

**MSFC
SATURN APOLLO
SELECTED MAJOR CONTRACTOR
MANPOWER PLAN**

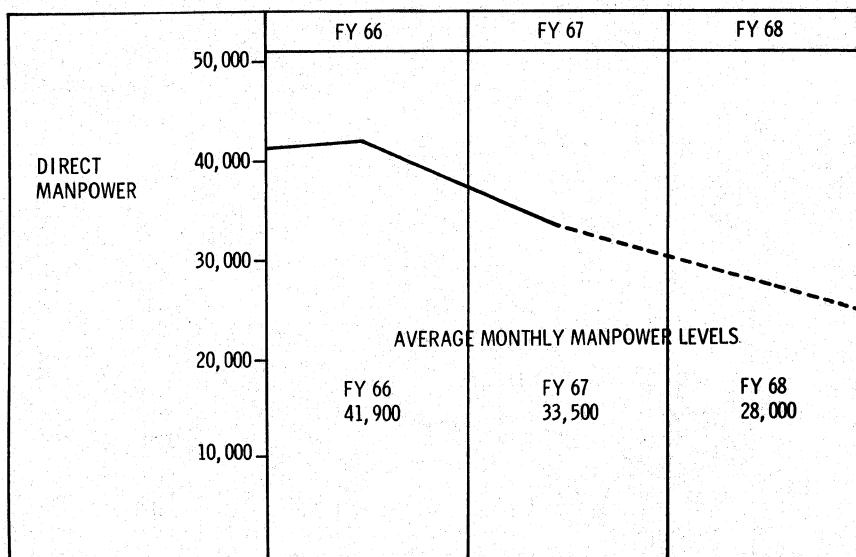


FIGURE 59

In conclusion (fig. 61), our confidence is quite high with regard to the uprated Saturn I program. The vehicle is qualified, and we hope that the perturbations and requirements resulting from the AS-204 accident will be rather routine engineering changes that will not seriously delay the program.

With regard to Saturn V, we plan to launch the first vehicle in the second quarter of this calendar year. I have discussed some of its major problems with you. We feel that to some extent our second stage is showing signs of improvement; we look forward to the first flight second stage being stacked in the AS-501 at KSC later this month.

We are proceeding with the initial steps for refurbishment of the Beta III Test Stand at Sacramento which was damaged by the third stage explosion. Estimates run about three-quarters of a million dollars for repair of this facility.

Our funding level, as contained in the President's budget while not as much as requested, should be adequate. Adequate that is, if no major failures or technical problems are encountered.

Of course, we are always subject to our funding being reprogrammed from Washington. Over the past year or so, by coordinating with headquarters and paring our programs, we have reprogrammed about

**MSFC
APOLLO APPLICATIONS
FUNDING PLAN
(OBLIGATIONS)**

	FY 66	FY 67	FY 68
<u>AAP</u>			
UPRATED SATURN I	1.0	24.0	78.5
SATURN V			45.6
LAUNCH VEHICLE MODS			5.0
EXPERIMENTS	4.3	9.0	39.2
MISSION SUPPORT	.1	4.4	31.3
TOTAL	5.4	37.4	199.6

DOLLARS IN MILLIONS

FIGURE 60

\$200 million in order to help solve problems at the other manned space flight centers, Manned Spacecraft Center and Kennedy Space Center.

We do have an active cost reduction and accident prevention program. One example of cost reduction is the elimination of a set of ground support equipment for the Saturn V second stage vertical checkout building at the Mississippi Test Facility. An identical set was required for the second stage test stands, and by conducting the postfiring checkout in the stands instead of the vertical checkout building, we saved several million dollars without impeding the static test schedule.

Our Manned Flight Awareness program and Accident Prevention program are very highly motivated programs. The examples shown today were not to leave you with the feeling that the program is accident prone but rather to acquaint you with the type of unplanned occurrences that can happen on a program of this sort. There are human errors and mistakes made even though the product has good design, and the Accident Prevention program is what is thought to be the ultimate.

This concludes the Saturn program review.

CONCLUSIONS

- UPRATED SATURN I
 - VEHICLE MATURE, PROGRAMMATICALLY MANAGEABLE
- SATURN V
 - LAUNCH SECOND QUARTER, CY67
 - TECHNICAL (DEVELOPMENT) PROBLEMS
 - SECOND STAGE SCHEDULE AND PERFORMANCE
- ENGINES
 - HIGH CONFIDENCE
 - FIRST FLIGHT OF F-1 ENGINE
 - J-2 RESTART
- FACILITIES
 - ADEQUATE AND AVAILABLE
 - BETA III TEST STAND, DOUGLAS SACRAMENTO
- FUNDING
 - ADEQUATE, BUT CONSTRAINING PROGRAM FLEXIBILITY.
 - AS-204 ACCIDENT
 - CONTRACTOR MANPOWER REDUCTIONS
 - WASHINGTON REPROGRAMMING
- COST REDUCTION
- ACCIDENT PREVENTION

FIGURE 61

NASA MICHLOUD-MISSISSIPPI COMPLEX

Before your visit to the New Orleans/Mississippi complex (fig. 62), I should take a few minutes to explain the facilities and how they are integrated into an efficient and self-sufficient operation.

The Michoud Assembly Facility, which is one of the best aerospace manufacturing and assembly plants in the country, is located in the northeastern part of New Orleans (fig. 63). This site is ideal for it is adjacent to intercoastal waterways.

The Michoud Assembly Facility is located on 897 acres near New Orleans. Forty percent of the plant is occupied by Chrysler which manufactures the first stage of the Uprated Saturn I and the remaining 60 percent of the plant is occupied by Boeing for the manufacture of the Saturn V first stage. The facility includes hazardous test facilities where the stages are pressurized and pressure-checked. A runway is used to take the stages to the dock where they are loaded on barges for intercoastal waterway transportation. Barges and ships

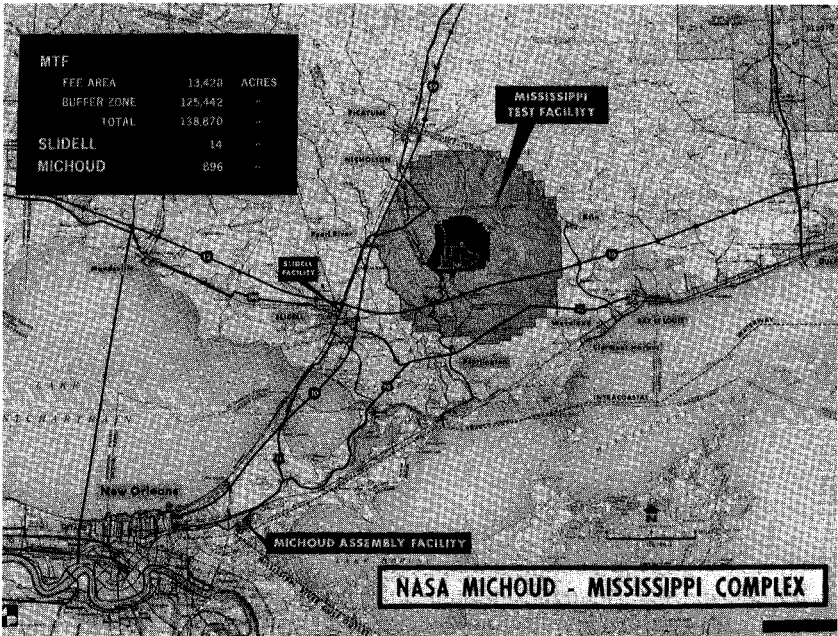


FIGURE 62



FIGURE 63

are used to transport the stages to the Mississippi Test Facility and to Kennedy Space Center.

Closely associated with this is the Slidell Computer Operations Office Facility (fig. 64) located between the Michoud Assembly Facility and the Mississippi Test Facility in the small town of Slidell, La. This facility originally belonged to the Federal Aviation Agency and was surplus a few years ago when we acquired it. Like Michoud, the Slidell operation is one of the best in this part of the country and serves both the Michoud and Mississippi facilities.

