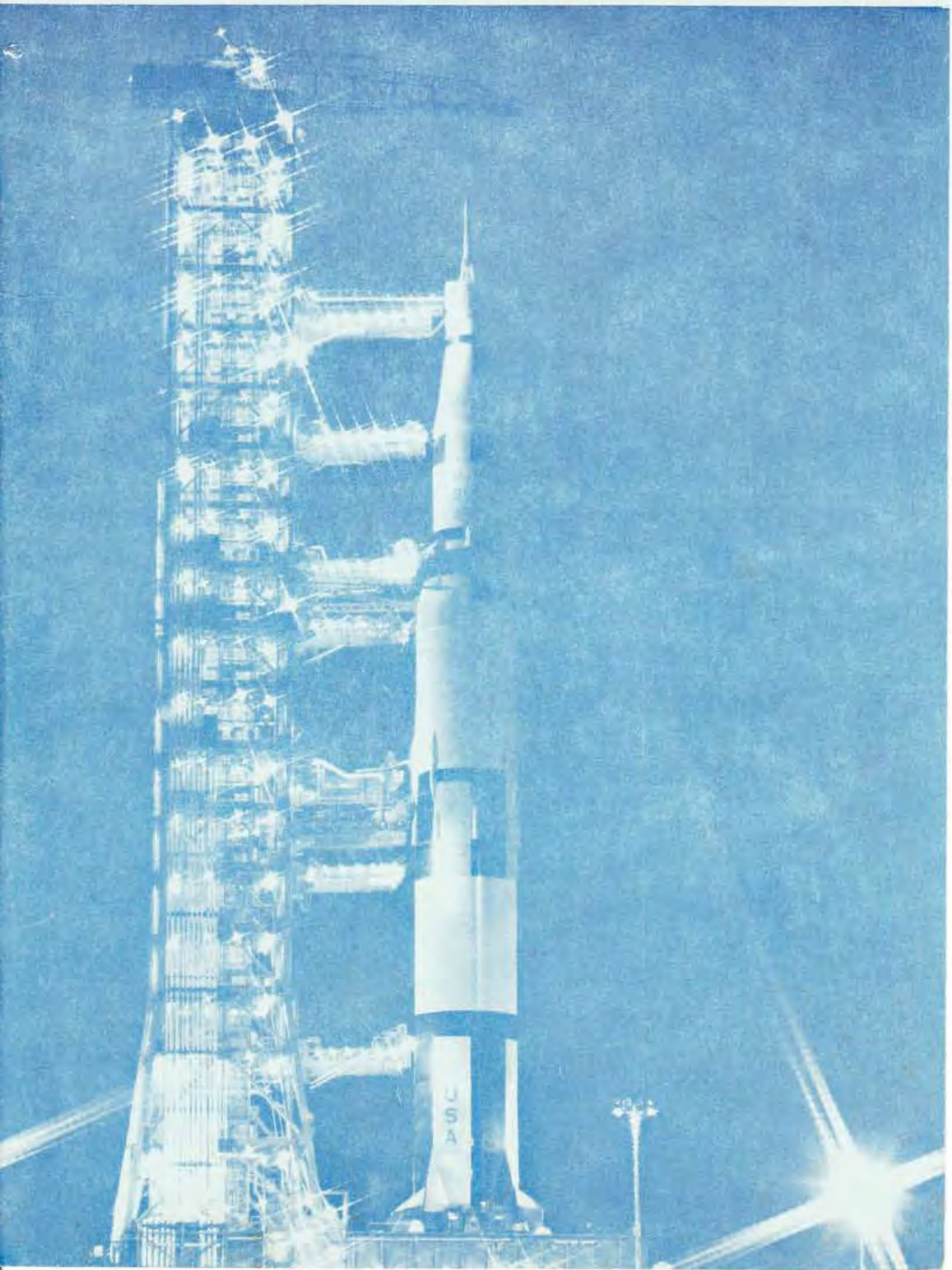
Welcome to
LAUNCH VEHICLE OPERATIONS
John F. Kennedy Space Center



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Welcome to Kennedy Space Center and to the Launch Vehicle Operations Directorate.

You are now an integral part of the greatest team ever assembled to explore and eventually to conquer the immensity of space and time. Your efforts in every aspect of your work will contribute to the benefit of your country and all mankind. Consequently, we feel that it is our duty to start you in the right direction by acquainting you, through this handbook, with some of the things you should know in order to make a swift adjustment to your new job and a lasting contribution to the team effort.

As you begin to adjust to your new surroundings, you are going to find questions this handbook does not attempt to answer. Feel free to contact your supervisor or your LVO administration personnel, Technical Planning and Support Office, for help. We wish you the best of luck in your new efforts, and look forward to a long and productive association.

H. Gruene
Director, Launch Vehicle Operations

INTRODUCTION

This handbook is for use in your program of orientation in the Launch Vehicle Operations Directorate at the Kennedy Space Center. Its purpose is to acquaint you with our history, organization, and operation. No attempt has been made to provide a comprehensive insight into all the various parts of our organization and our operating methods. Rather, our intent is to furnish you a general background that could previously only be obtained through years of experience. We hope you will find it an informative and accurate portrayal of LVO 'as it really is.'

The next section, History, provides an insight into our origins and some of the past accomplishments which have helped to make us traditionally 'success-oriented.' You will find that most of us feel individually responsible for the quality and technical accuracy of all areas of our work. Section three provides a view of our organization in perspective with the NASA-Headquarters and Kennedy Space Center functional charts. Brief summaries are given for each of our groups to the Branch level, and more information is available on request.

The philosophy of our Civil Service/Contractor launch team interface is outlined in Section four, and an effort has been made to convey the depth and meaning of our close inter-relationships. Our present launch philosophy depends on the quality of our teamwork, and this section deserves particular attention.

The KSC facilities, flight hardware, and checkout operations which concern us most directly are the topics of sections five and six. These areas will present, for Launch Vehicle Operations, the most pressing technical issues, for your understanding and daily attention. You can expect to develop a detailed knowledge of most of the operating areas within your technical discipline, and an overall feel for the problems and requirements encountered in the checkout and launch of a large-scale space vehicle system.

Section seven is devoted to the documentation system you will encounter (if you haven't already) in your work with both the contractor and civil service organizations at KSC. Read it carefully—it provides a roadmap to understanding how we function and what is required of whom. Section eight, on Administration Policies and Practices, is similarly important—and more personally oriented. The numerous references are available in most of our branch and section organizations. You should try to get a quick look at a few of them during your program. Finally, our missions—both present and future—are presented in Section nine, rounding out your orientation.

During your first few months you will come across many acronyms and abbreviations which you will not understand. We use them freely in all our work, and you'll find that you quickly adopt them as a part of your daily vocabulary. When you encounter one you don't know, ask—or check the library for "Space Age Acronyms" and GP-589, "A Selective List of Acronyms and Abbreviations." Along this same line, although we are limited in this handbook to a minimum of detail, sources are identified by document number for each major topic area. Use this book as a handy reference, and if you are unable to find the information you need, by all means ask someone!

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Early NASA. The National Aeronautics and Space Administration (NASA) came into existence on October 1, 1958, created by an act of Congress and signed into law by President Dwight D. Eisenhower. The organizational nucleus of NASA was the National Advisory Committee for Aeronautics, which already employed 8,040 personnel in four facilities. These were the Langley, Ames, and Lewis Research Centers, and the Flight Research Center at Edwards Air Force Base. Also immediately transferred to NASA were several space programs from Defense Department's Advanced Research Projects Agency, including five space probes, three satellite projects, and several rocket engine development programs. Various activities under Air Force and Army control also went into NASA. In addition, the Vanguard Project and 200 personnel from the Naval Research Laboratory brought their expertise into the new national agency. The Jet Propulsion Laboratory of the California Institute of Technology became a contract agency in December, 1958.

The goals of the Space Act which created the new agency were to: (1) Expand human knowledge of the atmosphere and space; (2) Develop new, and improve existing, aeronautical and space vehicles; (3) Perform long-range studies of the benefits and problems expected in aeronautical and space activities; (4) Maintain the United States position as a leading nation in aeronautical and space science; (5) Share acquired information with potential military application with the appropriate agency; (6) Cooperate with other nations in peaceful applications; and (7) Combine existing facilities and personnel to avoid duplication of effort.

Dr. T. Keith Glennan was appointed the first NASA Administrator. He was succeeded by Mr. James E. Webb, who directed NASA for eight years, until his retirement in October, 1968. Dr. Thomas O. Paine, who had replaced Robert C. Seamans as Deputy Administrator, became Administrator in March 1969. Dr. Paine announced in July 1970 that he would resign from this position effective September 1970. In March 1971, the U.S. Senate confirmed President Nixon's appointment of Dr. James C. Fletcher as the present Administrator of NASA.

The new agency's first efforts were focussed on solving problems of organization and facilities, formulating long-range goals, and ensuring the progress of on-going programs. NASA was the largest organization ever created by the transfer of existing government projects. During its first few years NASA grew faster than any agency in United States history, expanding from 8,000 to 16,000 personnel in its first 28 months. The detailed story of NASA's formative years may be found in a small booklet, EP-29, "Historical Sketch of NASA," prepared by the NASA Historical Staff.

Launch Vehicle Operations (LVO). The present Launch Vehicle Operations organization was formally chartered in 1963. However, as early as 1952, many of our personnel were working at what was then Cape Canaveral in the checkout and launch of early Redstone and Jupiter weapon system missiles under the Army Ballistic Missile Agency's (ABMA) Missile Firing Laboratory (MFL). Headquartered at the Redstone Arsenal in Huntsville, Alabama, early launch teams traveled frequently, making only a temporary home in the Cape area. Then, as the program grew, more permanent assignments were made to what would eventually become the forerunner of the Kennedy Space Center.

On July 1, 1960, the NASA George C. Marshall Space Flight Center (MSFC) was established in what had been the Army facilities at Huntsville, Alabama. The Army Ballistic Missile Agency was transferred to NASA at that time, and its director, Dr. Wernher von Braun, became MSFC's first

FIRST AMERICAN IN SPACE ABOARD A MERCURY-REDSTONE, 5-5-61 director. The 4,600 personnel who joined NASA included a contingent of German scientists who had been active in rocket development for over two decades. The Huntsville team had already gained experience in building and testing the V-2, Redstone, Jupiter, Jupiter-C, Juno, and Pershing missiles. On January 31, 1958, prior to the establishment of NASA, they had placed the first U.S. satellite, EXPLORER I, in orbit. They had also started development work on the Saturn I vehicle. On May 5, 1961, they launched the first American into space aboard a Mercury-Redstone vehicle.

The NASA Launch Operations Directorate (LOD) was established at Cape Canaveral, Florida, on July 1, 1960, as a subdivision of MSFC. It replaced the old Army Missile Firing Laboratory. The Air Force Atlantic Missile Range, which had supported the launch of military vehicles from the Cape since 1950, supported the new civilian agency on its first launches. Two years later LOD became an independent Center, the Launch Operations Center (LOC), under the direction of Dr. Kurt H. Debus. It was renamed the John F. Kennedy Space Center on November 29, 1963, in honor of the late President of the United States.

The first semi-permanent Launch Operations Center organization, put into effect in May of 1963, established, among other functions, that of the present Launch Vehicle Operations, under the direction of Dr. Hans F. Gruene. At first the personnel of this division reported to Dr. von Braun at MSFC for technical and engineering functions related to the launch vehicles, and to Dr. Debus at LOC on launch operations and administrative matters. The philosophy behind this double-reporting arrangement was that the launch team should be involved in the development phase of the vehicle as well as its operational phase. Operational and launch considerations had to be determined early in the basic design.

Saturn/Apollo. In May of 1961 President Kennedy announced the U.S. would attempt to fly men to the moon and back within the decade. Launch vehicles far larger than anything on the drawing boards would be required, and new launch facilities would be needed. Dr. Debus and Air Force General Leighton I. Davis performed a study for a new launch center location, eventually deciding on Merritt Island, Florida, adjacent to the then Cape Canaveral Air Force facilities. This area, the present John F. Kennedy Space Center, became totally NASA-controlled, separating the civilian and military manned space flight programs.

The increased size of the new and larger vehicles, namely the Saturn V, dictated new and more complex facilities. Dr. Debus and others worked on preliminary designs incorporating a totally new launch configuration, the Mobile Launch concept. The Saturn V was to be assembled and checked out on a Mobile Launcher (ML) inside the protected environment of a giant structure called the Vehicle Assembly Building (VAB). The complete vehicle and its launcher was then to be moved to the pad for final checks, fueling, and launch.

Giant dredges began preparing a channel into the selected area in November of 1962, and ground was broken for the VAB in August of 1963. In keeping with the number system established by the Air Force at Cape Canaveral, the new facility was designated Launch Complex 39 (LC-39). Work had already started on the first buildings in what was to become the industrial area of KSC, five miles south of the launch area. While the construction proceeded the flight development program of the Saturn I vehicle continued. The first U.S. manned space flight program, Mercury, was safely and successfully concluded, and planning began for the two-man Gemini space flights.

