehicle integration, heat protection, and other systems, before spacecraft design freeze.

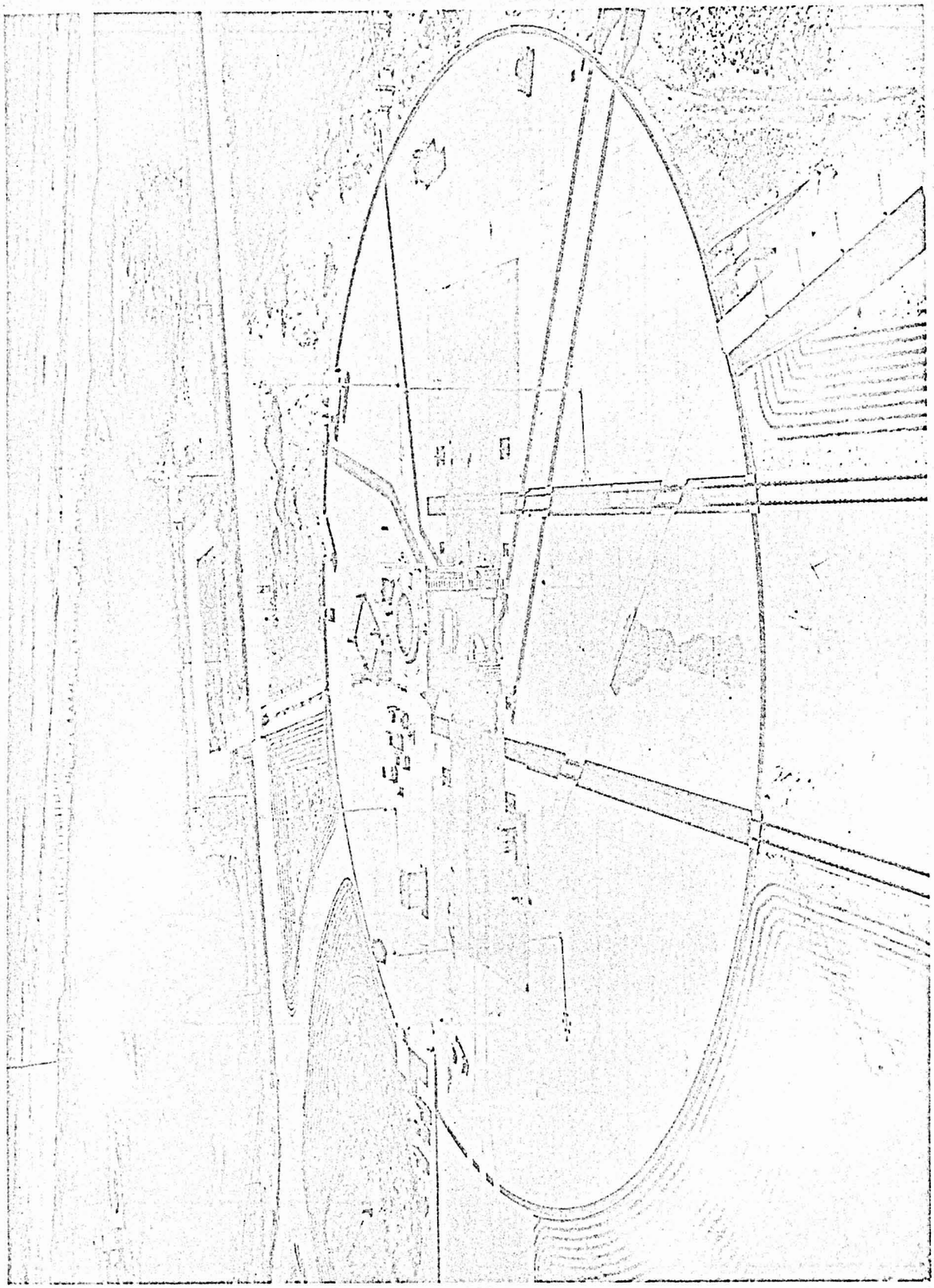

FIGURE 4-35. PAD AREA, LC-34

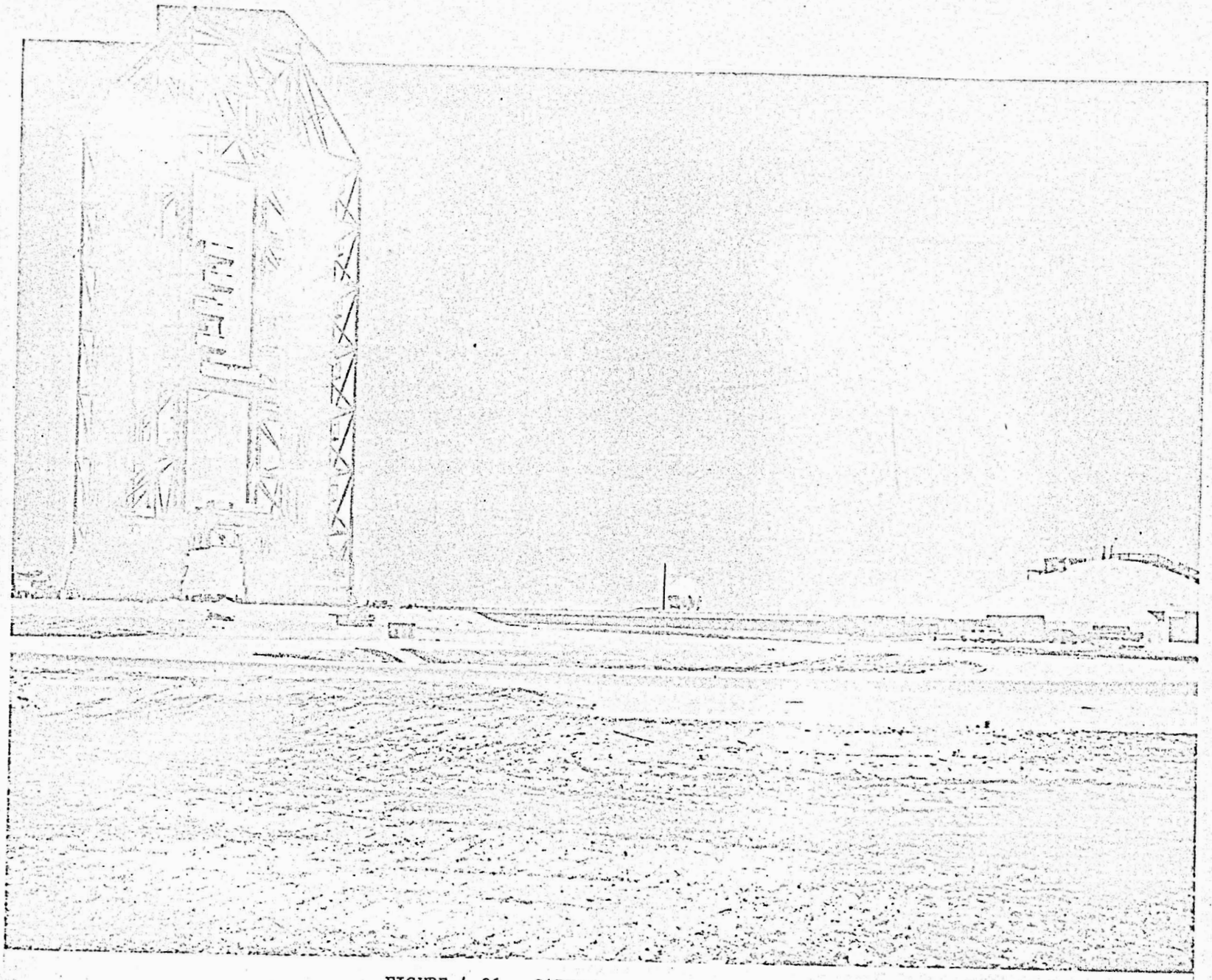