The Mississippi Test Facility (fig. 65), located northeast of Michoud, is in reality an important national test range. Here the first and second stages of Saturn V are test fired. Surrounding the test site fee zone where the Government owns the property, is a buffer zone in which we have certain rights which preclude, for example, habitation.

Located across the canal from the Michoud Assembly Facility is the Air Products & Chemicals Inc. plant (fig. 66). This is the plant from which we acquire most of the liquid hydrogen and liquid oxygen for the Saturn vehicles. Cryogenic barges transport the propellants along the intercoastal waterway, up the Pearl River and to the test stands at Mississippi (fig. 67).

To summarize the activities and the relationship of the facilities located in the Louisiana and Mississippi area (figs. 68 and 69), the

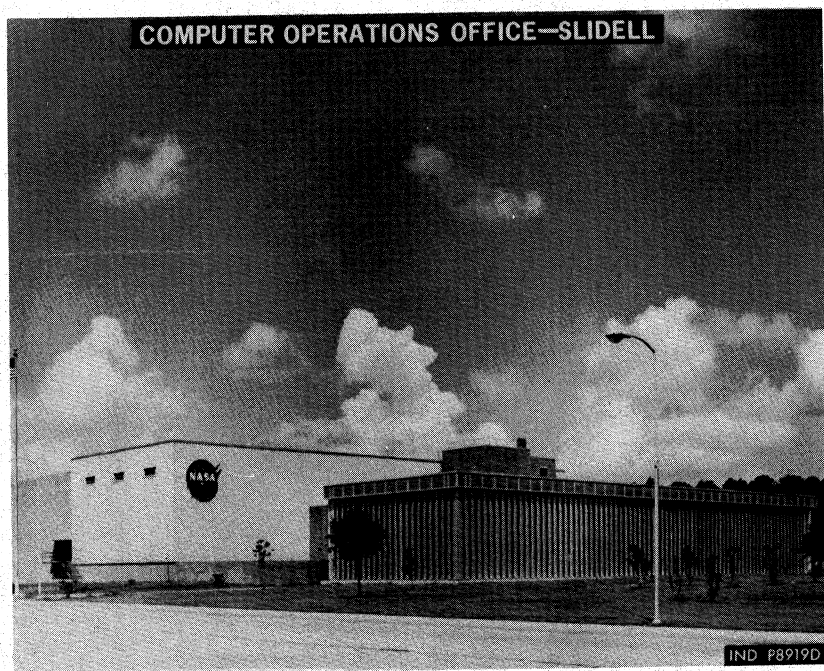


FIGURE 64



FIGURE 65



FIGURE 66

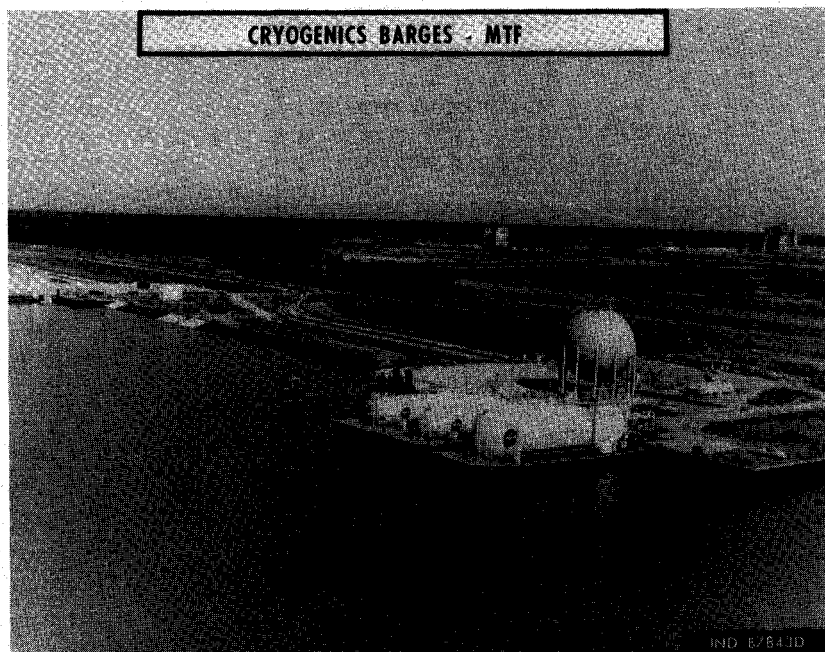


FIGURE 67



FIGURE 68

Saturn V first stage is manufactured at Michoud. The stage is barged to the Mississippi Test Facility for static firing. The Saturn V second stage, manufactured on the west coast and shipped by ocean-going vessel to Michoud, is also barged from Michoud to the Mississippi Test Facility for static firing. The first stage is returned to Michoud for checkout and refurbishment; second stage refurbishment is accomplished at the test site. Both stages are shipped by water to the Kennedy Space Center.

Many ancillary facilities have been activated by private industry in this area in support of the total Saturn program.

The complex has a work force of approximately one-half billion dollars or more. It is a very vital element in the Saturn Apollo and Manned Space Flight program and is one of the newest and most important national assets in the United States.

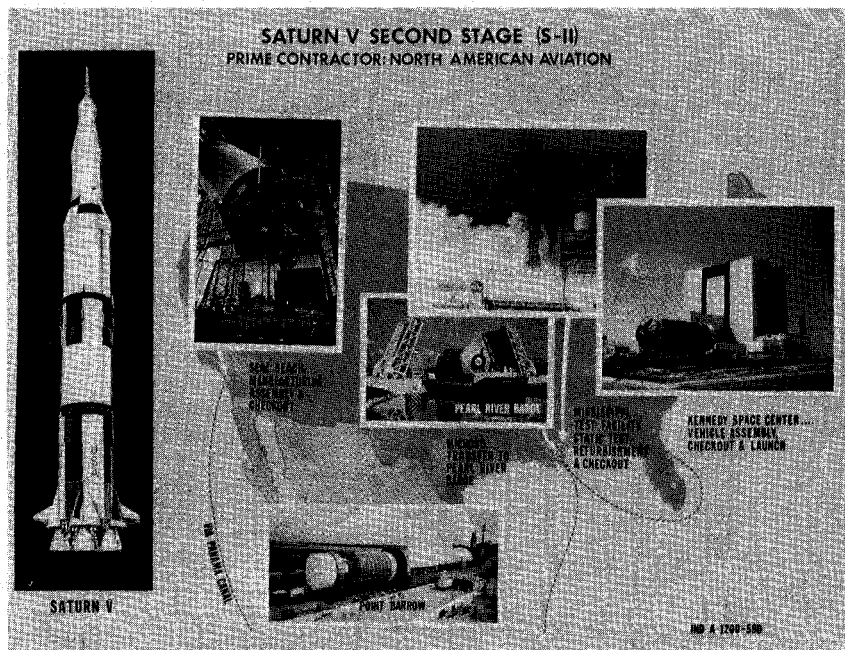


FIGURE 69

STATEMENT OF DR. WERNHER VON BRAUN

PART III. APOLLO APPLICATIONS PROGRAM AND FUTURE PROGRAMS FEBRUARY 10, 1967

Mr. Chairman, gentlemen, my presentation this afternoon will cover the Apollo Applications Program, and, in more general terms, some thoughts about our space program of the future. I will also touch upon the Voyager Program which, as you know, would send an unmanned probe to the planet Mars. Voyager is not a Manned Space Flight Program; it is under the cognizance of Dr. Newell's Office of Space and Applications. Marshall will play at least the role of launch vehicle supplier for this program because Voyager will fly aboard the Saturn V. It is possible that we shall also play a major part in the development of the interplanetary spacecraft. Finally, I would like to say a few words about potential applications in space of nuclear propulsion.