Over three years were required to build the giant facilities needed for the new class of launch vehicles. The first Saturn V rocket, complete except for rocket engines, entered the test cycle at KSC in January 1966. It emerged for its trip to the launch pad in May, just five years after President Kennedy had established the goal of a man on the moon before 1970. The Gemini program was under way on the existing Cape facilities, and the first flights of the Apollo program being planned for the Saturn IB vehicles. A steady series of scientific and planetary exploration satellites were being launched by unmanned vehicles. The U.S. space program had grown very large and complex, with activities in many concurrent areas. The culmination of most of them was the launch of a space vehicle from KSC. A history is available in "The Kennedy Space Center Story," published by the Public Affairs office at KSC.

The first Saturn V flight vehicle, AS-501, was launched from Pad A at Complex 39 on November 9, 1967. Other launches, including two in which three astronauts orbited the moon and returned, followed. And on July 16, 1969, AS-506 lifted off with astronauts Armstrong, Aldrin, and Collins. The successful completion of their mission fulfilled the late President Kennedy's pledge that the U.S. would land a man on the moon before 1970.


APOLLO/SATURN LIFTOFF

ORGANIZATION

The position of LVO within the structure of NASA can best be illustrated by charts. NASA, as explained in the history section, is a U.S. Government agency, and its administrator reports to the President. The national headquarters organization is in Washington, D.C. The first chart shows the basic structure of NASA. You will note that KSC is under the Office of Manned Space Flight (OMSF), along with the Marshall Space Flight Center (MSFC) at Huntsville, Alabama, and the Manned Spacecraft Center (MSC) at Houston, Texas. This office is headed by Mr. Dale Myers, Associate Administrator for Manned Space Flight, who reports to the NASA Administrator, Dr. James C. Fletcher.

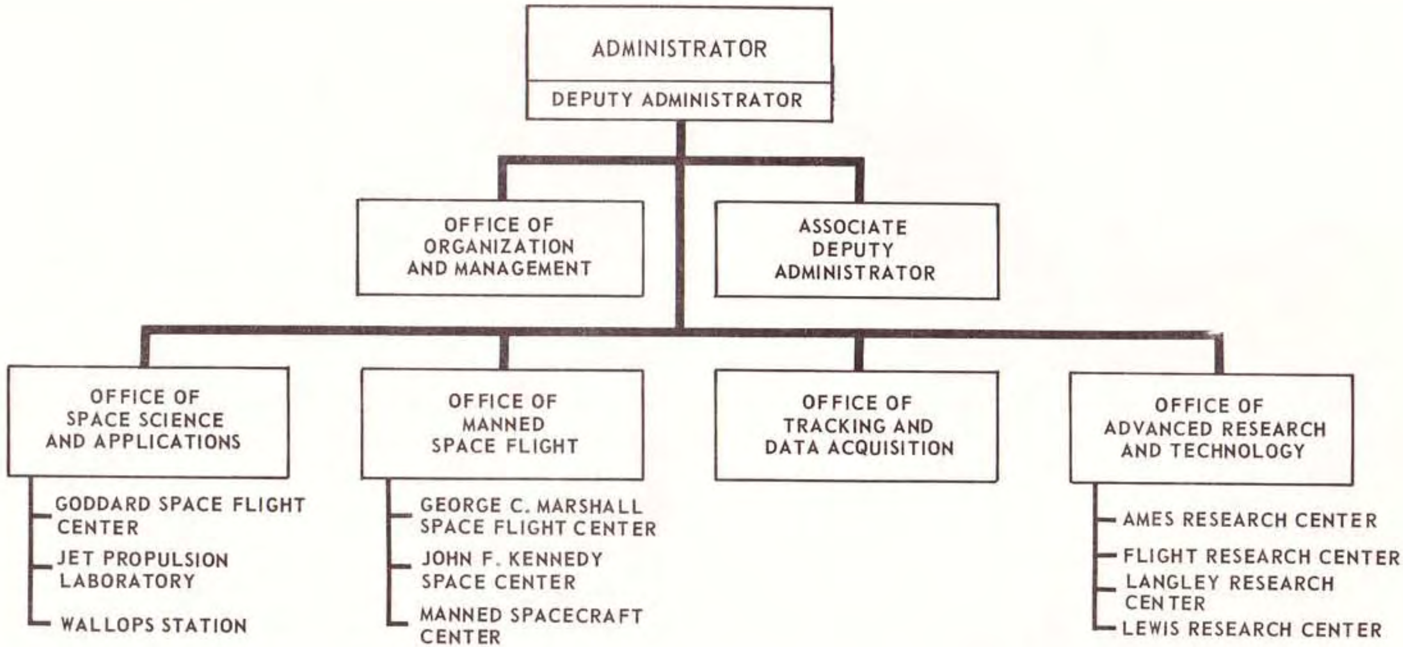
The second chart shows the basic structure of KSC. Dr. Kurt Debus, the Center Director, reports to Mr. Myers. At KSC Dr. Debus is responsible for overall management of the Center. This includes administrative functions, the design, construction, and maintenance of launch facilities, the checkout of all vehicle stages and spacecraft, and the launch of assembled space vehicles. KSC maintains close relations with the Air Force Eastern Test Range, coordinates its activities with those of its sister Centers in OMSF, and maintains working relationships with the other NASA Centers.

The third chart shows a breakdown of the Launch Operations (LO) Directorate at KSC. LO, under the direction of Mr. Walter Kapryan, is responsible for the checkout and launch of NASA flights from KSC. LVO is one of three 'second level' directorates under LO. LVO handles all stages of all vehicles rated for manned flights. At present this consists of the three Saturn V stages and two Saturn IB stages. Spacecraft Operations handles all spacecraft associated with manned space flight programs. This was Mercury and Gemini in the past, and Apollo and Skylab at present. Unmanned Launch Operations handles both spacecraft and vehicles for unmanned programs, such as the Orbiting Astronomical Observatory series, the Mariner interplanetary probes, and the various weather and communications satellites.

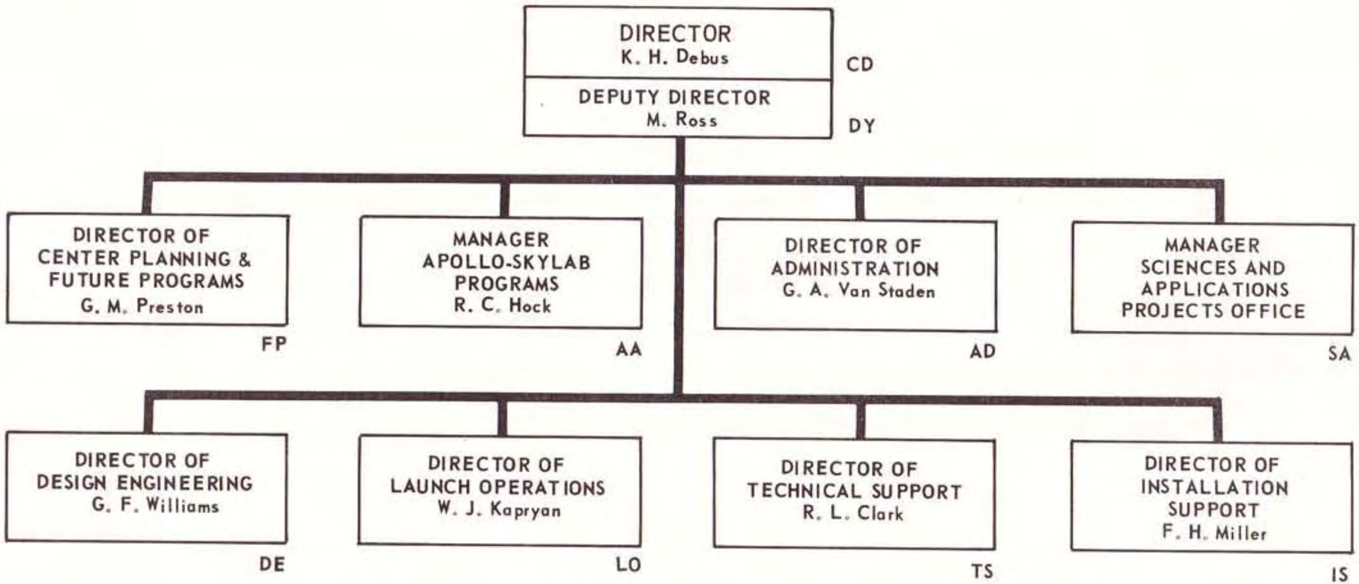
The fourth chart shows LVO down to the branch level. Dr. H. Gruene is Director and Mr. I.A. Rigell is Deputy Director and Chief Engineer. The directorate consists of four operating divisions and four offices, plus a systems engineering staff. The latter reports to the Deputy Director of LVO. Primarily this organization brings specialized knowledge and experience to bear when troubleshooting the complex problems which develop during checkout operations.

Three of the four operating divisions have primarily technical responsibilities. They are in charge of the actual testing, modifications, checkout and launch preparations for the hardware for their specific disciplines.

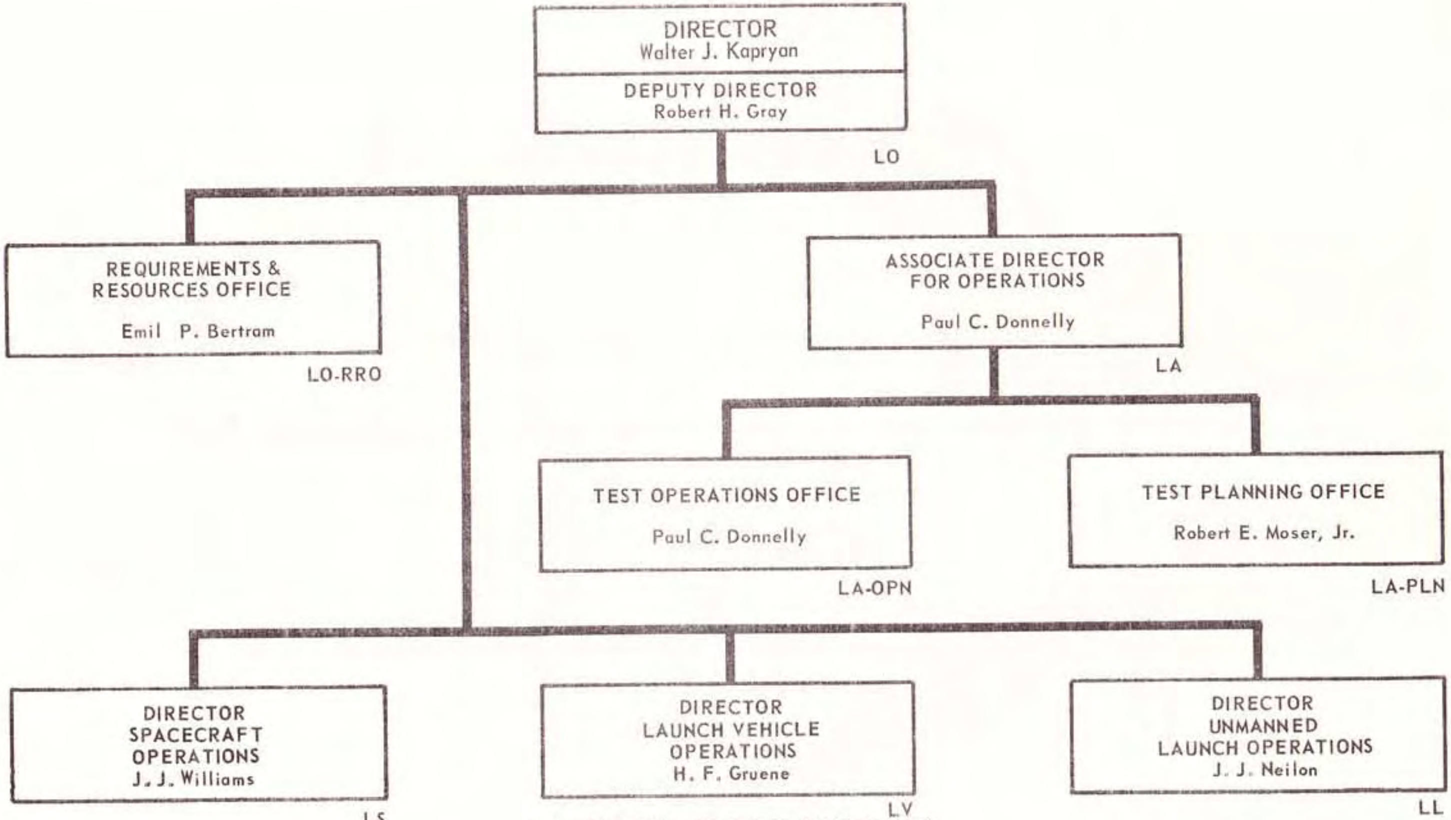
The Launch Instrumentation Systems Division, LV-INS, is responsible for on-board telemetry (TM) systems, in-flight measuring equipment, and radio frequency (RF) transmitters. This group also handles ground-based measuring systems. These consist primarily of the Digital Data Acquisition System (DDAS), and the receiving station for vehicle TM data. The primary breakout of work within LV-INS is between the RF and TM systems and the measuring equipment, as the chart shows.