FIGURE 4-36. SATURN SERVICE STRUCTURE

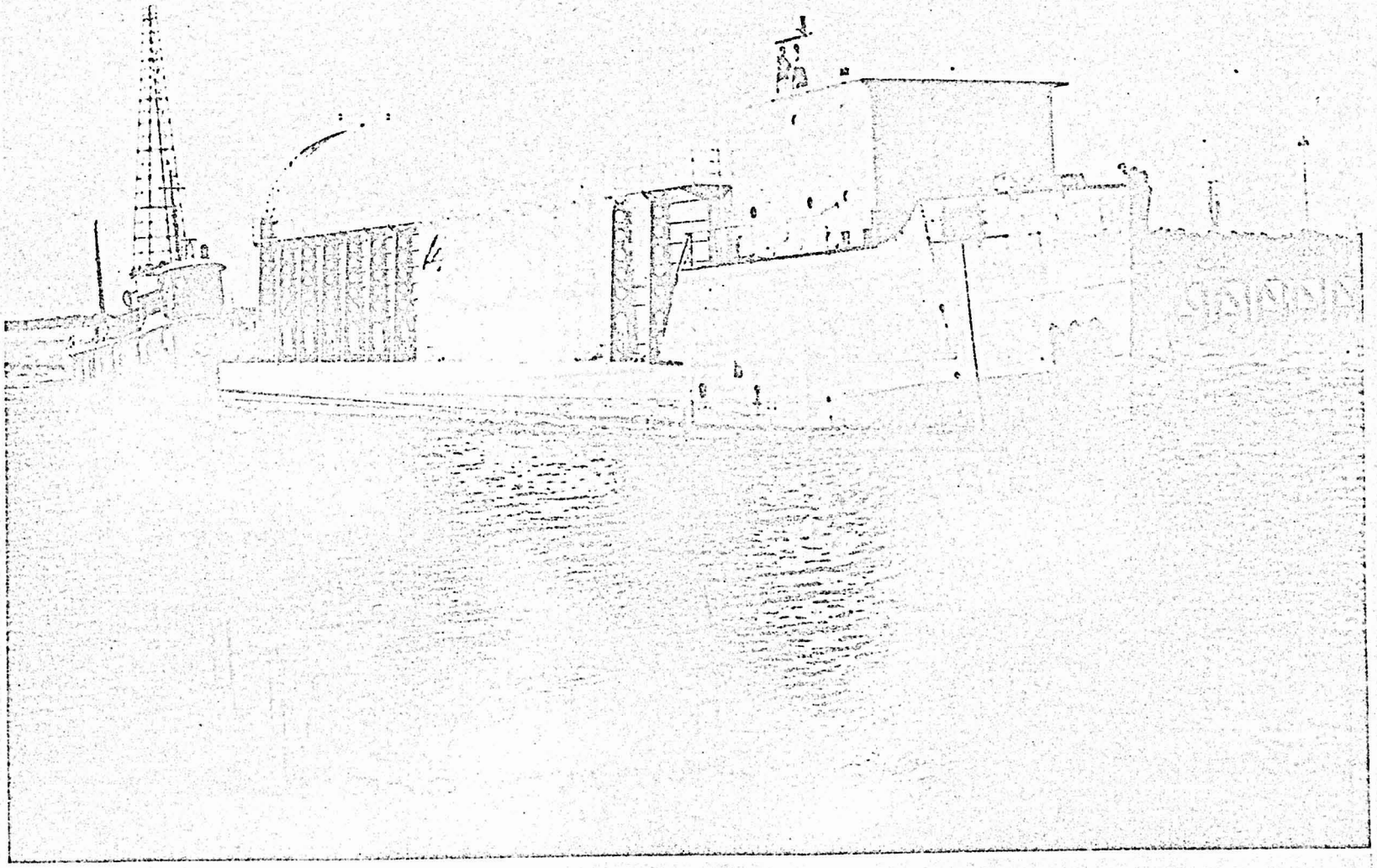