You have just heard a comprehensive report by General O'Connor on the status of our Saturn Program for Apollo. Perhaps the best way to begin a discussion about our next steps in space is to catalogue the manned space flight capability our country will have after the Apollo hardware and supporting capabilities become fully operational. This chart lists these capabilities.

First, Apollo will provide us with a capability to conduct manned space exploration as far out as the distance to the moon, about 250,000 miles from earth.

It will provide us with the capability to make a manned lunar landing and allow two men to spend 36 hours on the lunar surface.

Apollo will give us the capability to accommodate a three-man crew for a period up to about 2 weeks in earth orbit.

The flight hardware which will be provided by the Apollo Program includes two launch vehicles, the Uprated Saturn I and the Saturn V, and a spacecraft consisting of a command and service module, and a lunar module. The lunar module, in turn, is a two-stage rocket consisting of a descent stage and an ascent stage.

The development and manufacture of all this hardware, as well as the operations capability, are the product of a unique resource base which can readily be employed for our next steps in space. We have our worldwide data acquisition network. We have the factories and the laboratory and test facilities, such as Sacramento, Mississippi, Cape Kennedy, Houston and right here in Huntsville—about \$4 billion worth of Government investment.

And all of this is undergirded by a highly skilled manpower base. Today we have about 290,000 people in the Apollo program, about 60,000 less than the peak figure of 350,000 about 1 year ago. We believe that the \$20 billion investment in our manned space capability is really best manifested by these people. That's the greatest

MANNED SPACE FLIGHT CAPABILITIES
PROVIDED BY APOLLO PROGRAM

- Manned exploration of space as far as 250,000 miles from earth, including manned lunar landing and 36-hour stay time on lunar surface.
- Ability for three-man crews to carry out operations and experiments on earth-orbital flight missions up to two weeks in duration.
- Flight hardware:
 - Launch vehicles: Up-rated Saturn I and Saturn V
 - Spacecraft: Command and Service Module, and Lunar Module
- Unique resource base:
 - World-wide tracking and data acquisition
 - Facilities and logistics
 - Highly skilled manpower base
 - Management know-how

CHART 1

single resource that this program is producing. It has been said many times that in Apollo we are not spending our money on the Moon, we are not spending our money to pick up a handful of lunar dust and bring it back to earth. We are spending it right here on Earth, and by far the greatest single factor is the payroll.

People, who are learning how to do things in an unprecedented way by developing these systems for Apollo, are certainly our most vital resource as they apply their new-won skills to future programs.

Finally, to get this big job done, we have developed the management know-how: the know-how for keeping a large program, costing more than \$120 million a month, on track by providing sufficient visibility of the progress of all elements and subelements of the program in such a way that we can detect early enough where trouble can be expected. This, I would say, is really the gist of good management of such a program. If we wait until something caves in, it is then too late to take remedial action. So the eyes and ears of our management network must penetrate the contractors, Government agencies and universities participating in this program in such a way that we get seismic readings early enough to apply remedial action.

So management know-how is also a capability which is a direct product of our Apollo program, a capability, I might add, that can be applied not only for our future space programs, but for the management of other major private and government programs as well.

This brief listing of the Manned Space Flight capability provided by our Apollo program suggests the very considerable first steps we have taken to establish our country as a preeminent spacefaring nation. But we must remember that, impressive as these achievements are, they are only first steps when we consider the vast possibilities for the future which mastering this new ocean of space opens up to us.

I have listed on this chart areas which I think hold out the greatest promise for man as he continues his space adventure. There are four major areas. First, and certainly most important today for our problem-plagued planet, is providing systems to improve man's lot on Earth. Secondly, using new scientific tools for the general advancement of knowledge in fields like astronomy, physics, biochemistry, and so forth. Third, exploration of the Moon and the planets, manned and unmanned, and, finally, technological support to other national programs, to feed the know-how developed under the aegis of the space program into other sectors of national activity, so that we can keep our industry vigorous and progressive, and continue our technological leadership.

THE FUTURE PROMISE OF MAN IN SPACE

Improvement of Man's lot on earth

- Earth resources management
- Weather forecasting and control
- Navigation and traffic control
- World-wide communication and television

Advancement of Knowledge: Service to Science

Exploration of the Moon and Planets

Technological support to other National Programs

Now let me address myself to these four points in more detail.

Improvement of man's lot on Earth. We believe one of the most exciting prospects of the space program is providing a highly sophisticated tool for Earth resources management. As you know, the Earth is presently undergoing what is called a population explosion. The number of people on Earth is growing at an unprecedented rate. Let me give you a few figures. Between the birth of Christ and the year 1700, mankind doubled. It doubled again between 1700 and 1900; and in that interval it didn't take 1700 years, it took only 200 years to double. There are 3 billion people on Earth today, and right now the number of people on Earth is doubling every 33 years. This means there will be over 6 billion people by the year 2000 and from 12 to 13 billion by the year 2033. Now the year 2033 is only 66 years away from us. This means our own children will be very deeply involved in the consequences of our exploding world population. Our own children, born today, will be around 60 or 65 years old, and they will live in a world of 12 or 13 billion people. Now the experts believe that the Earth has enough basic resources to support 12 or 13 billion people. Even if many more countries become industrialized during that period of time, these experts believe there are enough resources in the form of oil, mineral resources, and so forth to support this population for hundreds of years.

But the problem is deeper than these absolute figures or the rate of growth. The areas of greatest population growth on Earth today, both absolutely and relatively, are the underdeveloped nations of the world. Modern medicine has begun to make its beneficent inroads in these nations, reducing the infant mortality rate and increasing life expectancy. But the rate of births has been rising, too. And so it is here, in these underdeveloped areas where people already have too little to eat, where the population explosion is having and will have its greatest impact. Moreover, more than 50 percent of the entire population in many underdeveloped countries consists of children under 15 years of age. No wonder we read forecasts of famine for vast areas of Asia:

Breadwinning in these areas becomes the sole preoccupation, as these nations spend their meager resources simply to stay alive, with little or no money left over for the development of new production facilities to improve their own lot or that of their children. It is a hopeless, almost vicious situation.

We believe that one effective antidote is a worldwide Earth resources management system, something which today is a very primitive thing. For example, only 9 percent of the land surface of the Earth is presently used, either in the form of acreage where food plants are being grown or where livestock are being raised, to feed the world's people. Much of the other land cannot be used because it is too mountainous, or too cold. But there is plenty of land that potentially could be used for agricultural purposes, if, for example, we are willing to go into the jungles of Brazil and convert these jungles into an agricultural area, a step which would require tremendous additional investment in the form of things like roads, railroads, telephone, and electricity. In view of the cost, many people who have studied this problem believe that the smartest thing to do, at least for the time being, is to get more

food out of the 9 percent that is presently being used. For it is a fact that the average crop yield in underdeveloped countries is about 25 percent of that found in highly developed agricultural countries such as the United States or Western Europe. Yields are excessively low in India, large parts of Africa, sections of Latin America, and so forth.

Now then, what has all this to do with our space program? We have all seen the pictures taken with a Hasselblad camera from the Gemini spacecraft. The Hasselblad is a simple hand-held camera, not very sophisticated, but its pictures showed a tremendous amount of detail. Now, if we can combine more sophisticated cameras, with better resolution, with some new types of film material that have recently been developed, we shall be able to use the space medium to conduct continuous, never-ending surveys of our Earth resources. We shall be able to tell rye from barley, and rice from soybeans. We shall even be able to tell how those soybeans or that rice is coming along. And this includes seasonal variations. We shall be able to mark the progress of these crops through their growing seasons, and the impact of weather—droughts, storms, hurricane damage—on that progress. And at harvest time, we can predict the harvest yield in various parts of the world. Now this business of being able to identify “what” and “where” and “how much” is going to be harvested in various locations of the Earth is half of the problem of Earth resources management; namely, the supply of food available.