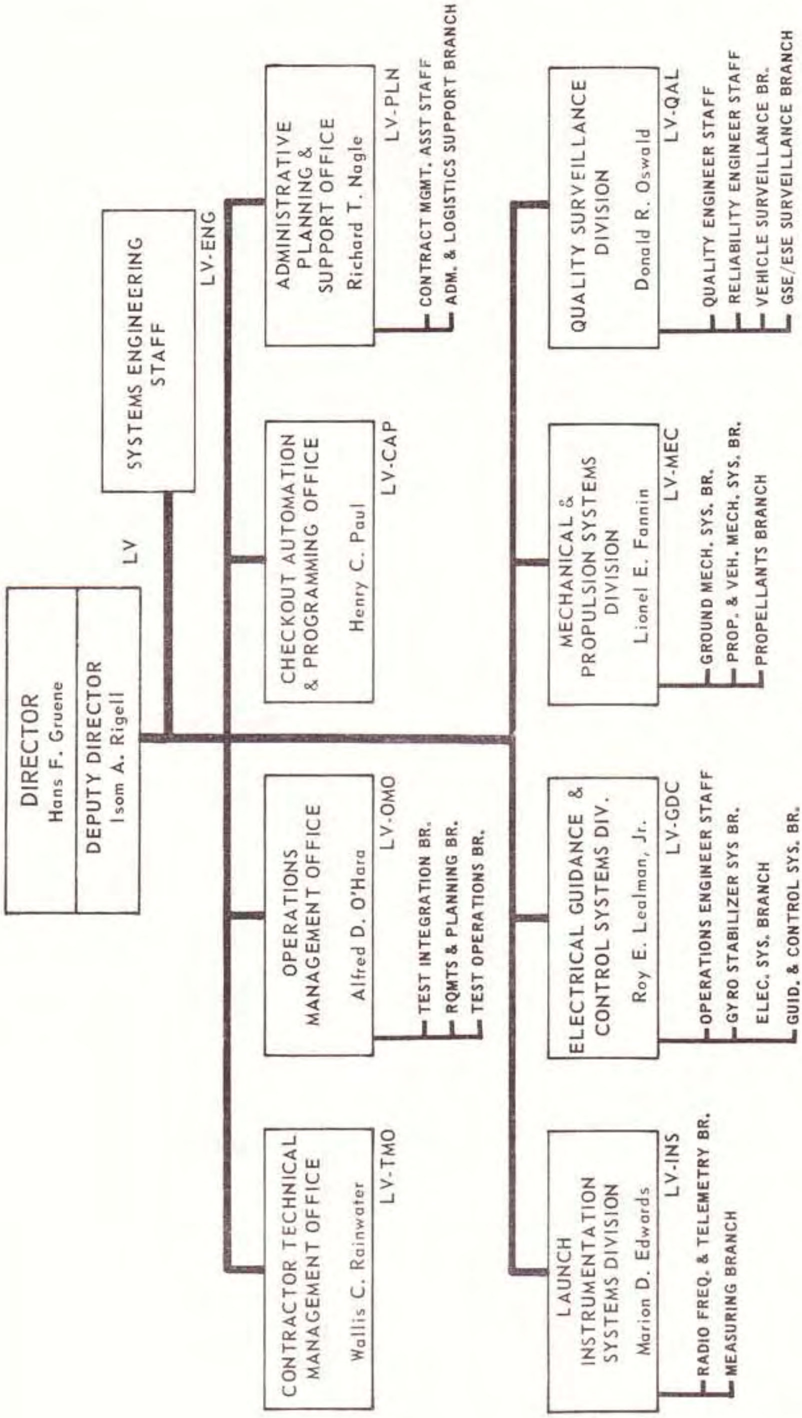
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



JOHN F. KENNEDY SPACE CENTER, NASA



LAUNCH OPERATIONS



LAUNCH VEHICLE OPERATIONS

The Electrical Guidance and Control System Division, LV-GDC, covers the remaining on-board electrical equipment. Cabling, power, batteries, flight computer, gyros, and engine gimballing controls are the main areas of concern. LV-GDC is also responsible for most of the ground electrical systems associated with vehicle checkout. Firing room panels, the RCA-110A computer used in automated testing, the ML and Firing Room relay racks, and the power supplies, all fall under LV-GDC. As shown on the chart, there are three branches under LV-GDC, assigned the responsibility for the functional systems of Gyros, Flight Controls, and Electrical Systems.

The Mechanical & Propulsion Systems Division, LV-MEC, manages all LVO mechanical tasks. These include the launch vehicle systems of pneumatics, engines, propellant tanks, valves, and associated Ground Support Equipment (GSE), such as the Environmental Control Systems (ECS), hydraulics, and pneumatics. LV-MEC is also responsible for the mechanical portion of the propellant loading system; cryogenic transfer lines, pumps and valves; and those mechanical ML systems which interface directly with the vehicle. Some of these are the service arms, umbilicals, and holddown arms. This division is divided by task functions into branches dealing with Propellant, Vehicle Stage, and various Ground Systems.

The fourth operating division, LV-QAL, is charged with assuring that acceptable standards of quality are maintained in workmanship, test specifications, and standards. They must also ensure that modification instructions which must be followed by LVO contractors are adhered to. LV-QAL is also responsible for the reliability function.

The remaining four offices on the chart provide the functions of administering, coordinating and integrating the efforts of the operating divisions. LV-CAP is charged with the automation of testing and launch vehicle checkout, to the extent feasible. LV-PLN provides administrative support, including handling of personnel matters, logistics and supply, and budgeting. LV-TMO is the assigned official interface for LVO when dealing with contractors. The Contract Technical Managers (CTMs) within LV-TMO are empowered to speak for NASA when performing their official functions.

The Operations Management Office (LV-OMO) coordinates the test and checkout activities as defined in an integrated checkout schedule. The LV-OMO organization includes the Test Conductors who direct the operation and the personnel who prepare and process test and checkout procedures (TCPs). There is also a group which coordinates LVO requirements for support from other KSC directorates.

Each organizational element within LVO is specialized and responsible for a particular system or related group of systems. For additional detail and functional statements, see KN 1142.12.

CONTRACTOR RELATIONS

The national space program is a joint undertaking of the Federal Government and the aerospace industry. Contractors receive more than 90% of the NASA budget. This unique welding of Government and contractor organizations is well demonstrated at KSC, where integrated teams perform complex launch missions.

The Apollo Program engages more of the Center's resources than any other activity. The contractors who are involved with Saturn vehicle stages and Apollo spacecraft comprise about half the total KSC manpower, and each is responsible for his product from design through flight performance. In some areas NASA pays its contractors incentive fees over and above audited costs, adjustable according to the performance of the stage in launch preparations and flight.

MSFC supervises contractors building the Saturn 1B and Saturn V vehicles. Chrysler fabricated the first stage of the Saturn 1B, and Boeing the first stage of the Saturn V. North American Rockwell built the second stage for Saturn V, and McDonnell Douglas the S-IVB, which forms the second stage for the 1B vehicle and the third stage for the Saturn V. International Business Machines built the Instrument Units for both. At KSC all the contractors assist in checking out, assembling, testing and launching the two vehicles.

In order to balance the contractor effort and maintain operating schedules, clear-cut interfaces must be established. Very frequently more than one contractor must work in the same place at the same time. Only NASA can legally instruct the separate contractors, although their work must be interwoven and coordinated in fine detail. This is accomplished by publishing detailed schedules, which spell out what each contractor will be doing in the launch vehicle and spacecraft, and at what time. These work schedules are planned and adjusted in frequent meetings, chaired by NASA.

Each contractor at KSC reports to the Center organization having primary interest in his performance. Saturn Vehicle stage contractors operate under the supervision of the Director of Launch Vehicle Operations. Contractors involved in technical communications, instrumentation and launch support receive guidance from the Director of Technical Support. (The latter include Bendix, in charge of a variety of primarily mechanical launch support services, Federal Electric, in communication, instrumentation and data receiving and recording, and General Electric, which provides the Acceptance Checkout Equipment system (ACE) and other electronic equipment support.) North American Rockwell also supplies the Apollo Spacecraft, and Grumman Aerospace provides the Lunar Module. Both report to the Director of Spacecraft Operations under these contracts. In addition Boeing, under a separate contract, provides basic support as the Center's housekeeper, including a wide variety of services not directly related to the launch activities. Pan American World Airways furnishes support to the Design Engineering directorate. A host of contractors provides support in other areas, including spacesuits, guidance systems, and simulator operation for astronaut training. In addition, the Unmanned Launch Operations Directorate has a group of contractors which support the checkout and launch of unmanned scientific and technical spacecraft.

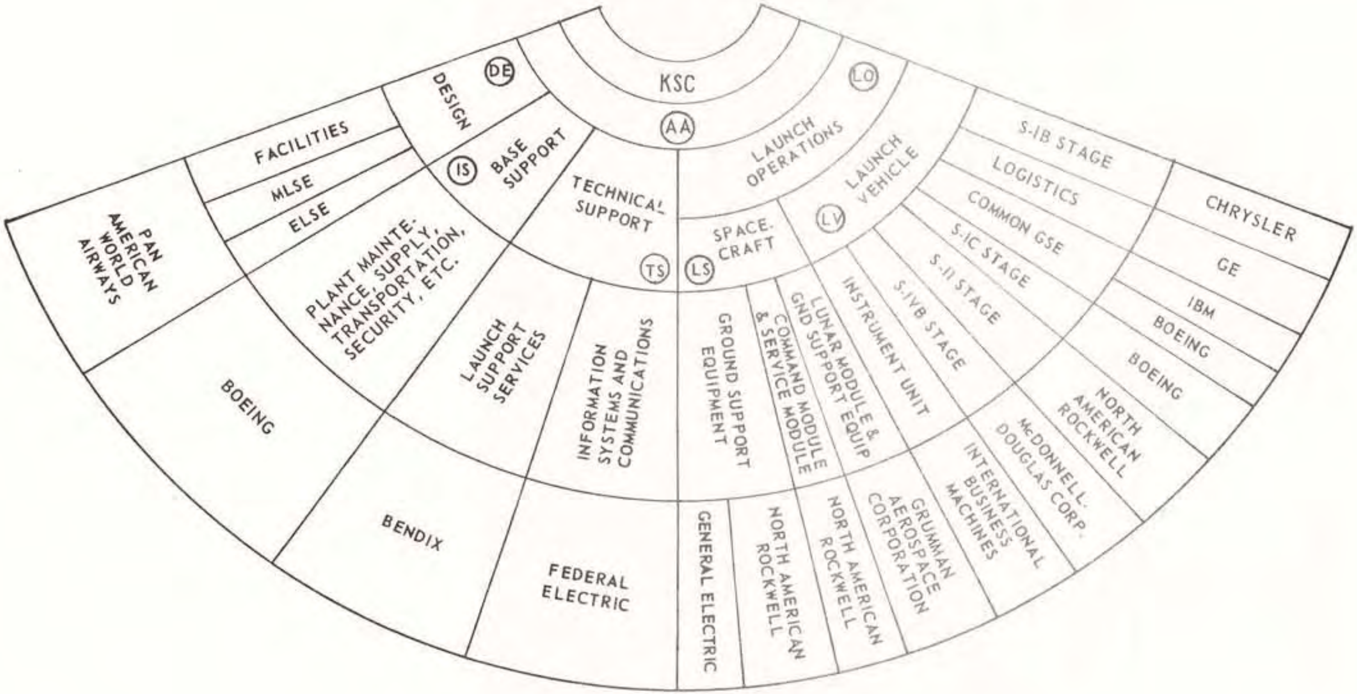
KSC Director Dr. Kurt Debus regularly schedules Government-contractor staff meetings to facilitate communications between Center managers and the prime contractors. Membership includes the KSC senior staff and the contractor base managers. They meet frequently to discuss mutual concerns in a completely frank atmosphere.

The Apollo Program is the largest, most dispersed, and most complex scientific and exploratory project ever attempted. Apollo makes the building of the pyramids, and other wonders of history, seem small by comparison. The program draws upon a far wider spectrum of talents than any other peace-time effort in world history. Apollo has created an intimate and potentially significant new sociology involving government, university, and industry. The approach is midway between the old 'arsenal' concept used by the Army and Navy, and the 'systems' idea developed by the Air Force. In the latter, private corporations manage, develop, and build complete weapon systems. The NASA approach combines certain advantages of each, while drawing upon the total abilities of both private and government organizations. The contracting firms contribute research capabilities, manufacturing facilities, and some technical expertise, plus flexible staffing. The Government's role is generally an integrating and directing one. It also acts as a central fund of deep experience, and a point of transfer for knowledge, technology, and new management techniques.

The industry teams at KSC display an intense loyalty to their program objectives, accepting NASA as a directive agency second only to their own corporate management. In daily operations NASA and contractor personnel are virtually indistinguishable. Together they form an efficient, smoothly functioning team. Most personnel consider working in the space program the most fascinating job experience of their lives.

One of the major impacts of the Apollo Program may prove to be as much sociological as technical. This is the working out of techniques for directing the massed endeavors of scores of thousands of minds in a close-knit community of effort. This includes employees of Government, the contractors, and the universities; the latter contribute heavily to the scientific aspects of the space program. This ability to coordinate diverse elements and achieve a specific great goal has been limited in the past primarily to warfare. The completion of the Apollo Mission, a man on the moon just over eight years after that became a national objective, opens a new era. The management techniques that accomplished this have been called "potentially the most powerful tool in Man's history." (See "The Kennedy Space Center Story," Chapter XVII.)