FIGURE 4-44. SATURN BARGE

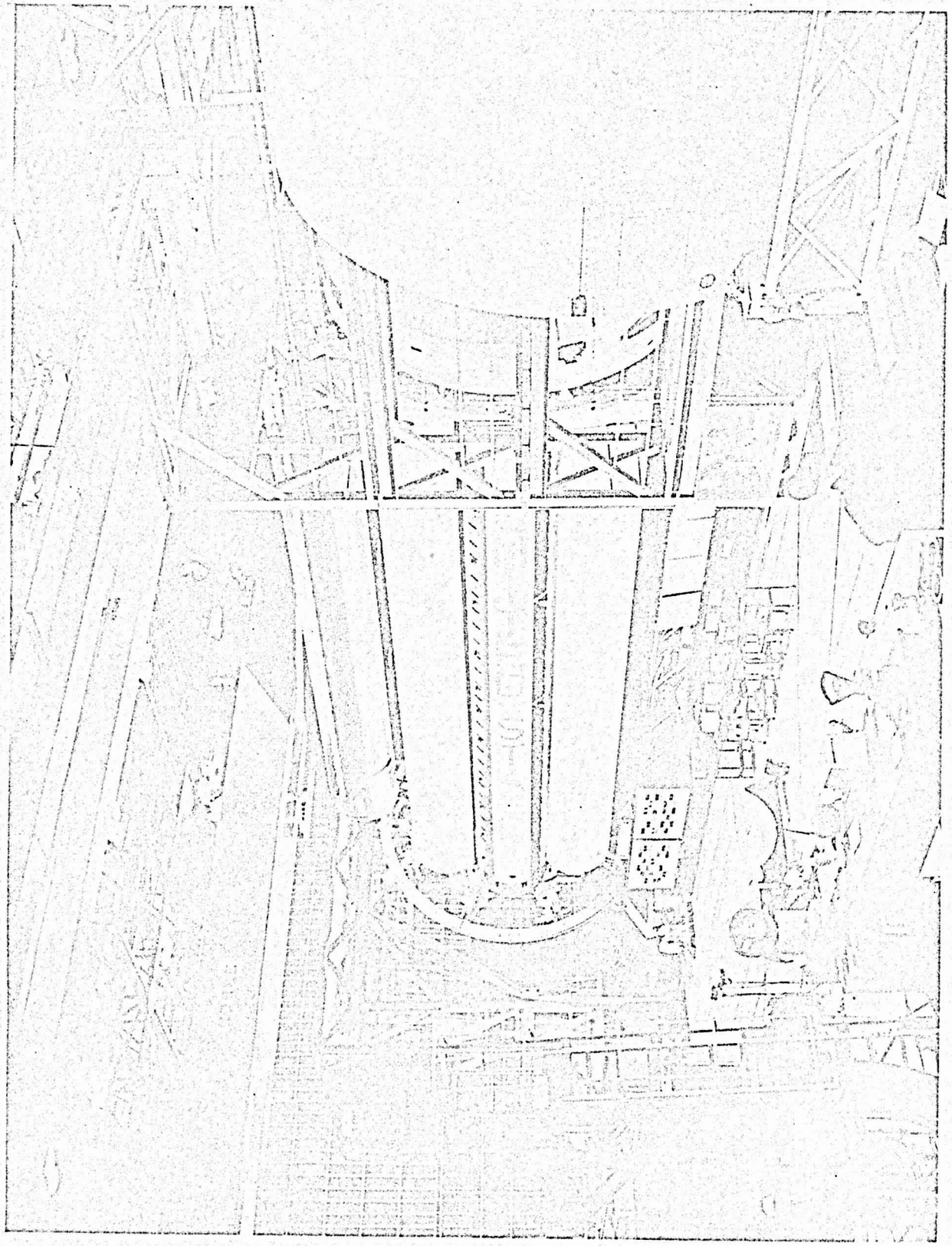

FIGURE 9-20. ASSEMBLY OF FLIGHT BOOSTER