The other half is the demand, and this is measured in numbers of people. The very same system that enables us to distinguish between types and qualities of crops can also give us the pattern of population growth. If we continuously overfly the same areas we can learn by city and town where man is multiplying most rapidly. We can know how many eaters there are and where they live.

These supply-and-demand data gleaned from Earth-orbiting spacecraft would give us the information needed for resource management.

We would feed this information into a computer, and the computer would tell us many weeks ahead of time of famine in Calcutta or somewhere unless we do something soon. Food shipments could be initiated before disaster hits. This is one benefit.

But there are other benefits. Suppose we learn that the yield in certain parts of the world are consistently poor. As part of our worldwide system we could employ multispectral sensors to find out what the problem is—too much salinity in the soil, poor fertilization, not enough water, maybe soil erosion. We could convert this information not only into food shipments, but into words of advice to solve a chronic agricultural problem. Instead of food, we could ship fertilizer, or even consultants to give some advice on the spot. And then, if we bring our communication satellites into play, to educate people directly on steps they can take to help themselves, we have another powerful tool in space for solving the problem.

The system I have been describing could do more than just look at crops and people.

In addition to application for food management, these same sensors could also be used for prospecting for ore and oil deposits and for updating maps. It has been estimated that it costs about \$1 billion a year to update all the maps in the world. And no systems are simpler

and more effective than doing this updating with photography from orbit could be.

We could also use this tool for oceanography, another important aspect of earth resources. Not only could we determine things like sea state and water temperature, but we could also measure, for instance, salinity of water and plankton content. These elements in combination have a direct effect on the habits of fish. Plankton is a basic food material produced by the sea, and wherever there is plankton, there you will find little fish. And where you find the little fish, you find the big fish. So if we keep an eye on the plankton distribution in the oceans, we can tell our fishing fleets where to go.

Now I don't want to mislead you in this area. We are not in a position to inaugurate, effective tomorrow, a complete worldwide resources control system that can do all these things. This is a very major research and development proposition. Much work would have to be done in what we call ground truth correlation tests. It is necessary to overfly accessible patches of land, for instance, not only in the United States, but also in other climatic regions to calibrate our sensors and photographs under conditions where we can compare the pictures with what we really find on the ground. And this procedure of calibrating sensors and cameras is the first step.

Now, the question may arise, "Why go into orbit to make these surveys? Can't we simply get this information by sending questionnaires to the Department of Agriculture?" Well, maybe in the United States we can, but we surely cannot do this in areas like India or central Africa, or northern Latin America. These data certainly have not been collected and organized, and the farmers individually don't know. So photography from above is necessary.

Then the question, "Why not take the pictures from an airplane?" Well, it's a question of cost, really. Whenever we want to continuously watch, record, or measure on a global scale anything that constantly changes, like crops, we would have to run up an exorbitant fuel bill if we did it with an airplane. On the other hand, sending a space system to orbit may be more costly, but once it gets up there, it stays there; and the longer it stays there the more economical it becomes. We can easily establish fixed points where we can say, for example, that a Saturn V, after half a year, breaks even with a DC-8; and after 1 year breaks even with a Cadillac; and after a year and a half breaks even with a Volkswagen; and beyond that, even beats a Honda scooter in miles to the gallon. So whenever we have need for a system that we need to do a job for a long, long time, such as constantly surveying vast expanses of earth, the space system is simply more economical.

You know, all these questions about one booster being a little cheaper than another are completely masked by this overall effect: that, if we extend the operating usefulness of the system, it will pay for itself. It will pay for itself just because of this basic feature that in orbit we don't have to burn fuel to stay there. So, I personally do not believe we can run a system like this any other way with anywhere near the economy than we can from space. This is a new capability that space is providing us.

The way we would do it would be to put a satellite, or several satellites, into orbits with sufficiently high inclination to the Equator, so

that earth rotates within the orbit. The northernmost part of the orbit would be close to the Arctic Circle, and the southernmost part close to the Antarctic Circle. Thus we would have basically all of the interesting land and sea masses under the swath of the spacecraft that continuously overflies it.

One of the most challenging aspects of this whole operation will be data processing. The computer center on the ground, unless we do it right, can be virtually drowned by the continuous torrent of data coming down from the spacecraft. The spacecraft gets its electrical power from the sun, through solar cells that never wear out. Incidentally, our little Vanguard satellite is still beeping although it went up 9 years ago. So here the question is "What shall we do with all this data?"

Well, much of the data collected is probably not needed, such as that picked up when overflying oceans or cloud-covered areas; or if we have 4 weeks of good weather somewhere in the United States, we don't need any more data of that particular area. Yet there may be other areas where the weather is, on the average, pretty bad and where we can get a good clue to the crop situation only occasionally. These data are important. The most important function of this computer center will be to reject the useless data and select what's really important and process it. This includes distribution to the interested parties. For example, the Department of Agriculture or the Department of State may want to know about crops; the U.S. Geological Survey may want to get data on oil or mineral deposits; and maybe the Navy would like to get some data on oceanography. So dissemination to many, many agencies would be involved.

Another application for improving man's lot on earth is global weather forecasting. The basic technique would be the same. We would look down at the weather from the spacecraft as we have already done with Tiros and Nimbus satellites, and get all the information on the movement of cold fronts, overcasts, and so forth.

Now these early systems, Tiros and Nimbus, certainly real achievements in their own right, may be considered primitive when considered with future possibilities. Tiros and Nimbus use television cameras. But imagine for example, the employment of a technique called cross-beam correlation. With this technique we can measure turbulence layers, including the famous clear air turbulence in the air at various altitudes. Clear-air turbulence is a problem for our high-flying military and commercial jets. And advanced satellite weather forecasting system can also employ ground stations. For example, we could have 100 stations on the ground in various locations, some even in buoys anchored in the oceans, so that whenever the satellite appears on the horizon, the ground station would release a balloon. As the balloon rises through the atmosphere, it would record the temperature, density and humidity, stratification of the atmosphere, and then radio this information up to the passing satellite. The satellite would simply record it. It would code the number of the station and write down what the station records. Then whenever this same satellite overflies a central weather report station in the United States, it would just dump its information collected from all over the world into the central station. The station would feed it to a computer, and the computer

would process it and provide forecasts, for example, of what the weather will be in New York in the next 2 hours, 4 hours, 6 hours, 8 hours, 24 hours, and so forth.

The question of how we could make such a system pay—it must obviously be done on an international basis—could be solved quite easily by offering people who participate in the program the benefit of this weather service. Take a smaller country, like Portugal, that cannot afford its own major space program. The Portuguese could either subscribe to the service or they could get this service in exchange for making a few trawlers available to service some buoys in a certain stretch of the Atlantic Ocean.

Now the next item listed for improving life on earth is navigation and traffic control. We are conducting a study here at the Marshall Center on what else one can do in the area of navigation and traffic control from orbit. You may be aware that there are transit satellites in orbit today that are used by the Navy to track ship positions. Such satellites are relatively simple. When such a satellite comes over the horizon of a ship anywhere on earth, the satellite furnishes its own orbital data, in coded form. Now these orbital data were originally established when the thing went into orbit, but due to normal orbital decay, it is necessary to update these data and this is done with ground tracking stations. Every now and then they send the satellite a new set of updated orbital data on its own position in orbit that's good for the next few weeks. Now there's a receiver on the ship that gets this signal from the spacecraft as it passes. It makes use of the doppler effect.