KSC APOLLO/SATURN TEAM



KSC NASA/Contractor Functional Relationships

Launch Complex 39. LC-39 is the KSC assembly, checkout, and launch facility for Saturn class vehicles and payloads. The vehicle stages are assembled vertically on the Mobile Launcher (ML) and mated with a spacecraft or other payload. The assembly operations and most of the checkout are performed in the Vehicle Assembly Building. A large tracked vehicle called the Crawler-Transporter (C/T) lifts the ML and assembled space vehicle (unfueled) and transports them as a unit to the launch pad. Other major elements of the launch complex are the Power Substation, Launch Control Center (LCC), the crawlerway on which the C/T moves while transporting the ML/space vehicle, and the Mobile Service Structure (MSS).


VAB, LCC, ML'S & TURN BASIN

Vehicle Assembly Building. The VAB is 525 feet high, 518 feet wide, 716 feet long, and covers 8 acres of ground. It contains 129 million cubic feet of space and provides a protected environment for the receipt and checkout of the stages of the Saturn V vehicles. The VAB is divided into two major areas, the high and low bays. A 92-foot-wide transfer aisle extends the length of the building. The low bay area provides the facilities for preliminary checkout and preparation of the S-II and S-IVB stages, and the high bay for the erection and checkout of the S-IC stage. The high bay contains four checkout bays, three of which have been outfitted and activated. For the Saturn V, an ML is brought into one of the bays, the S-IC stage is erected on it, and the S-II and S-IVB stages, and the Instrument Unit (IU), are stacked on the S-IC. Just prior to rollout, the spacecraft is mated to the launch vehicle, and the heavy ordnance is installed throughout the vehicle. The Saturn 1B vehicle will be handled in a similar manner.

Floors of office space rise alongside the high bays and portions of the low bays. These are used primarily by stage contractors to house checkout instrumentation and for general office space.

Launch Control Center. The LCC is the focal point for control and monitoring of space vehicle checkout and launch. The LCC is connected to the VAB by an enclosed above-ground walkway. Both buildings are far enough away from the launch pads (minimum of 3-1/2 miles) so that heavy construction for protection against a possible explosion at the pad is not required.

The LCC is a four-story structure, with the ground floor devoted primarily to offices and service areas such as the cafeteria. The second floor houses telemetry, data retransmission, and data recording equipment. The third floor divides into four separate control sections, each containing a firing room, computer room, mission control room, and a visitor gallery. Three of the firing rooms have been equipped and activated, and the fourth is utilized for program control functions. An active firing room is assigned to a specific space vehicle from the time it enters the VAB until launch. The fourth floor contains firing room display equipment and miscellaneous operating units.

Power requirements in the VAB and LCC are extensive, and are met by two separate systems, industrial and regulated industrial. The regulated industrial supplies the instrumentation systems and is designed to protect them from the adverse effects of switching transients, large cycling loads, and intermittent motor start loads. The unregulated industrial services power systems with less stringent requirements. Communication and signal cable troughs extend from the LCC via the enclosed above-ground walkway to each ML location in the VAB.


CRAWLER-TRANSPORTER

Crawler-Transporter. The C/T is a tracked vehicle capable of supporting the almost 19 million pounds of C/T, ML, and space vehicle and connects the pads to the VAB. The C/T also moves the MSS to a parking site alongside the crawlerway, 7,000 feet from Pad A, when it is not in use.

The C/T operates in either direction from control cabs located at each end. The adjustable deck keeps the ML or MSS vertical while they are traversing the pad access 5-percent grade ramp. The C/T moves at 2 miles per hour unloaded, 1 mile per hour loaded, and 1/2 mile per hour when climbing the ramp with a full load.

Mobile Launcher. The ML is a transportable two-story platform 25 feet high, 160 feet long, and 135 feet wide, equipped with an umbilical tower 380 feet high. The space vehicle (SV) is assembled on the platform on supports centered around a 45-foot-square opening for engine flame exhaust. The opening extends through both floors. The umbilical tower provides horizontal service arms for access to important levels of the vehicle during assembly, checkout, and servicing. The service arms also hold and route the cables and conduits that provide the flow of essential services and information between the SV and the GSE, from the time the arms are connected to the vehicle until launch.

The umbilical tower has two high-speed elevators, which service 18 landings, and which can be controlled from the firing rooms for emergency astronaut egress. The tower also contains distribution equipment for the propellant, pneumatic, electrical, and instrumentation subsystems, as well as other GSE. A 25-ton hammerhead crane tops the structure and can be operated by remote control from numerous locations on the ML.

MOBILE LAUNCHER & MOBILE SERVICE STRUCTURE AT THE PAD

Mobile Service Structure. The MSS provides access to those portions of the space vehicle which cannot be serviced from the ML while at the launch pad. It is emplaced by the C/T in the same manner as the ML, and sits opposite it on the pad. The MSS is 402 feet high and weighs 12 million pounds. It contains five work platforms, with the lower two vertically adjustable. The outboard sections swing open and close again around the vehicle, and the second and third from the top are enclosed to provide environmental control for the spacecraft.

Launch Pad. There are two launch pads, A and B, at LC-39. Both are cellular, reinforced-concrete structures 42 feet high at maximum, and approximately 3,000 feet in diameter. A ramp with a 5-percent grade provides access from the crawlerway to the top of the pad. The C/T places the ML with the space vehicle in position on support pedestals at the pad, above a flame trench 58 feet wide and 450 feet long. A 700-ton mobile, wedge-shaped flame deflector is located within the trench. A two-story concrete building within the fill on the west side houses environmental control and pad terminal connection equipment. On the pad surface, elevators, staircases, and interface structures provide access to the ML and other equipment.

Launch Complexes 34 and 37. These two complexes on CKAFS were used for the assembly, checkout and launch of Saturn 1B vehicles. At these sites, the umbilical towers are permanently attached to the pad, and the service structures move on rails. The vehicle stages and payloads are assembled on the pad. LC-34 has one pad, while LC-37 has two pads but only one service structure. The LCC for each pad is a blockhouse, located within the perimeter fence, which has been structurally designed to withstand blast damage in case of an explosion. Spacecraft activities are monitored at each complex via cables which connect them to the Acceptance Checkout Equipment (ACE) at KSC. These complexes have been deactivated.

KSC Industrial Area. The industrial area is a large complex of buildings located 5 miles south of LC-39. Most of the functions required to support operations at the launch complex area are performed here. The industrial area is manned by NASA and contractor managers, engineers, technicians and other personnel.

Headquarters Building. This building is the management center of KSC. It contains the offices of the Center Director and his immediate staff; the Director of Administration; Chief Counsel; Public Affairs Office; Range Safety Staff; Director, Quality Assurance; Director, Safety Office; Manager, Apollo-Skylab Programs; and the Directors of Design Engineering, Installation Support, Technical Support, Support Operations, and Center Planning and Future Programs. Several KSC support contractors, including Boeing Support Operations, Pan American World Airways, and the Bendix Corporation, also occupy offices in the Headquarters Building. Service functions available include the KSC technical library, microfilm and film library, film processing laboratory, reproduction facilities, a U.S. Post Office, KSC internal mail service center, and a cafeteria. Four other government activities, the Marshall Space Flight Center, Defense Contract Audit Agency, NASA Regional Inspections Office and Regional Audit Office, and the U.S. General Accounting Office, also occupy offices in the building.

Operations and Checkout Building (O&C). This is the largest building in the Industrial Area. The directorates of Launch Operations, Launch Vehicle, and Spacecraft Operations are located here. This facility contains the S/C assembly and checkout areas, including two altitude chambers large enough to hold the Apollo Command Module (CM) and Lunar Module (LM). Living quarters, and medical and spacesuit facilities, are provided for the astronauts' use during their extensive operating, training, and test activities at KSC. This building also contains laboratories for malfunction analysis and for checking out radar, communications, environmental control, Apollo guidance and navigation, stabilization and control, and electrical power systems, as well as biomedical and flight experiments. The third and fourth floors house Acceptance Checkout Equipment, the primary system used in S/C checkout.

Central Instrumentation Facility. The CIF provides the major instrumentation and data processing operations at KSC. This facility operates ground instrumentation systems for telemetry, flight television, special-purpose RF systems, and launch data collection and retransmission to data users at KSC, MSC, and MSFC. The CIF also provides data reduction, storage, and presentation; scientific, general-purpose, and business computing; and engineering and development activities for instrumentation.

Fluid Test Area. This area contains special laboratories and testing facilities dispersed over a wide area south and east of the O&C Building. The dispersal is because of the hazardous pressure tests, pyrotechnic tests and installations, performed here on the spacecraft and Lunar Module, and modular subsystems of these spacecraft. Systems tested include hypergolics, cryogenics, and pyrotechnics. Special equipment of a potentially hazardous nature, such as the nuclear power unit of the Apollo Lunar Surface Experiment Package (ALSEP), is checked out and prepared for installation here.

Flight Crew Training Building. This facility, located east of the O&C Building, is operated by personnel from MSC. It provides simulation equipment with which the astronauts and MSC flight controllers perform practice runs. The building contains two CM simulators and one LM simulator.

Other Industrial Area Buildings. Numerous other buildings supplying various support services are located in the Industrial Area. These include cafeterias, warehouses, a fire station, security office, utilities, occupational health facilities, a Press Center, and others.

Shops and Laboratories. There are four main types of technical shops: electronic, electrical, machine, and mechanical. There are also facilities maintenance shops, and mobile technical shops that travel throughout the Center. Several types of laboratory support services are available.

Electronic Shops. These shops have facilities for the fabrication of electronic control panels, patch panels, chassis, consoles, distribution racks, breadboards, black-box prototypes, printed circuit boards, and welded electronic modules.

Electrical Shops. The electrical shops have facilities for the fabrication and assembly of power and instrumentation cables, harnesses, and related work. Field crews perform on-site installation, checkout, repair, and operation of electric motors.

Machine Shops. The machine shops have facilities for machining, milling, grinding, shearing, painting, baking, engraving, welding, and drilling operations, and for sheet metal fabrication.

Mechanical Shops. The mechanical shops maintain, refurbish, and fabricate mechanical devices. In addition, they are responsible for the operation of mobile heavy equipment used in transporting, erecting, and unloading boosters, assemblies, and associated space vehicle components.

Facilities Maintenance Shops. These shops perform the services required for plant maintenance, operation, repair, installation, inspection and minor alterations in the areas of carpentry, painting, sign painting, sheet metal, plumbing, welding, and air conditioning.

Calibration Laboratories. These laboratories provide instrument calibration, repair, cleaning, and maintenance. They also establish controls for periodic recalibration where necessary, maintenance of NASA and other standards, and calibration and certification of working standards. The central laboratory is located in the CIF, with several satellite locations in other areas. The laboratory facilities include specially shielded and environmentally controlled rooms, special instrument-cleaning equipment, and mobile calibration equipment.

Cleaning Laboratory. This laboratory, located in Building K7-516 at LC-39, provides precision cleaning of system hardware to any needed level. It is also responsible for cleaning in place those systems which cannot be disassembled for laboratory processing.

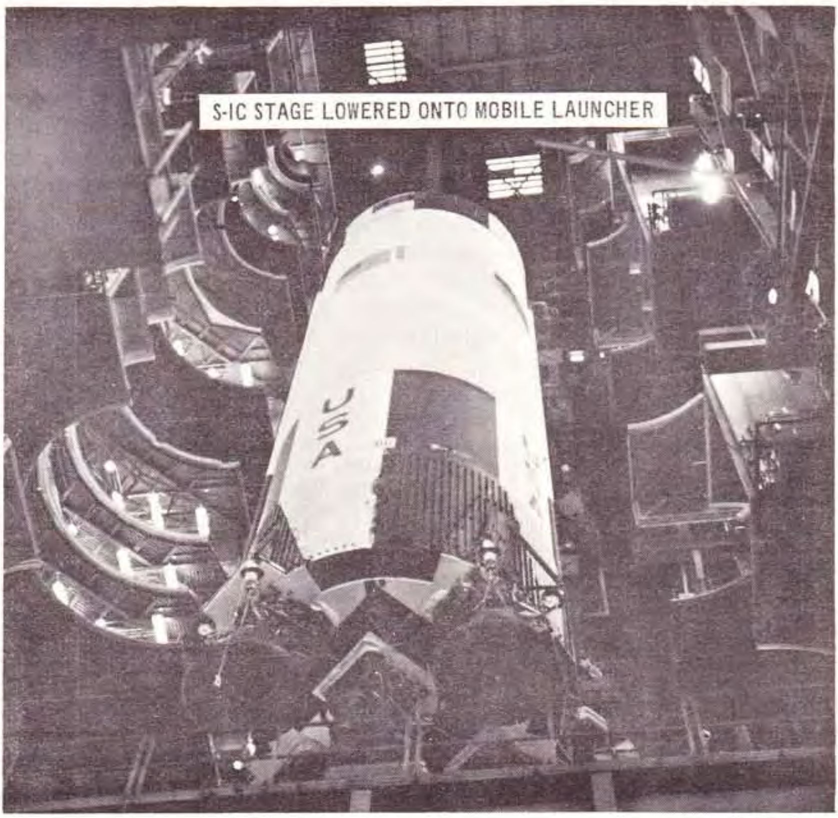
Materials Analysis Laboratory. This laboratory, located in Room 1233 of the O&C Building, provides malfunction analysis, chemical analysis, and materials testing.

FLIGHT HARDWARE AND CHECKOUT OPERATIONS

The primary flight hardware of the Apollo Program consists of a Saturn V Launch Vehicle and an Apollo Spacecraft. Collectively, they are designated the Apollo/Saturn V Space Vehicle (SV).

LAUNCH VEHICLE

The Saturn V Launch Vehicle (LV) is designed to boost the SV to an altitude of about 230,000 feet (approximately 38 nautical miles) and to provide for lunar payloads of over 100,000 pounds. The Saturn V LV consists of three propulsive stages (S-IC, S-II, S-IVB), two interstages, and an Instrument Unit (IU).



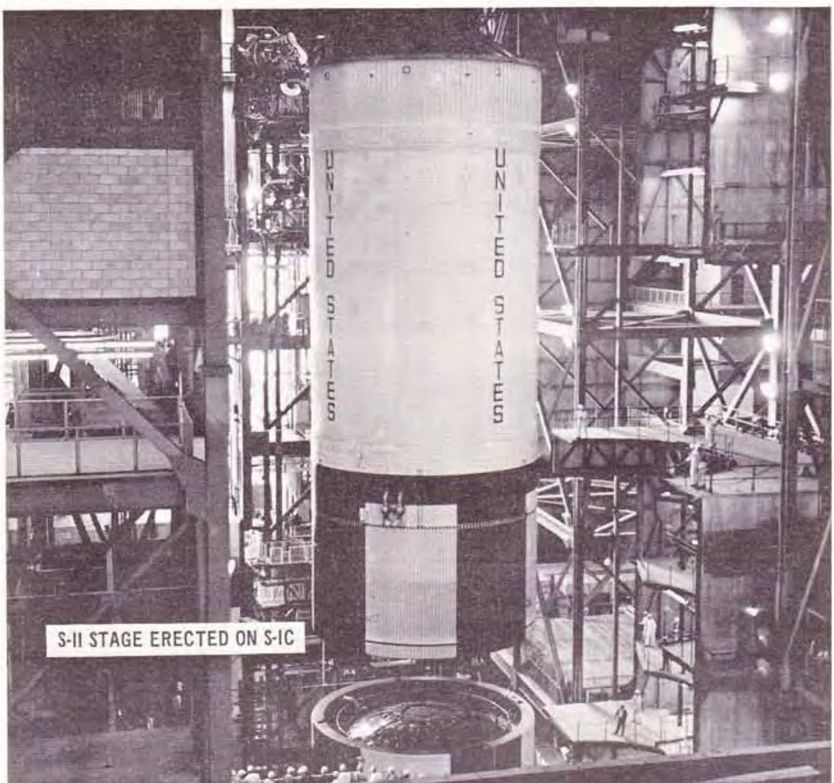
S-IC Stage. The S-IC stage is 138 feet long and 33 feet in diameter and is powered by five liquid propellant F-1 rocket engines. These engines develop a nominal sea level thrust total of approximately 7,650,000 pounds. The S-IC stage interfaces structurally and electrically with the S-II stage. It also interfaces structurally, electrically, and pneumatically with Ground Support Equipment (GSE) through two umbilical service arms, three tail service masts, and certain electronic systems by antennas.

The S-IC structural design reflects the requirements of F-1 engines, propellants, control, instrumentation, and interfacing systems. The major structural components are the forward skirt, oxidizer tank, intertank section, fuel tank, and thrust structure. The forward skirt interfaces structurally with the S-IC/S-II interstage.

The F-1 engine is a single-start, 1,522,000-pound fixed-thrust, calibrated, bi-propellant engine which uses liquid oxygen (LOX) as the oxidizer and Rocket Propellant -1 (RP-1) as the fuel. The four outboard engines are capable of gimbaling and have provisions for supply and return of RP-1 as the working fluid for a thrust vector control system. The engine contains a heat exchanger system to condition engine-supplied LOX and externally supplied helium for stage propellant tank pressurization. An instrumentation system monitors engine performance and operation.

The normal inflight engine cutoff sequence is center engine first, followed by the four outboard engines. Engine optical-type depletion sensors in either the oxidizer or fuel tank initiate the engine cutoff sequence.

The electrical power system of the S-IC stage consists of two basic subsystems: the operational power subsystem and the measurements power subsystem. Onboard power is supplied by two 28-volt batteries. Batteries supply power to their loads through a common main power distributor, but each system is completely isolated from the other. The S-IC stage switch selector is the interface between the Launch Vehicle Digital Computer (LVDC) in the IU and the S-IC stage electrical circuits.



S-II STAGE ERECTED ON S-IC

S-II Stage. The S-II stage is 81.5 feet long and 33 feet in diameter. The engine system consists of five single-start, high-performance, high-altitude J-2 rocket engines of 230,000 pounds of nominal vacuum thrust each. Fuel is liquid hydrogen (LH_2) and the oxidizer is liquid oxygen (LOX). The four outboard engines gimbal, and the fifth engine is fixed, mounted on the centerline of the stage. A capability to cut off the center engine before the outboard engines may be provided by a pneumatic system powered by gaseous helium which is stored in a sphere inside the start tank.

Major S-II structural components are the forward skirt, the 37,737-cubic foot fuel tank, the 12,745-cubic foot oxidizer tank (with the common bulkhead), the aft skirt/thrust structure, and the S-IC/S-II interstage. The forward and aft skirts distribute and transmit structural loads and interface structurally with the interstages. The aft skirt also distributes the loads imposed on the thrust structure by the J-2 engines. The S-II stage has structural and electrical interfaces with the S-IC and S-IVB stages, and electric, pneumatic, and fluid interfaces with GSE through its umbilicals and antennas.

S-IVB Stage. The S-IVB stage is 59 feet long and 21.6 feet in diameter, powered by one J-2 engine. The S-IVB stage is capable of multiple engine starts. Engine thrust is 200,000 pounds. This stage is also unique in that it has an attitude control capability independent of its main engine.

The major structural components of the S-IVB stage are the forward skirt, propellant tanks, aft skirt, thrust structure, and aft interstage. The forward skirt provides structural continuity between the fuel tank walls and the IU. The propellant tank walls transmit and distribute structural loads from the aft skirt and the thrust structure. The aft skirt is subjected to imposed loads from the S-IVB aft interstage. The thrust structure mounts the J-2 engine and distributes its structural loads to the circumference of the oxidizer tank. The stage interfaces structurally with the S-II stage and the IU.

The high-performance J-2 engine as installed in the S-IVB stage has a multiple start capability. The S-IVB J-2 engine is scheduled to produce a thrust of approximately 200,000 pounds during both burns. An electrical control system that uses solid state logic elements is used to sequence the start and shutdown operations of the engine. Electrical power is supplied from aft battery No. 1.

The restart of the J-2 engine is identical to the initial start except for the fill procedure of the start tank. During the first burn period, gaseous hydrogen (GH_2) is bled from the thrust chamber fuel injection manifold, and LH_2 is received from the Augmented Spark Igniter (ASI) fuel line to refill the start tank for engine restart.

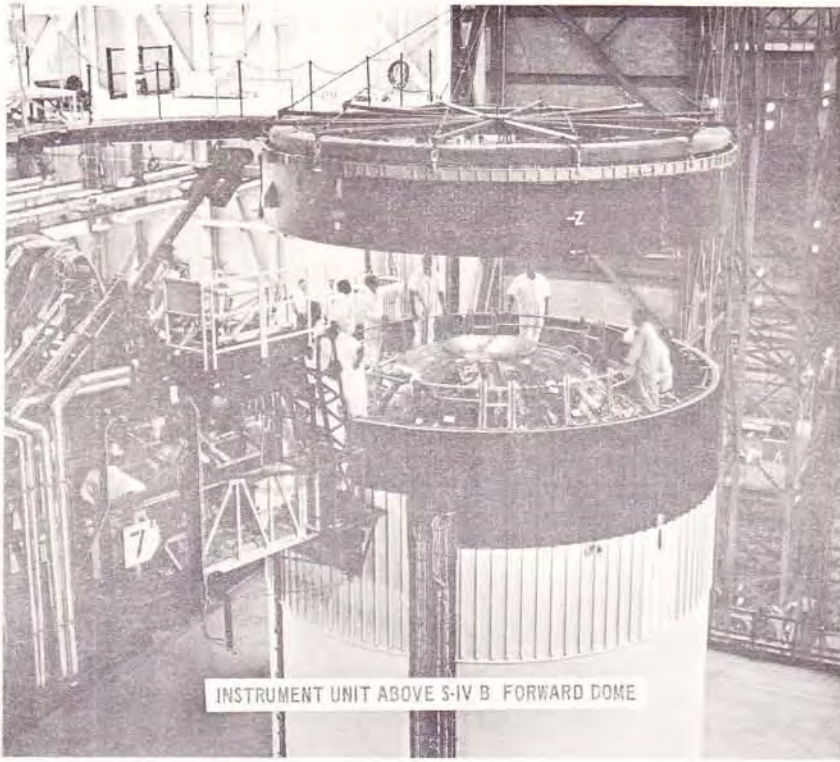
LOX is stored in the aft tank of the propellant tank structure at a temperature of -297°F. A six-inch, low-pressure supply duct supplies LOX from the tank to the engine. The LH_2 is stored in an insulated tank at less than -423°F. LH_2 from the tank is supplied to the J-2 engine turbopump by a vacuum-jacketed, low-pressure, 10-inch duct.

The electrical system of the S-IVB stage is comprised of two major subsystems: the electrical power subsystem which consists of all the power sources on the stage; and the electrical control subsystem which distributes power and control signals to various loads throughout the stage. Onboard electrical power is supplied by four zinc silver-oxide batteries.

Instrument Unit. The Instrument Unit (IU) is 21.6 feet in diameter and 3 feet high, installed on top of the S-IVB stage. The unit weight 4310 pounds. The IU contains the guidance, navigation, and control equipment which will guide the vehicle through its earth orbits and subsequently into its mission trajectory. In addition, it contains measurements and telemetry, communications, tracking, and crew safety systems, along with supporting electrical power and the Environmental Control Systems.

The basic IU structure is a short cylinder fabricated of an aluminum alloy honeycomb sandwich material. Attached to the inner surface of the cylinder are cold plates which serve both as mounting structure and thermal conditioning units for the electrical/electronic equipment.

The LV is guided from the launch pad into earth orbit primarily by navigation, guidance, and control equipment located in the IU. An all-inertial system utilizes a space-stabilized platform for acceleration and attitude measurements. A launch vehicle digital computer (LVDC) is used to solve guidance equations and a Flight Control Computer (FCC) (analog) is used for the flight control functions. The IU command system provides the general capability of changing or inserting information into the LVDC.



INSTRUMENT UNIT ABOVE S-IV B FORWARD DOME

The instrumentation within the IU consists of a measuring subsystem, a telemetry subsystem, and an antenna subsystem. This instrumentation is for the purpose of monitoring certain conditions and events which take place within the IU and for transmitting monitored signals to ground receiving stations.

The Command Communications System (CCS) provides for digital data transmission from ground stations to the LVDC. This communications link is used to update guidance information or command certain other functions through the LVDC.

The IU carries two C-band radar transponders for tracking. Tracking capability is also provided through the CCS. A combination of tracking data from different tracking systems provides the best possible trajectory information and increased reliability through redundant data.

The Emergency Detection System (EDS) is one element of several crew safety systems. There are nine EDS rate gyros installed in the IU. Three gyros monitor each of the three axes (pitch, roll, and yaw) thus providing triple redundancy. The control signal processor (CSP) provides power to and receives inputs from the nine EDS rate gyros. These inputs are processed and sent on to the EDS distributor and to the FCC. The EDS distributor serves as a junction box and switching device to furnish the spacecraft display panels with emergency signals if emergency conditions exist. It also contains relay and diode logic for the automatic abort sequence. An electronic timer in the IU allows multiple engine shutdowns without automatic abort after 30 seconds of flight. Inhibiting of automatic abort circuitry is also provided by the vehicle flight sequencing circuits through the IU switch selector.

Primary flight power for the IU equipment is supplied by silver-zinc batteries at a nominal voltage level of 28 vdc. Where ac power is required within the IU it is developed by solid state dc to ac inverters. Power distribution within the IU is accomplished through power distributors which are essentially junction boxes and switching circuits.

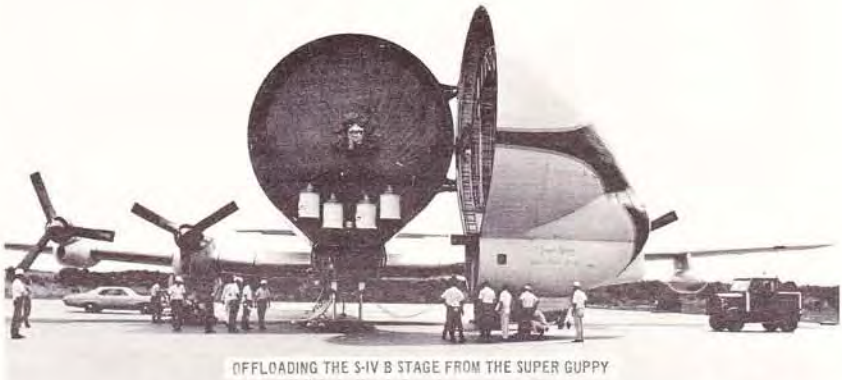
For additional details, see MSFC-MAN-510, "Saturn V Flight Manual, SA-510."