For an example of the doppler effect, when a locomotive is approaching you with its whistle blowing, the tone suddenly drops as the locomotive is passing you. It is just as if you are in a boat running against the waves; you see waves of higher frequency than you would if you were running with the waves. So as the sound waves are coming from the train approaching you, you hear a higher frequency than when the train is going away from you. The same doppler effect, the electronic equivalent of it, is used in these navigation satellites. The satellite produces a tone, and you measure the doppler effect. If you have a slanting pass, the doppler effect is not as great and not as abrupt as if it passes directly overhead. Now for the ship to calculate its position, it follows a procedure similar to that used by a surveyor who wants to know where he is. He looks at mountain A and mountain B, and makes a triangulation. He knows the distance between the two mountains, so he knows the baseline of the triangle. He measures the angle between the two mountains and thus determines where he is. Well, when the satellite goes through an orbit, it knows its orbit and it knows: At this moment I am here, a little later I am there, and still a little later I am over yonder. So what the ground- or ship-based computer really does is make a triangulation with a single but "moving mountain." The ship itself need not send out any signals at all. It carries a handbook showing when a particular satellite will be visible from a certain part of the world just like you get a sunrise and sunset chart. So all the skipper does is take the satellite's signal, and after the satellite has passed, the little combination receiver-computer in the ship gives him a print-out of the longitude and latitude of his

own ship. Incidentally, if you have a seagoing yacht, you can buy, for about \$12,000, one of these little gadgets. At any rate, this shows us what is being done with satellites today in the area of navigation.

Traffic control is a more elusive thing. Right now in the North Atlantic we have the problem of increasing air traffic. During the same optimum time of day or night, every transatlantic airline wants to go across at the optimum route and altitude westbound or eastbound, as determined by wind and weather conditions. For customer convenience every line wants to fly during a few rush hours, so there are tremendous peaks where a lot of traffic is condensed into a very narrow airplane and a very narrow time window. Today they space these airliners at a minimum separation distance of 120 nautical miles, at the same altitude. This is considered reasonably safe, but they are now talking about reducing this to 90 nautical miles. This proposal has caused some heated debate among airline captains as to whether this is really a safe thing to do. If any one of these planes isn't exactly on the spot where it's supposed to be, it will endanger the plane ahead or behind. So there is a pressing demand for positive transoceanic air traffic control, particularly in the North Atlantic area.

Air traffic experts would also like this traffic control to be integrated with better weather advisory service, preferably in the form of a weather map being cast directly onto the pilot's weather radar so that he can see where he is, where the other planes are, and where the bad weather is—the whole thing in an integrated display. We believe this is a very promising thing and may be so promising that it could even become attractive for aviation over the continent.

The final item on the chart, under improving man's lot, is worldwide communication and television. Today Syncom is the only undertaking in the world that is making money out of space. They are leasing channels for transatlantic telephone now, I believe, for 11 cents a minute for telephone calls, which is a fraction of the cost to lease a cable. Again, I believe, this is only a beginning. A relay satellite system employing synchronous satellites at 22,000 miles' altitude, moving from west to east, in the plane of the Equator, with the speed of the rotating earth, provides relays that are simultaneously visible from all North America, Latin America, Europe, and Africa. They are high enough so that they are in direct line of sight, and since they rotate at a period of revolution of 24 hours, they appear to stand still at one point above the Equator, for example, a little bit east of the mouth of the Amazon River. There are several satellites sitting there at this very moment providing such radio telephone relay links.

You can use these same things for global television. In fact, they have already been used. The method is to tie up a large number of telephone channels and use them for television. But in due time there will be full-time television relay satellites of this kind. But one can go even beyond that. If we put into such a synchronous orbit a relay satellite, not only operating at a couple of hundred watts as these present things do, but put a 50-kilowatt station in there, we can go directly into home antennas on the ground. All we would have to do is give people about a 2-foot dish that's pointing at one point in the sky, and they could receive these signals directly. We call that television broadcast by satellite. The present relays, by contrast, work through

a large ground station with a big dish on the ground, which in turn rebroadcasts the television programs locally.

Now the political implications of direct TV broadcast are pretty clear. If a country wants to participate in a worldwide television and telephone service, it can arrange this under the present relay concept by buying a ground station for something like \$3 or \$5 million. With that ground station, it can pick up from the satellite whatever it wants to rebroadcast locally. The essential point is that the government that controls the ground station also controls the switch that permits it to turn programs on and off. If it doesn't like a program, it doesn't rebroadcast it. Now if we go with more powerful satellite transmitters directly from orbit into the home antenna, we could bypass these governments, something which might not be so popular with many countries. On the other hand, of course, such a system would be an extremely powerful tool for all kinds of programs from educational television to political propaganda. Fully recognizing that economic and political pitfalls exist, we should bear in mind that this technique is technologically within reach today. David Sarnoff, chairman of RCA, once said that with such a television system, we could eradicate illiteracy from the face of the globe within 10 years. I think this is no overstatement.

Well, I think I have said enough about improvement of man's lot on earth, but I would like to leave a message with you that we can indeed do a great deal with our present space capability to help man right here on earth.

This doesn't mean that we don't believe that space as an arena to advance science is important. After all, it is science that feeds the mechanism of progress. You had a briefing this morning about our astronomical telescope mount and its purpose to observe the sun in the light of X-rays, gamma-rays, and far ultraviolet. Because the atmosphere of the earth is opaque for these radiations, very little knowledge is available about the sun's appearance in the "light" of these rays. To those who would question why we should study a thing as obtruse as X-rays emanating from the sun, I would say that thermonuclear energy was first observed in the sun. Our hydrogen bombs today, as well as our efforts to generate thermonuclear energy for other purposes, is a direct result of discoveries made while observing the sun. And yet, all we know about the sun today is what we have learned in the region of visible light for which the earth's atmosphere is transparent. But when you look at the entire electromagnetic spectrum, this region is only a tiny little window. For most of the rest of the spectrum, our atmosphere is opaque, the sole exception being a "window" for certain radio waves, which has led to the new science of radio astronomy during the last few decades. Dr. Fred Whipple, head of the Smithsonian Observatory, once said that all we know about the universe is what we've learned through the dirty basement window of the atmosphere. This is certainly true, and I think we are liable to learn a great deal about the most fundamental processes at work in the universe simply by opening up this dirty basement window. We are about to do this now in our Apollo applications program by going out in space and observe and measure these ultraviolet, X-ray, and gamma radiations from the sun and stars.

Another area holding great promise for man in space is exploration of the moon and the planets. I do not have to say very much about this. Man has always been curious, and he has learned through history that it has paid off very handsomely to continue to satisfy his innate curiosity. It is hard to predict what the direct payoff of exploratory ventures will be. After all, curiosity was a primary motive compelling Columbus to sail westward, and look what he found. Who knows the bonanza awaiting us through exploration of the moon and the planets.

The final item on this chart is technological support to other national programs. This includes the application of the new knowledge, new technologies, and new management techniques provided from our space program to other national endeavors, running the gamut from military to industrial and medical programs.

Thus, we can see that man in space holds out simply tremendous possibilities for the future. But, after all, this is what I have been doing for these past minutes: Attempting to describing what can be in store for us in a future space program.

Today, in manned space flight, we stand on a plateau of technology provided by the Apollo program. This technology provides much of the platform for doing many of the things I have been describing, but it certainly does not satisfy all of our technology requirement for such a future program. We cannot stop now. We must continue to grow technologically if we are to realize the real promise of man in space.

If we want to utilize fully man's capability in space, we shall need a space station. We shall need a capability for man to stay in orbit for long periods of time so that he can work and rest and sleep and eat under conditions as similar as possible to what he's used to here on earth. You saw today our humble beginnings in this area in our orbital workshop, and we feel that this is really a bargain basement deal to come to grips with the habitation problems in outer space. We don't propose to have all our future space stations built into empty tanks of rockets, but we feel since these Saturn IB's are going up there anyway, this is the cheapest and easiest way to learn. Techniques on how to build space stations can very well be based on this learning, too.

Long stay time in space involves not only building a space station but also the provision of a logistics supply system. We can have a space station that is good for several years, but nobody would like to stay there for the life of the station. So we have to rotate crews; we have to fly new supplies up there; we have to bring data back to the ground; we have to update equipment; we have to support this entire system with logistic supply systems.