APOLLO SPACECRAFT

The Apollo Spacecraft (S/C) is designed to support three men in space for periods up to two weeks, docking in space, landing on and returning from the lunar surface, and safely entering the earths atmosphere. The Apollo S/C consists of the Spacecraft-LM Adapter (SLA), the Service Module (SM), the Command Module (CM), the Launch Escape System (LES), and the Lunar Module (LM). The CM and SM as a unit are referred to as the Command/ Service Module (CSM). All the hardware associated with the Apollo S/C falls within the purview Spacecraft Operations (SCO) under the direction of Mr. J. J. Williams.

CHECKOUT OPERATIONS

The processing of a space vehicle begins with the arrival of each component at KSC. For the launch vehicle, the S-IC first stage, and the S-II second stage, arrive by barge and are offloaded for receiving inspection at the VAB. The S-IC is erected immediately on an ML in the high bay area, while the S-II is taken to a checkout cell in the low bay area for inspection and pre-erection checks. Both the S-IVB third stage and the IU are flown to KSC aboard a special aircraft called the "Guppy." They are offloaded



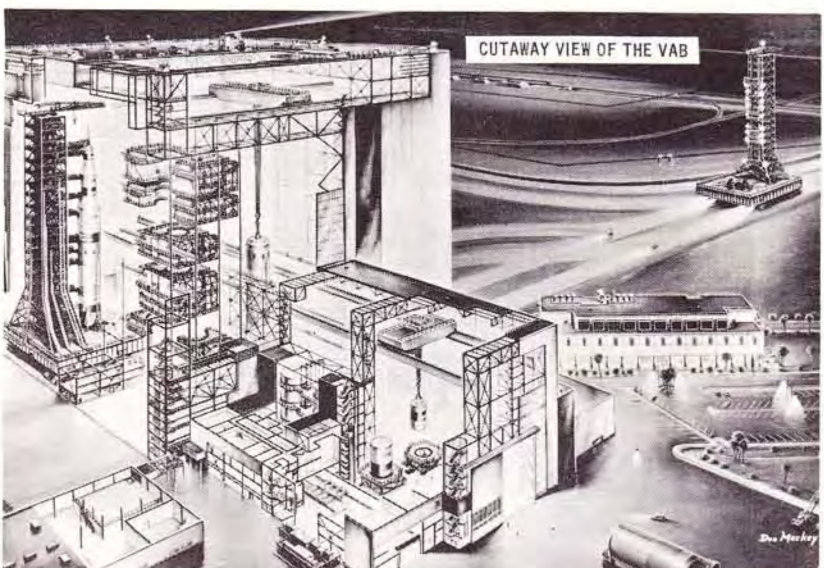
OFFLOADING THE S-IV B STAGE FROM THE SUPER GUPPY and transported to the VAB low bay area for initial checkout and preparations for space vehicle buildup.

When the pre-erection preparations have been completed, the S-II and S-IVB stages, and the IU, are each separately hoisted into place and mated mechanically as well as electrically. At this point an extensive testing sequence is undertaken to verify system performance in preparation for mate with the spacecraft.

Concurrent with LV checkout operations, the spacecraft modules arrive by air transport and are processed in the Operations and Checkout (O&C) Building in the KSC industrial area. Component and systems tests, manned altitude chamber runs, and simulated mission runs are performed. Following completion of these tests, the CM and SM are mated and tested, then the CSM is mated with the SLA and LM. The fully assembled spacecraft is transported to the VAB for final erection and space vehicle mating.

After final mating of the SV, a comprehensive integrated testing sequence is performed to check all systems and interfaces prior to rollout to the pad. Then upon completion of ordnance installation and separation from VAB systems, the Crawler-Transporter carries the entire SV on its ML to the launch pad for final tests prior to launch.

Three primary operations remain to be performed at this point. A Flight Readiness Test (FRT) is run to sequence countdown and in-flight activities and to verify system compatibilities. A two-part Countdown Demonstration Test (CDDT) is timed and sequenced exactly as the launch will be, including the use of a "launch window," to exercise every system and all personnel involved in the mission. During the "wet" portion of the CDDT, propellants are loaded in the SV. The CDDT proceeds through a series of procedural steps just prior to ignition time. In the "dry" CDDT, the terminal portion of the countdown is performed without LV propellants but including astronaut ingress and plus-time flight functions. On completion of the CDDT, final preparations are made for launch countdown.



When propellants have been loaded aboard the spacecraft and the S-IVB stage Auxiliary Propulsion System (APS) tanks are filled, the ordnance items are connected. Then, on launch day propellants are loaded on-board the LV, the astronauts enter the command module, and the final countdown is performed.

If we have all performed out work assignments satisfactorily, and the hardware performs as it was designed, all these months of preparation and checkout culminate in an on-time launch and a subsequently successful mission.

For additional information, see K-V-051, "Apollo/Saturn V Launch Operations Plan."

DOCUMENTATION SYSTEMS

There are five basic documentation systems at KSC. Management documents detail the functions and responsibilities of the various directorates. Program documents emphasize the requirements of a particular program. Contractors generate documents required under their NASA contracts. Technical documents provide the means for performing the primary technical functions of the Center, and preserve engineering and other technical knowledge produced at KSC. Directorate and second-level documents are issued for use only within the individual organization, and do not materially affect other directorates at KSC.

Management Documents. Management documents are issued in two basic series; Kennedy Management Instructions (KMIs) and Kennedy Notices (KNs). These are used for local implementation of management documents issued by NASA Headquarters, and to give instructions, assign responsibilities, and formalize policies concerning intracenter matters. In most cases, the Headquarters directives are management in content, or technical but not identified with a special program or mission. Kennedy Handbooks (KHBs) are used where a large amount of detail must be presented.

Program Documentation. The program managers issue Kennedy Program Directives (KPDs) which levy requirements on the operating directorates as necessary to complete assigned programs. Each program manager establishes the plans, policies, and procedures to be implemented by the directorates through program documentation trees.

Contractor-Furnished Documentation. In large contracts, each document to be generated as a control requirement is identified by a Data Requirement Description (DRD). The DRDs are entered on the contract Data Requirements List (DRL). The DRLs constitute important indexes for locating data/documents prepared by contractors.

Technical Documentation. A wide and varied series of technical documentation systems support the KSC efforts. These include Checkout Plans, Test Outlines, Test and Checkout Procedures (TCPs), and many others. External agency requirements for KSC support are submitted to the Director of Technical Support in the form of Program Support Requirements Documents (PSRDs). A Kennedy Program Requirements Document (KPRD) levies program requirements on KSC support elements. A Requirements Document (RD) specifies in detail the test and checkout support requirements for a specific operation. New or revised requirements that develop shortly before a test are handled through "Expedite RDs." Design Specifications provide a clear, accurate description of the technical requirements for a particular item, and Design Standards establish engineering or technical limitations and applications.

Directorate and Second-Level Directorate Documentation. Each directorate issues documentation for its internal use requiring no signature higher than that of the director, providing the item does not materially affect other directorates. These documents cover a wide range of information instructions. Those used in LVO fall into four categories. Policy documents prescribe, establish, or define administrative and operational guidelines and responsibilities. Operational documents initiate work, document procedures, and establish methods for day-to-day activities. Quality documents validate task accomplishment, specify inspection points, and process de-

LVTC — LAUNCH VEHICLE TEST CONDUCTOR

SUMMARY OF LVO DOCUMENTATION SYSTEM

DOCUMENT	AUTHORITY	TYPE	PREPARATION	APPROVAL	USER	FUNCTION
AI	LV-AI 1410-1	POLICY	LV-PLN	LV-DIRECTOR	ALL LV CIVIL SERVICE	DOCUMENT ADMINISTRATIVE POLICY
TI	TI 1-1	POLICY	LV-TMO	LV-DIRECTOR	LV CIVIL SERVICE AND CONTRACTORS	SPECIFY TECHNICAL POLICY AND PROCEDURE
TCP	TI 2-17	OPERATIONAL	CONTRACTOR	LV TECHNICAL DIVISIONS & LVTC	CONTRACTOR AND CIVIL SERVICE TEST TEAM	SPECIFY STEPS FOR TEST AND CHECKOUT
TRS	TI 2-44	OPERATIONAL	CONTRACTOR	CONTRACTOR & LV TECHNICAL DIV	TECHNICAL DIVISIONS AND LVTC	DOCUMENT TROUBLESHOOTING
TPR	TI 2-36	OPERATIONAL	CONTRACTOR	LV TECHNICAL DIVISIONS	LV AND CONTRACTOR MANAGEMENT	REALTIME PROBLEM VISIBILITY
DR	TI 2-2 TI 2-43	QUALITY	CONTRACTOR (LV-QAL BY EXCEPTION)	CONTRACTOR & LV TECHNICAL DIVISIONS & QUALITY	CONTRACTOR & LV TECHNICAL DIVISIONS & QUALITY	DISPOSITION OF ANOMALIES
UCR	TI 2-2	QUALITY	CONTRACTOR	NOT APPLICABLE	CONTRACTOR & LV RELIABILITY	DOCUMENT FAILURE AND DESIGN ACTION
SR/RD	TI 2-29 TI 2-37	OPERATIONAL	CONTRACTOR	LV-OMO	SUPPORT AGENCIES	REQUEST FOR GENERAL SERVICES AND TEST SUPPORT
CR	TI 2-50	CONFIGURATION MANAGEMENT	CONTRACTOR	LV TECHNICAL DIVISIONS	ENGINEERING & DESIGN ORGANIZATIONS	REQUEST ENGINEERING CHANGES
FEC	TI 2-51	CONFIGURATION MANAGEMENT	CONTRACTOR	LV TECHNICAL DIVISIONS	ENGINEERING & DESIGN ORGANIZATIONS	IMPLEMENT REALTIME ENGINEERING CHANGES
MIP	TI 2-53	CONFIGURATION MANAGEMENT	DESIGN	DESIGN	CONTRACTOR & LV TECHNICAL DIVISIONS	AUTHORIZE AND SPECIFY MODIFICATIONS
KSC-R	TI 2-45	GENERAL PURPOSE	CONTRACTOR & LV	LV (RELEASE) DESIGN (RESPONSE)	CONTRACTOR & LV TECHNICAL DIVISIONS	OBTAIN DESIGN CONCURRENCE FOR SIGNIFICANT PROBLEM RESOLUTION

fective or failed equipment. And configuration management documents authorize modifications and provide engineering data for processing changes.

Policy Documents. Two basic policy documents provide overall guidance for all LVO activities. Administrative Instructions (AIs) are issued to section-level organizations, as above, for LVO civil service personnel only. The content includes policy and methods for administrative, as opposed to operational, matters. Technical Instructions (TIs), issued in two basic series, cover operational policies and establish the prime documentation for day-to-day test and checkout activities. The TI series includes both LVO civil service and contractor organizations. All LVO personnel should be familiar with those TI documents which directly affect their areas of work. Contact your supervisor or check the KSC Library.

Operational Documents. Since LVO is basically an operational organization, most of our work involves operational documents. These cover everything from the generation of test and checkout procedures to a request for telephone service. Each document is established via a Technical Instruction which explains its flow, use, and approval. Four particularly significant documents used in LVO are: Test and Checkout Procedures (TCPs), used for all test and checkout operations in LVO; Troubleshooting Record Sheets (TRSs), used to document troubleshooting operations in any LVO equipment; Test Problem Reports (TPRs), which provide LVO management with an up-to-date set of open problems and the current status of solutions; and Support Requests (SRs) and Requirements Documents (RDs), which are used to request support on action from groups external to LVO. See the summary form attached at the end of this section for more detail.

Quality Documents. Documents used primarily by our Reliability and Quality Assurance personnel are categorized as quality documents. They are used in the identification and processing of discrepant hardware, the recording and tracking of unsatisfactory conditions, and the processing of on-site repair work (known as 'Material Review Actions'). The most important forms are the Discrepancy Records (DRs) and the Unsatisfactory Condition Reports (UCRs). Their use and approval is also outlined in the attached summary.

Configuration Management. The fourth category of documentation involves the paperwork required to request and process changes to the existing configuration of hardware systems. Under normal circumstances a fairly involved flow of paperwork, finally compiled as a Modification Instruction Package (MIP), as described in TI-2-53, is required to request, initiate, and complete a hardware modification. In the event that a late modification is mandatory for a launch, a Field Engineering Change (FEC) is used. Both types of document require rigid compliance with established control channels, as defined in the applicable TI.

The remaining document listed on the summary form is called a KSC Request. It is an all-purpose form used by the Chief Engineer in solving various significant problems which arise during the vehicle processing. For the particulars of use and approval, see TI-2-45.

The foregoing sections have provided only the briefest of introductions to the KSC and LVO documentation systems. A thorough familiarity with those described, plus many not included but significant in your particular area of endeavor, will speed your work and maintain the strict traceability and accountability that our operation requires.

ADMINISTRATION POLICIES AND PRACTICES

LVO Civil Service employees perform their assignments within the policies and procedures established by the Civil Service Commission, NASA Headquarters, the Kennedy Space Center, and the LO/LVO Directorates. Following is a very brief explanation of certain policies which apply to LVO employees. The information is intended to assist new employees with questions, and to permit adjustment to the work assignments in a timely manner. Additional information about any of the following topics may be secured from the referenced policy documents, and by contacting individual supervisors.

Personnel. An Employee Record Card on each employee in Launch Vehicle Operations is maintained in the Administration Section of LVO, LV-PLN-13. These records are available to supervisors for information regarding the employee's previous background, such as: date of last promotion; date of last within-grade increase; reassignments; and awards.

The Administration Section of LVO serves all offices within the Directorate, assisting in any administrative or personnel type of question or problem. All requests for personnel actions are initiated in this Section.

Tours of Duty (KMI 3610.1A, "Duty Hours"). There are several standard tours of duty, such as: 8:00-4:30, 7:30-4:00, 3:30-12:00 p.m., and 7:00-3:30, on a five day work week—Monday through Friday. The majority of the engineers in LVO work on a "First 40 Hour Tour." This enables the supervisor to use a variable work day in scheduling his employees, to cover all emergencies and special schedule requirements that may arise.

Pay Period Time & Attendance (KHB 9620.1B/AD, "Time and Attendance Reporting"). Pay is based on a two-week period, with pay days on Mondays except when a holiday falls on Monday, in which case the prior Friday is pay day. Pay checks may be mailed to your bank, home, or hand-carried to you in the office upon your written request. Payroll deductions for Credit Unions, Bank Accounts, and U.S. Savings Bonds may be arranged in any amount, at your request.

The secretary in your immediate office is your timekeeper. She maintains a Time & Attendance record noting your time in and out each day, and any sick or annual leave taken. At the end of a two-week period this record is certified by your supervisor and submitted to the Payroll Office, for issuance of your pay check.

Leave (KMI 3630.1B/AD, "Leave Administration"). An employee earns sick and annual leave each pay period, but annual leave must be approved by by each employee's supervisor prior to taking off. Each employee must serve 90 days before he is eligible to take annual leave. If time needs to be taken other than sick leave before the employee has completed his 90 days, it will be charged as leave without pay (LWOP). Sick leave may be taken as you earn it. You earn four hours each pay period for sick leave. Annual leave is governed by the number of years service (civil service and military) you have to your credit. One to three years service—earn four hours each pay period; three to fifteen years—six hours per pay period; and fifteen years and over—eight hours per period. After you have been on-board for one continuous year, your annual leave for the year will be advanced to you for use. If you use all your advanced leave before you have earned it and terminate, you must pay for the leave you have used but not earned.

Promotion (NHB 3335.0EC, 3335.1). A Merit Promotion Plan functions within the Center in the form of numbered announcements of openings to afford all those qualified to apply for positions that are being upgraded, (that is, from one GS grade to the next highest GS grade). A Standard Form 172 is submitted to the Placement & Recruitment Office for evaluation by a selected panel. When a selection is made, the employees are notified whether they have qualified and if they have been selected for the noted position. An employee can also be promoted in the job he occupies, if the position warrants a higher grade; this is accomplished after a specified period of time.

Training (KMI 3410.2/AD, "Employee Development and Training"). LVO has a broad training program, which is comprised of the following:

Systems Training. LV Contractors conduct extensive formal classroom training courses on the Saturn Apollo Launch Vehicle and Associated Ground Support Equipment. LV employees participate in appropriate classes.

Safety Training. There are mandatory safety training classes/courses for LVO operational personnel, depending upon the work assignment of the individual.

Management Training. The extent of participation in this category depends upon the responsibilities of the individual employee. A wide range of management training courses are offered.

College Training. LV personnel participate extensively in college training courses offered locally by Colleges and Universities. Depending on need, LV personnel travel to Universities/Colleges out of the area for special courses in state-of-the-art categories.

Seminars, Professional Meetings, Symposiums. LVO personnel participate extensively in professional organizations and are afforded the opportunity, from time to time, to attend seminars, conferences, meetings of professional organizations, and special events.

Each year LVO supervisors meet with their employees to project future training plans and programs for the organization and each individual. The projections of requirements for each LVO employee are submitted to the KSC Training Office, for budget purposes and for the planning of classes throughout the fiscal year. Each LVO Division/Office has a training coordinator to assist and monitor the training plans of each respective employee. LV also has a Directorate Training Coordinator to work with the KSC Training Office for overall management of the training activities.

In addition to formal training opportunities for LVO employees, there is a comprehensive on-the-job training program for each new employee, within his assigned LV organization. Every possible effort is made to provide all LV employees with the training necessary for the organization to perform its mission, and to permit individual employees to develop professionally. LVO also participates in a center-wide Co-op Training Program, Summer Employees Program, and other similar programs.

Travel (KMI 9710.2C/IS, "Implementation of NASA Travel Regulations"). Work requirements in LVO occasionally require personnel to travel on Temporary Duty Assignments (TDY) to other NASA Centers and to Contractor/Vendor facilities. Travel orders are issued for all travel and require the approval of individual supervisors. Preparation of travel orders and coordination of reservations and airline tickets is accomplished with each employee's office, in conjunction with the KSC Travel Office. Strict controls are applied to travel, and funding is budgeted on a monthly basis.

Security and Badges (KMI 1610.1/IS, "Personnel Security Program"). In addition to the regular Kennedy Space Center Identification Badge given to each employee when he starts employment, LVO employees may have work assignments which require additional badges. Employees working in hazardous areas or within the launch complex will be given special safety training and subsequently assigned special badges. These will permit them to gain access to various special work areas in the operational complex. Special security badges called APIP (Apollo Personnel Identification Program) are also required of personnel performing critical functions with the Launch Vehicle or Ground Support Equipment. Arrangements for special training and special badging are made by LV supervisors.

Government Furnished/Owned Motor Vehicles at KSC (KMI 6730.1A/IS). Most general purpose motor vehicles at this Center are furnished to NASA by the General Services Administration (GSA). All vehicles having a 'G' prefix on the tag are owned by GSA and are utilized by KSC Civil Service Organizations and their Contractor organizations. Those trucks displaying an 'NA' prefix on the tags are owned and maintained by NASA. All these vehicles are for official use only and are available through your assigned office. A valid Government Motor Vehicle Permit is required to operate any official vehicle at KSC. Drivers of government vehicles may obtain gasoline at the GSA Service Station located in the KSC Motor Pool. It should be noted that vehicles are almost always in short supply. All employees are encouraged to utilize the KSC Shuttle Bus System, which runs through most areas at 10 minute intervals throughout the majority of each workday.

Government Motor Vehicle Permit (KMI 6730.2A/IS). When it is determined by the individual's supervisor that it is necessary for the employee to obtain a permit to perform his duties, the employee completes the application sheet, KSC Form 7-441, and submits it to his supervisor. These permits are valid (after the individual signs) for a 3 year period, unless sooner revoked for reasons mentioned in the above cited reference. Instructions for completing the application are listed on the reverse side of the form. Permits should be carried along with the individual's state license, ready for display when required.

Motor Vehicle Parking at KSC (KMI 1620.2A/IS). The above referenced Instruction contains policies and procedures concerning parking at KSC for both private and government vehicles. Ample space is available and most areas are unrestricted unless fenced or specifically marked by individual name or other identification. Employees are cautioned not to illegally park a vehicle, whether government owned or private. The referenced Instruction also contains regulations concerning motor vehicle traffic. These regulations are established for KSC, Cape Kennedy Air Force Station (CKAFS), and Patrick Air Force Base (PAFB) by a joint operating and support agreement. A point system is in effect through this agreement, and covers traffic violations committed on all three installations. This is a reciprocal arrangement, and copies of all citations are forwarded to AFETR/KSC Traffic Records Bureau for recording purposes. The traffic violation point assessment listing, as outlined in attachment A to the above cited reference, notes penalties for each violation. A total of 12 points in any 24 month period may result in suspension of your operator's permit.

Clothing (KMI 1730.1A/SF, "Protective Clothing and Equipment"). Special clothing requirements may be necessary from time to time during the operational testing and countdown/launch of the Saturn Apollo Launch Vehicle. These requirements generally consist of protective-type clothing (coveralls, smocks, hardhats, rubber aprons, etc.) and are provided by the LVO supply organization, LV-PLN-11.

Supply and Control of Government Property (KHB 4000.1A/IS; LV-AI 4000). LV personnel are provided the supplies and material necessary to accomplish their work assignments. Certain supplies and materials are expendable in nature (consumed in use) and do not require accountability. LVO has two Property Accounts managed by two Supply Specialists/Property Custodians. For items requiring accountability (capitalized personal property, sensitive items, personally attractive items, and items under $200.00 which require periodic scheduled maintenance), the supply specialists are available to help LV employees. They will fill their requirements for tools, special clothing, requisitions, and other supply/material items. No individual will receive, transfer, loan, cannibalize or dispose of assigned property without coordination with the Supply Specialist/Property Custodian.

Spare parts support for systems operated/maintained by LVO personnel may be secured from the LV Components Logistics Section, LV-PLN-11.

Reference documents cover this area in detail and should be reviewed when requirements for Supply/Logistics support develop.

Procurement of Equipment, Supplies, Spares and Services (AI 5100, dtd. 3/10/71). Personal requirements for equipment, supplies, spare parts, or special services not locally available, arise occasionally in the various work assignments. The referenced Administrative Instruction calls out a step-by-step procedure to follow in the preparation of a Procurement Request.

Telephones and Other Communication Systems. Telephones and other communications systems are provided to LV employees for official business. Telephone service to other NASA Centers and other government facilities is provided by the Federal Telephone System (FTS). Requirements to call off the FTS network may be met by calling the KSC Operator and asking for assistance. All long distance telephone calls off the FTS net require identification of the caller and an authorization number. Datafax service is also available. See your supervisor for proper justification.

NASA Locator (KMI 1590.3A, "NASA Personnel Directory"). A center-wide locator system is in effect. A NASA Locator Form is completed when entering on duty. A copy is sent to the Locator File, one to the Administration Office in KSC, and another to the Administration Section in LVO. This enables anyone calling in to contact an employee.

Medical Services (KMI 1810.1B/IS, "KSC Medical and Environmental Health Program"). KSC has a contract with Pan American World Airways to furnish medical services. LV employees may make use of this service for emergencies and physical examinations. Emergency treatment is available in the VAB, at the Main Dispensary on the Cape Road (Cape Kennedy), and at the Main Dispensary in the KSC Industrial Area. The referenced KMI should be reviewed for the requirements established for taking physical examinations.

Inventions and Suggestions (KMI 1450.1B/AD). NASA employees are encouraged to offer recommendations for improvement of operating procedures, techniques, equipment design, and safety practices. All suggestions are carefully evaluated, and if accepted, the contributor is eligible for a monetary award. A suggestion is submitted as either a recommended cost reduction, or as a new invention. If the suggestion reduces costs, the employee should contact the cost reduction representative for his division and obtain a NASA Form #1105A. The cost reduction representative will assist in completing and submitting this form.

In the case of an invention, the employee should apply to the Patent Council/Technology Utilization Officer for an award. The invention should be considered of value as a scientific or technical contribution, and of major importance in advancing the state of knowledge in aeronautical or space activity. The invention must also have been developed during the inventor's tenure as a NASA employee.

Library (KMI 2240.1/IS). The KSC Library, located in Room 1301 of the Headquarters Building, provides a service quite vital to Launch Vehicle Operations in that it is the only complete reference source at the center. Although most LVO divisions maintain a convenient assortment of frequently used documents, none is equipped with extensive related material. Shelved volumes, as well as professional periodicals, technical papers, specifications and standards, and locally generated documents are maintained by a competent library staff. Reading rooms are provided for the convenience of the user. A library card is used for checkout purposes and may be obtained by completing KSC Form 16-24 at the library desk.

Activities Available to KSC-LVO Employees.

KARS. For those interested in the outdoors, a Kennedy Athletic and Recreation Social (KARS) membership is available to KSC Civil Service and Contractor personnel. Facilities are available for picnics, swimming, boating, and camping. Clubs of various types function within the framework of KARS, (i.e., Gun Club, Softball Leagues, Travel Club.) For more information call the KARS Manager at Complex 99.

Service Station. An automobile service station is located in the KSC Industrial Area. Emergency service may be secured.

Credit Union. The KSC Credit Union is open to all LVO employees. Details concerning membership, savings accounts, and loans may be secured by contacting the Credit Union Office, which is located in Room 1484 of the Headquarters Building.