It was actually this interrelationship between the logistic supply system and the conduct of science at the far end of this logistic supply system that motivated Robert Gilruth and Max Faget of the Houston Center and Ernst Stuhlinger and myself from the Marshall Center to take a trip to Antarctica a few weeks ago. We had long felt that there was a great deal of similarity between some aspects of the space program and the Antarctic program. Of course, we knew they don't wear space suits in Antarctica, and you can't wear a parka on the Moon. Also, they don't fly in rockets to the South Pole, but in turbo-props. But other than that, we found our belief fully confirmed that

many operational aspects of work in Antarctica and future work in space are similar enough to make fullest use of the tremendous body of practical experience accumulated "down there" over the years. When they have sudden emergencies on the ice, their logistics system must respond just as quickly as ours will have to respond in space. And the scientists in those remote polar stations are just as vulnerable and just as dependent on the working of this long logistic supply system as an astronaut scientist would be in a space station. We just wanted to know how this interface between science and operational support looks and how it really works. We learned a great deal.

Now the question: how do we get from here to there? How do we get from the capability provided by the Apollo program to the kind of capability we shall need to realize a future in space of the type I have just described?

We can answer this in the abstract, or we can answer it in the light of today's realities and constraints. I prefer to do the latter, because it is these constraints which have provided the basic rationale for the Apollo Applications program.

This chart lists these constraints. First, our next step must be a logical one toward our longer range objectives in space. Next, because we are confronted with an austere budget situation for new starts in fiscal year 1968, we shall have to make maximum use of the hardware and resources provided by Apollo—and this includes capitalizing on the momentum of Apollo. One unknown in Apollo is that we really don't know exactly how many flights we will need before we are successful in meeting our objectives, so there may be some hardware left over from the mainstream Apollo program. If there is, we would like to employ this hardware immediately in the follow-on program. So it is highly desirable to convert this not-needed Apollo mainstream hardware as fast as the situation will permit to these follow-on objectives.

To summarize these first three points, we want to provide the greatest gain in space capability at the lowest possible additional cost.

This chart lists the objectives of the Apollo Applications program.

A great deal has been said about what men "can" do in outer space, but in Apollo Applications we plan to address ourselves more and more to the question of what "should" he do. For example, is a man desirable as a maintenance man or does he just get in the way if you have him up there? Where can he really make a major contribution? For instance, it's pretty obvious that when it comes to measuring cosmic radiation in outer space, man doesn't have a built-in sensor to measure it, so his only function would be to bring up an instrument and read the instrument. Man really is not necessary for this kind of a job because we could much more easily telemeter the information down and read the instrument on the ground. But let's take another example. Any geologist can tell you that an untrained man can walk many miles in an area and find nothing, but a trained geologist might find a single pebble in that same area that is the key to the geological history of the whole area. In this case, man is very necessary with his ability to absorb information, correlate it with previous experience, and draw a conclusion. No computer can do this today and probably never will. We must learn those activities where men can really make a great contribution.

THE NEXT STEP AFTER APOLLO

CONSTRAINTS

- Logical evolutionary step toward proposed national space objectives.
- Austere budget to support new starts.
- Maximum use of Apollo investment: hardware, resources and momentum.
- Greatest gain in space capability at lowest possible additional cost.

CHART 3

APOLLO APPLICATIONS PROGRAM

OBJECTIVE: Use Apollo capability to -

Determine role of man in space science, applications and operations: what can he do; what should he do.

Develop capability for economical space flight by modifying flight hardware for long-duration flight and re-use.

Determine whether sensing devices can be effectively and economically employed in earth orbit for earth resources management, meteorological, communication, navigation and traffic control purposes.

Conduct observations in astronomy and space physics.

Conduct extended Lunar exploration.

CHART 4

We will always have to pay a price for carrying man along. He has to be kept alive and provided all the equipment with which to live and function. This costs money, so we must identify those areas where man can contribute more than he costs. We are deep in the process of doing that.

I mentioned the question of long stay-time. This, of course, ties in with man's ability to be effective in space. We must answer important questions here, too. Do we need artificial gravity as we extend our stay-time in space, or will people be perfectly happy with the zero gravity they had so far? To what extent can man use his manipulative skills if he is encased in a space suit? Then there's the question of just simple, plain creature comforts. I think it was astronaut Frank Borman who was asked, "What is it really like to spend 2 weeks in a Gemini spacecraft?" He replied, "Have you ever spent 2 weeks in a stall in the men's room?" I think this a pretty vivid description. We have to get out of this very primitive state of affairs and provide them with a little more comfort so that they can sleep better, eat better, and have a little more privacy so they can do some thinking, some paper work, and maybe have a little entertainment.

Our Apollo Applications program aims at providing a 1-year stay-time capability as a first objective. This program will also provide the means for men to do a great deal in the development and evaluation of sensing devices. I mentioned these sensing devices earlier for Earth resources control, for prospecting, for weather, and also for traffic control. Now while some of these systems may ultimately run unmanned, it is still necessary to first evaluate which of the many possible sensors are really optimum. And we believe that men will play a very important role in a spacecraft during the development period to make these evaluations, even if he does ultimately withdraw and the operational system then works unmanned.

To take traffic control as an example. I don't think we would want to expose North Atlantic air traffic control to new-fangled, untested automatic satellites without first having monitored and evaluated the system by people on the spot to make sure the system will actually do what we want it to do.

So man may play a temporary role in some areas. This may be the case in some portions of our future space astronomy program. Finding out what measuring methods are most effective, say to study the Sun, may require man, but an eventual operational Sun-monitoring system designed to predict radio communications disturbances on Earth from X-ray bursts emanating from the Sun may well be automated.

It is my conviction, and most of us feel this way in NASA, that the demarcation between manned and unmanned space flight, a very natural split while we were learning how to fly man in space, will get more and more fuzzy in the future. After all, now that we know that man can fly in space, his reason for being there is essentially in the area of applications and in the area of science. To say it differently, if we want to conduct applications and science first class, we better use man in those areas where his contribution is necessary. We shall have to address ourselves to this problem more and more in the future. No longer can we compartmentize things as we have in the past.

Here we see the fiscal 1968 budget estimates as shown in the President's budget for Apollo Applications. The total NASA Apollo Applications program for 1968 is proposed at a level of \$454.7 million, of which Marshall would have \$199.6 million. The lion's share of our \$200 million would be to buy launch vehicles—to buy Saturn I and Saturn V rockets for the follow-on period. About \$39.2 million would go into experiments for Apollo Applications and \$31.3 million for mission support, which includes the integration and qualification of these various payloads so that we can safely fly them. Now I would like to show you some of the things this money would buy.

Here is the orbital workshop. We have seen this thing today in the flesh, so I don't want to go into too much detail. We visited all these rooms here; here's the airlock again; this is the upper end of the hydrogen tank; this space is for what one might call "extravehicular tests inside the vehicle"; this is the multiple docking adapter to which modules for resupply and mapping, the astronomical telescope mount with its associated LM control room, as well as the service and command modules, can be docked. The working area of the workshop is roughly 10,000 cubic feet or about 35 times the crew area in the Apollo command module. Our fiscal year 1968 money would pay for some of the experiments as well as modifications we would make to all this basic Apollo hardware.