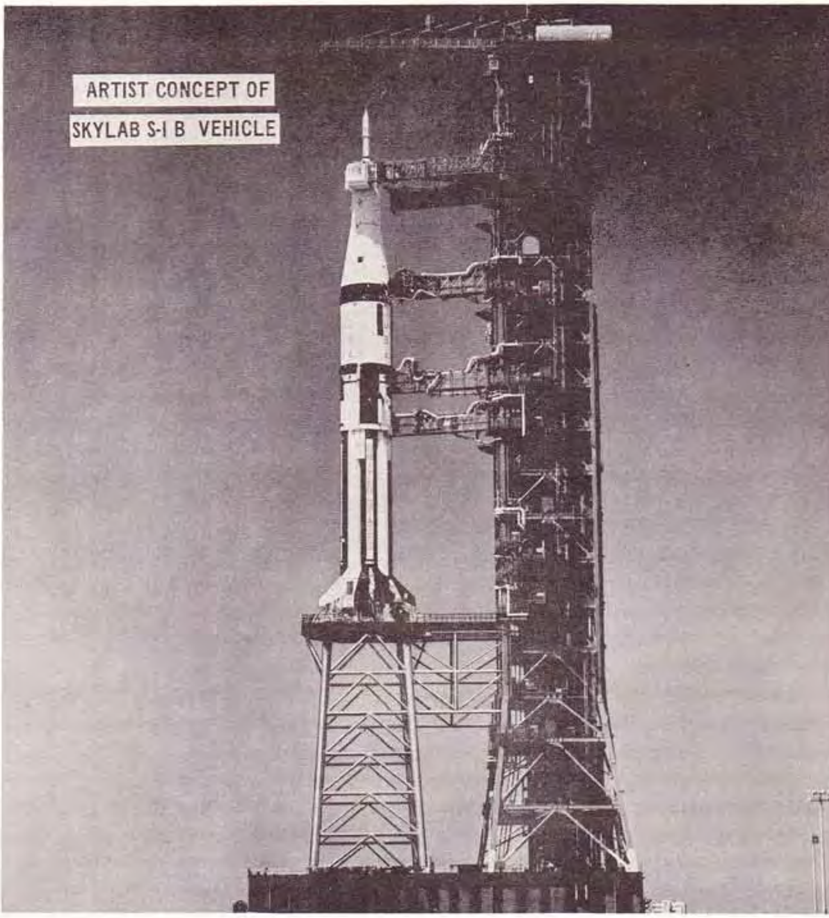
The U.S. Post Office, a Sundry Store and a Barber Shop, all located in KSC Headquarters Building, are available to LV employees.

NOTE

For additional information regarding support services, see KHB 8610.1A/AD, "Support Services Handbook." Also, check the classified listing in your KSC telephone book for specific requirements (Security, Supply, Medical, etc.).

MISSIONS: PRESENT AND FUTURE

Present. There are two final missions left in the Apollo Program; numbers 16 and 17. These flights will conclude the first phase of the greatest feat of exploration performed by Mankind to date. Both missions will utilize the Lunar Rover and enlarged scientific experiment packages, to provide the highest possible return of information from the surface of the moon. The Saturn V vehicles will be launched by LVO in the established manner.



ARTIST CONCEPT OF SKYLAB S-I B VEHICLE

The second major on-going program is the Skylab mission. Skylab is a prototype space station, designed to test the ability of men to live and work in zero gravity for extended periods. Skylab will contain by far the most complex scientific instrumentation placed in Earth orbit by the USA. Basically, Skylab adds another utilization for Apollo Program hardware. The major component, the Orbiting Workshop, is a Saturn V third stage whose interior has been outfitted with living and laboratory facilities. Modified Apollo spacecraft will carry crews to the workshop and return them to Earth.

Other main components are the Multiple Docking Adapter (MDA), which provides the docking port for the Apollo spacecraft, and the Airlock Module (AM), which has an airlock for extravehicular experiments, the main communication and data links, and the environmental, thermal, and electrical power systems controls. The primary scientific payload is a separate module called the Apollo Telescope Mount (ATM), which houses the solar experiments. The ATM is designed to perform the most comprehensive study of the sun ever attempted above the atmosphere.

The Skylab Program will require four separate launches. The first will be of a modified Saturn V carrying the three connected modules of the laboratory, plus the ATM. The following three will be of Saturn IBs, carrying three-man astronaut crews. The Saturn V will be launched first with the initial Saturn IB flight scheduled for 24 hours later. The astronauts will return to Earth after 28 days in orbit, and a second crew will be launched later for a 56 day stay. A third and final crew will follow for another 56 day mission.

One ML at KSC is in process of being modified to launch Saturn IB vehicles from a Saturn V pad. A second ML is being modified for the new configuration of the Saturn V required to carry the Skylab. The adaptation of Saturn V equipment for Saturn IB launches enabled NASA to deactivate IB Complexes 34 and 37 on Cape Kennedy, for a substantial anticipated reduction in launch operations costs. A second Skylab mission may be authorized for the 1974-75 time period, but this is uncertain at present.

The Unmanned Launch Operations Directorate of KSC has a continuing series of unmanned scientific, weather observation, and communications satellites scheduled for launch from the present throughout the decade of the seventies. Detailed information on these missions can be obtained from the KSC Public Affairs office.

Future. The major program expected to heavily impact KSC during the decade of the seventies is called the Space Transportation System (STS). This consists of four basic units: A space logistics transport, commonly called the Space Shuttle; A six to twelve man space station in semi-permanent orbit; An atomic-powered rocket that would be used only in space for long-duration missions such as flights to Mars; and a space tug that would shift personnel and equipment from low to high Earth orbits, and land them on the moon or Mars and return them to lunar or Martian orbit.

Space Shuttle. This vehicle is planned as a two-stage transport with both stages powered with liquid hydrogen and oxygen engines. It will be capable of carrying from 25,000 to 50,000 pounds into Earth orbit. Each shuttle would have a useful lifetime of 100 flights. The vehicle would be launched in the vertical position like a rocket, but both stages would return to Earth in a horizontal landing mode, in the manner of an airplane. KSC has proposed to house the shuttle configuration in the VAB, using a ML and the Crawler/Transporter to move the flight-ready vehicle to the launch pad. A landing strip would be constructed nearby for the returning stages. (An interim approach using a standard one-shot rocket for the first stage, with orbiting upper stage as described above, is under consideration at present.)

Space Station. Several studies have been performed on possible space station configurations. The most likely is a modular concept, where

ARTIST CONCEPT OF SPACE SHUTTLE AT VAB

launches would orbit large sections that could be joined together in space. The exact number and type of launches required is unknown at present.

Atomic-Powered Rocket. A vehicle system wherein hydrogen gas is heated in a reactor and expelled through a rocket nozzle to provide thrust as a monopropellant has been in development for several years. This vehicle would be launched as cargo on a conventionally-powered chemical rocket, and would operate only in space. When perfected, this vehicle would be capable of up to two years of operational life on a single mission. Its primary application would be as a transport between orbits for transplanetary flights.

Space Tug. The space tug would be a utility vehicle, primarily for use where the distances involved make utilization of the atomic rocket too expensive or too hazardous. Short trips in Earth orbit, such as from the relatively low orbit of the space station, at less than 300 miles altitude, to synchronous satellites at 23,000 miles altitude, would be one application. Another would be as a landing vehicle on the moon and later Mars, where the one-sixth gravity of the moon and the roughly four-tenths gravity of Mars make the utilization of small vehicles practical. Like the atomic rocket, it would be placed in orbit by a chemical rocket.

President Nixon has established the following specific objectives for the space program:

1. Explore the moon.
2. Explore the planets and the universe.
3. Reduce the cost of space operations.
4. Extend man's capability to live and work in space.
5. Hasten and expand the practical applications of space technology.
6. Encourage greater international cooperation in space.

"*As we enter a new decade,*" the President said, "*we are conscious of the fact that man is also entering a new historic era. For the first time, he has reached beyond his planet; for the rest of time we will think of ourselves as men from the planet Earth. It is my hope that we can plan and work in a way which makes us proud both of the planet from which we come and of our ability to travel beyond it.*"

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KMI 1730.1A/SF	"Protective Clothing and Equipment"
KHB 4000.1A/IS	"Supply and Control of Document Property"
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KMI 1590.3A	"NASA Personnel Directory"
KMI 1810.1B/IS	"KSC Medical and Environmental Health Program"
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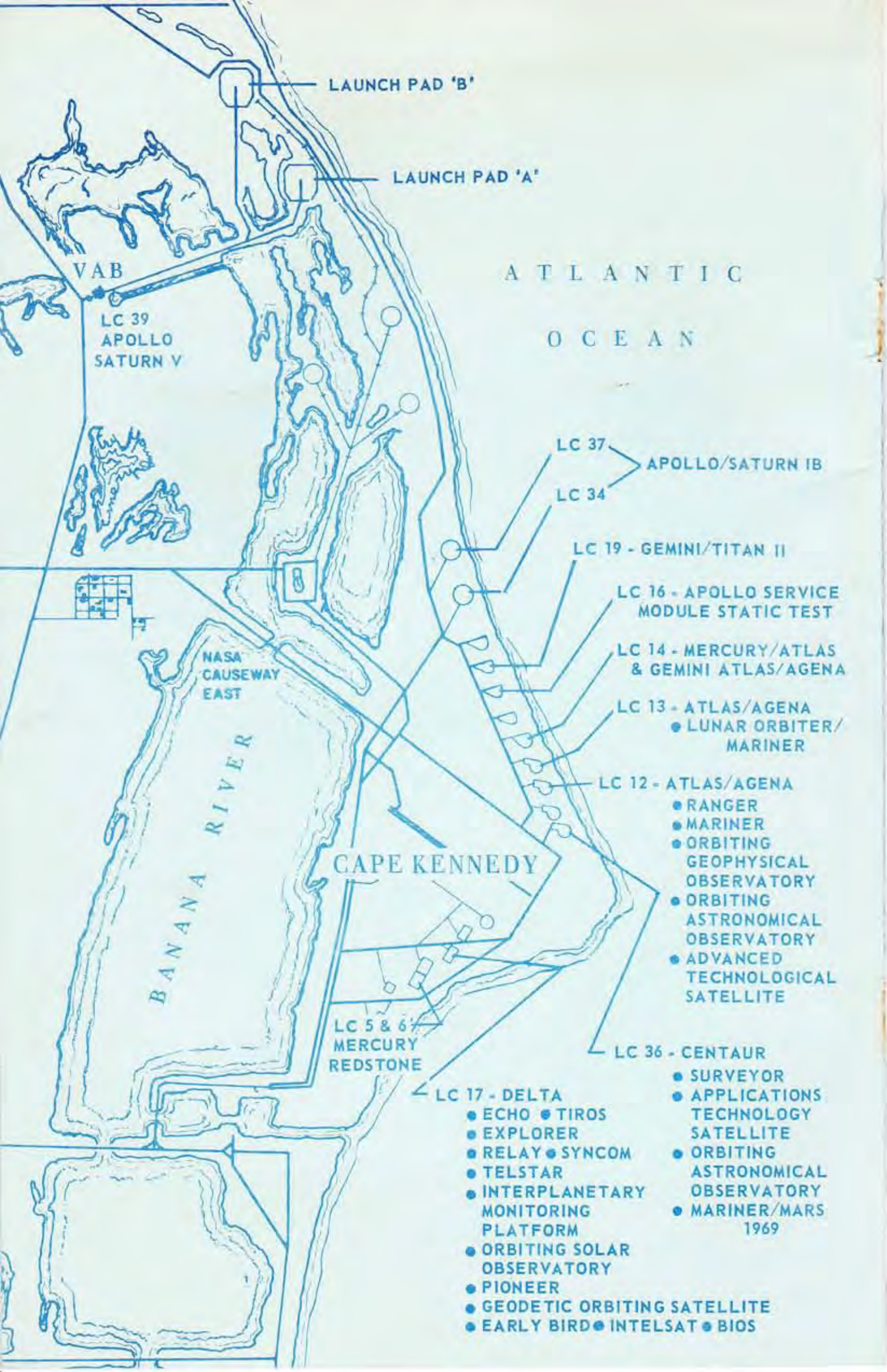
KMI 2240.1/IS	"Library"
KMI 3610.1A	"Duty Hours"
KHB 9620.1B/AD	"Time and Attendance Reporting"
KMI 3630.1B/AD	"Leave Administration"
NHB 3335.0EC, 3335.1	"Promotion"
KMI 3410.2AD	"Employee Development and Training"
KMI 9710.2C/IS	"Implementation of NASA Travel Regulations"
KMI 1610.1/IS	"Personnel Security Program"
KMI 7630.1A/IS	"Government Furnished/Owned Vehicles at KSC"
KMI 6730.2A/IS	"Government Motor Vehicle Permit"



LAUNCH PAD 'B'
LAUNCH PAD 'A'
VAB
LC 39
APOLLO
SATURN V
ATLANTIC
OCEAN
LC 37
LC 34
APOLLO/SATURN IB
LC 19 - GEMINI/TITAN II
LC 16 - APOLLO SERVICE MODULE STATIC TEST
LC 14 - MERCURY/ATLAS & GEMINI ATLAS/AGENA
LC 13 - ATLAS/AGENA
• LUNAR ORBITER/ MARINER
LC 12 - ATLAS/AGENA
• RANGER
• MARINER
• ORBITING GEOPHYSICAL OBSERVATORY
• ORBITING ASTRONOMICAL OBSERVATORY
• ADVANCED TECHNOLOGICAL SATELLITE
NASA CAUSEWAY EAST
BANANA RIVER
CAPE KENNEDY
LC 5 & 6
MERCURY
REDSTONE
LC 36 - CENTAUR
• SURVEYOR
• APPLICATIONS TECHNOLOGY SATELLITE
• ORBITING ASTRONOMICAL OBSERVATORY
• MARINER/MARS 1969
LC 17 - DELTA
• ECHO • TIROS
• EXPLORER
• RELAY • SYNCOM
• TELSTAR
• INTERPLANETARY MONITORING PLATFORM
• ORBITING SOLAR OBSERVATORY
• PIONEER
• GEODETIC ORBITING SATELLITE
• EARLY BIRD • INTELSAT • BIOS