Here we see again the ATM, the Apollo telescope mount, which we saw on tour, which will be used to conduct solar astronomical observations during the 1968-70 maximum of the solar cycle. The Sun has an 11-year cycle ranging from maximum and minimum solar activity. By activity, we mean not only the number of sunspots,

APOLLO APPLICATIONS PROGRAM

FY-68 Budget Estimates

(In millions of dollars)

NASA	Total	\$454.7
MSFC	Total	\$199.6
	Space Vehicles	129.1
	Experiments	39.2
	Mission Support	31.3

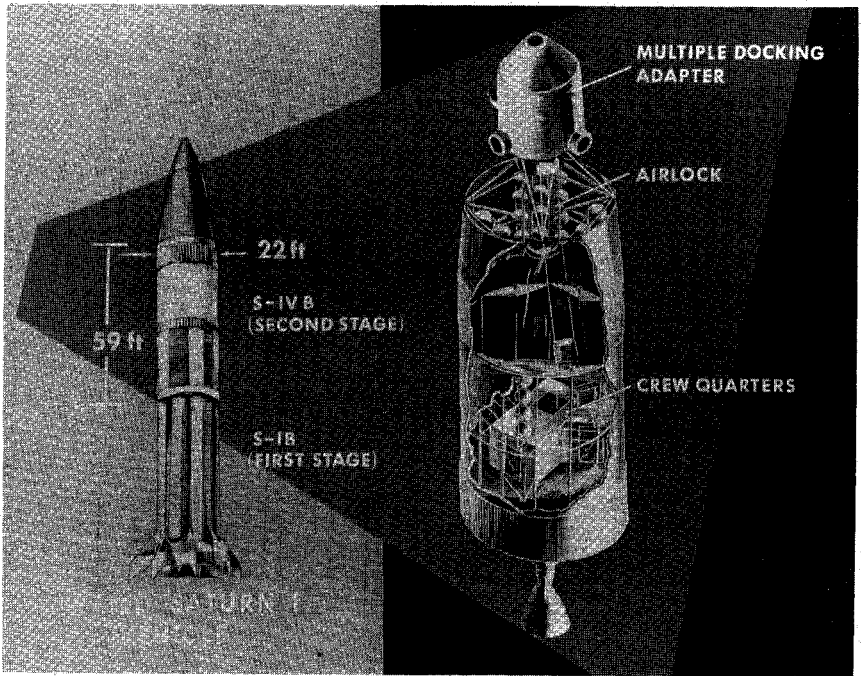


CHART 6

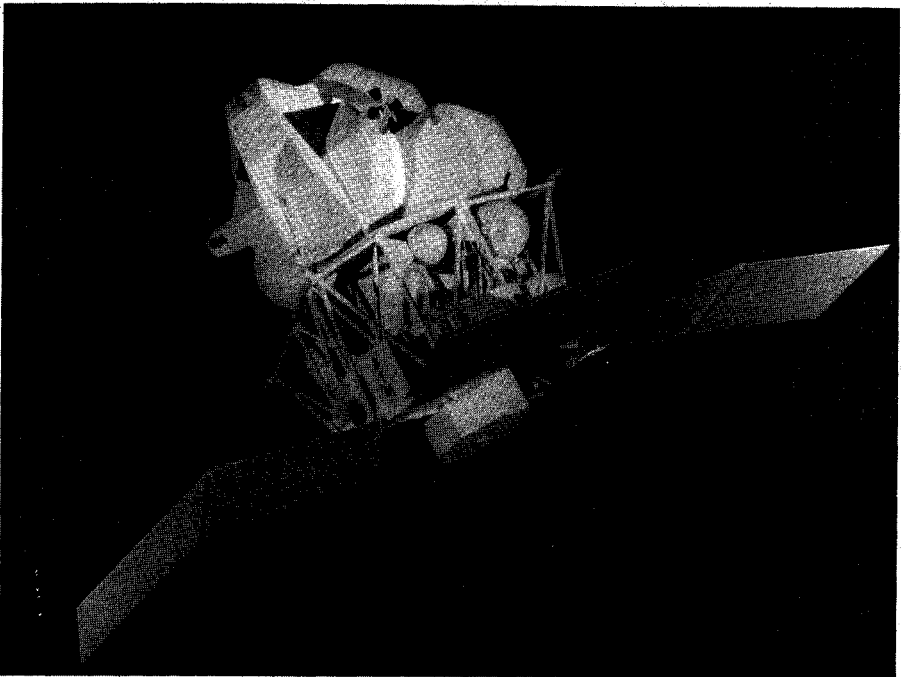


CHART 7

but also the number of emissions of solar flares. These flares are vast clouds of protons and electrons exuded by the Sun which travel millions of miles through space. They can play havoc with communications on Earth, they affect the total number of electrically charged particles trapped in the Van Allen belt and they cause many other effects.

The most important aim of this research is not just the establishment of a better Sun monitoring system for the prediction of radio communications disturbances, but simply a better understanding of the underlying mechanism of interactions between the Sun and the Earth. After all, everything that lives on Earth depends on the Sun. So we have a vested interest in the Sun. And yet the detail mechanism by which the Earth receives energy from the Sun is not very well known. It was only a few years ago man began to realize that although the Sun doesn't seem to change in appearance at all, except as to the sunspots, actually the Sun is undergoing continuous change. For example, the energy conveyed to the Earth in the ultraviolet region varies greatly over a period of hours and days. Long-term weather conditions are affected quite a bit by the variations in ultraviolet energy transferred to the Earth.

Man's role in the Apollo telescope system will be first, that of pointing and carefully alining the telescope. We will have a pointing accuracy in the ATM system that permits us to vector in precisely any given spot on the Sun and to study that area in the light of radiations not received at the bottom of the atmospheric shell. Next the scientist-astronaut, working the ascent stage of the lunar module from where the ATM is operated, can change camera settings, exposure sequences, and filters according to visual observations or previously obtained results. The astronaut-scientists will also provide maintenance, monitor the operation of the equipment, replace film cassettes, record their visual observations on tape, and send films and tapes back to Earth. Of course they could also select visual "targets of opportunity" on the Sun. Whenever there is something conspicuous developing on the Sun, they will aim their instruments on the interesting spot and capture the incident while the action is on.

We consider this solar astronomical telescope only the forerunner of another instrument for similar observations, not of the Sun, but of the stars. It would be used for the study of ultraviolet, X-ray, and gamma rays emissions from the stars. Out of these first generation projects may develop in due time something like a Mount Palomar Observatory in orbit, a tool of inestimable worth to our astronomers. Our fiscal year 1968 budget would provide some of the funding for development of the Apollo telescope mount.

This chart shows the sequence of events by which we would put our workshop and ATM into orbit. We would use a total of four Apollo Applications flights. Here are the days, counting from day zero here, marking the time intervals between flights. On the left margin is the altitude of the orbit. We would start out by sending up a manned Saturn I with a mapping and survey system. That is the high-resolution camera you saw mocked up in the hangar today. In orbit, the service and command module would detach, turn around, and make the transposition just like with the lunar module. After transposition, the

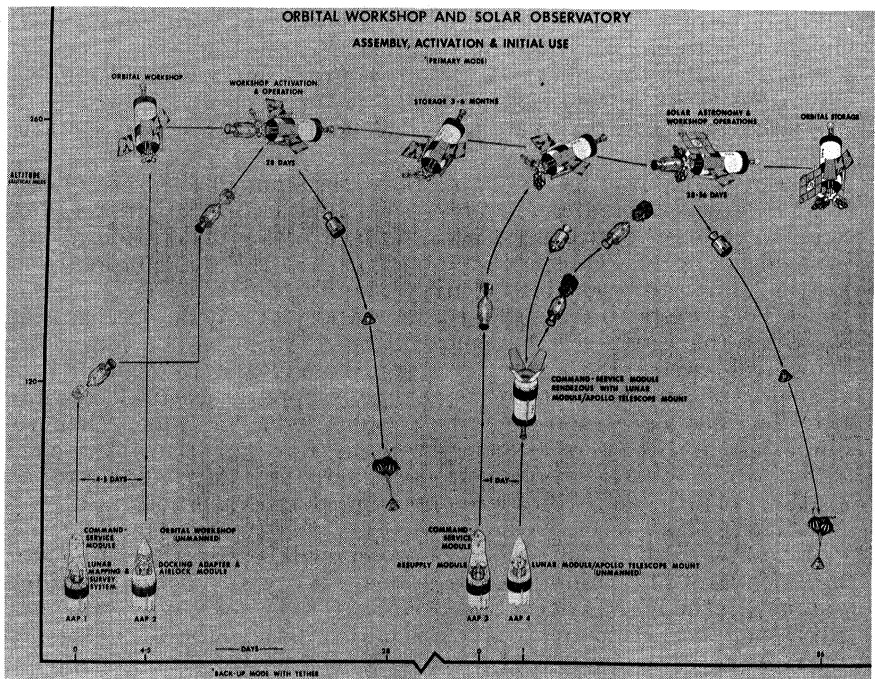


CHART 8

service and command module pulls this mapping module out of the nose of the rocket. The crew would then calibrate this mapping and survey system which will be used for later high-resolutions pictures of the Moon, by photographing certain targets on the Earth. This would take something like 5 to 8 days. Next, the orbital workshop would be launched. It would fly up unmanned, and would look like this. The airlock in front of it would be an aerodynamic shroud so the entire configuration would look like this on takeoff. The shroud would be jettisoned upon arrival in orbit.

Here's our orbital workshop, with the airlock that you saw, arriving in orbit unmanned. It would now be visited by the same spacecraft that has finished its mapping job. The spacecraft would dock to the airlock, whereupon the same three men who activated the survey system will activate the orbital workshop. They would first vent the remaining hydrogen out, let all the pressure out of the bottles, activate the electrical power generation system, move the experiments from the docking adapter into the workshop, make the whole complex habitable, and then sleep in their new "orbital hotel" for a couple of hours. All this activation work would take about another 2 weeks. So after 28 days, these astronauts would finally come home and leave the complex unattended.

Later the third vehicle would go up with a Command and Service Module carrying three new men, and a resupply module. This module would furnish a fresh supply of oxygen, water, and some hydrogen for

the fuel cells that generate electricity. The astronauts would dock the resupply module at one of the docking positions of the multiple docking adapter and activate the workshop again. Then they would get busy and continue the scientific program. You saw during your tour the 21 experiments that we are preparing. Most of these experiments would go up on the first flight of the series, but some of them would be exercised only now. Some are medical experiments, some are experiments in support of DOD, and some are just pure scientific tasks.

Finally, with the fourth flight we would send up our Apollo Telescope Mount. This flight is again unmanned. After it is in orbit, the manned Service and Command Module would pick it up, place it into another part of the multiple docking adapter and then dock itself again into another position. That's how we come to what we call our orbital cluster configuration.

We would activate this complete cluster for up to 56 days and during that time carry out all our astronomical research. Even after this period, the entire cluster, of course, remains in orbit. The "orbital hotel" is there, the mapping module is there, the astronomical telescope is there, and if we continue to send new resupply modules, we could continue the operation of the entire scientific complex indefinitely. Gradually, of course, the orbit would decay, but it happens very slowly. It is entirely feasible to use the rocket engine in the Service Module to kick the entire cluster back up some 10 or 20 miles, thereby increasing the lifetime another 10 to 15 years. So the orbital workshop cluster with its scientific modules, and supported by resupply modules, really offers us an open-end scientific program in orbit. It puts us in a position to decide at any time to either continue it for another few years or to say, "We've learned from this cluster as much as we can and on the basis of all the things we've learned, we should now build a better second generation space station."

That, in essence, is the idea. We call the whole concept the Apollo Applications Program because we follow the ground rule that existing Apollo hardware is used to the greatest possible extent.

This chart shows the cluster again in more detail. Here's the telescope mount, the mapping module, service and command module, and here's our orbital workshop.

From the cluster I have just shown you, we can progress to other more sophisticated concepts and still adhere to the same basic principle of using Apollo hardware. For instance, should we find out in all these tests that artificial gravity over long periods of time is not a good thing, we could keep a spent second stage of the Saturn V attached to an S-IVB workshop which we have completely outfitted on the ground. That is, in this case, we would not put propellants into this S-IVB stage and use its propulsive force to climb into orbit. Rather, we would equip all our laboratory and living rooms in that stage on the ground and put that "prefabricated orbital workshop" in orbit with the first and second stages of a Saturn V. Now, by putting a spin on this thing, which we could do with the existing attitude control nozzles on the S-IVB, the orbital workshop would revolve around the center axis using the empty S-II stage as a counterweight. The rotation would produce artificial gravity on the various floors of

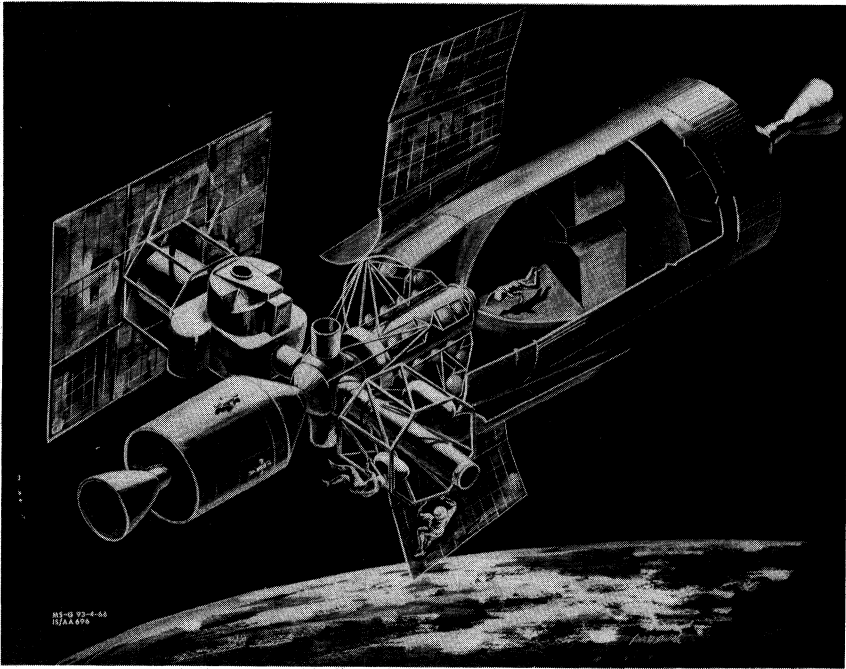
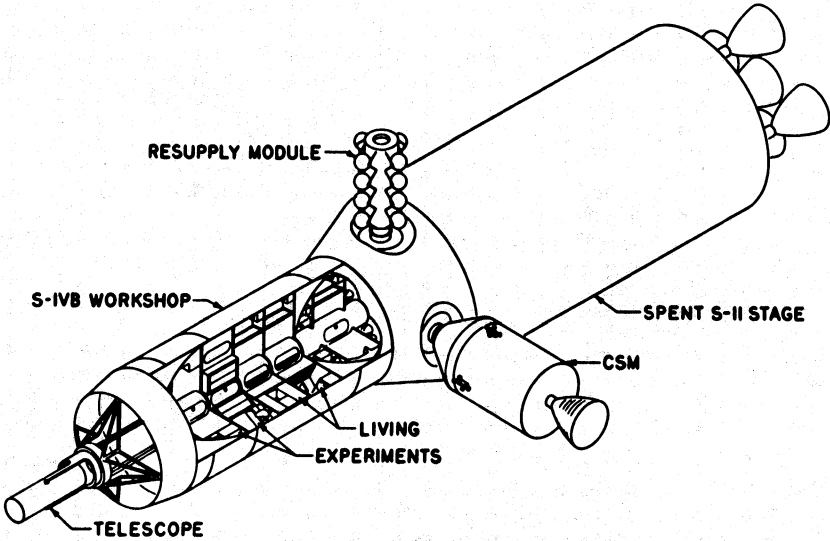


CHART 9



ONE-YEAR S-IVB WORKSHOP STATION

CHART 10

the orbital workshop so that an astronaut could stand upright on any one of them. Depending on whether we want $\frac{1}{4}$ g. or $\frac{1}{2}$ g., we would use a slower or a faster spin.

This artificial gravity configuration would use the same multiple docking adapter. As the command and service module approaches for docking, the astronauts line themselves up with the axis of the slowly rotating station and just drive into the docking port, for the center of gravity would be precisely at the location of these ports. Resupply of such a rotating station, of course, could be done in the same fashion.

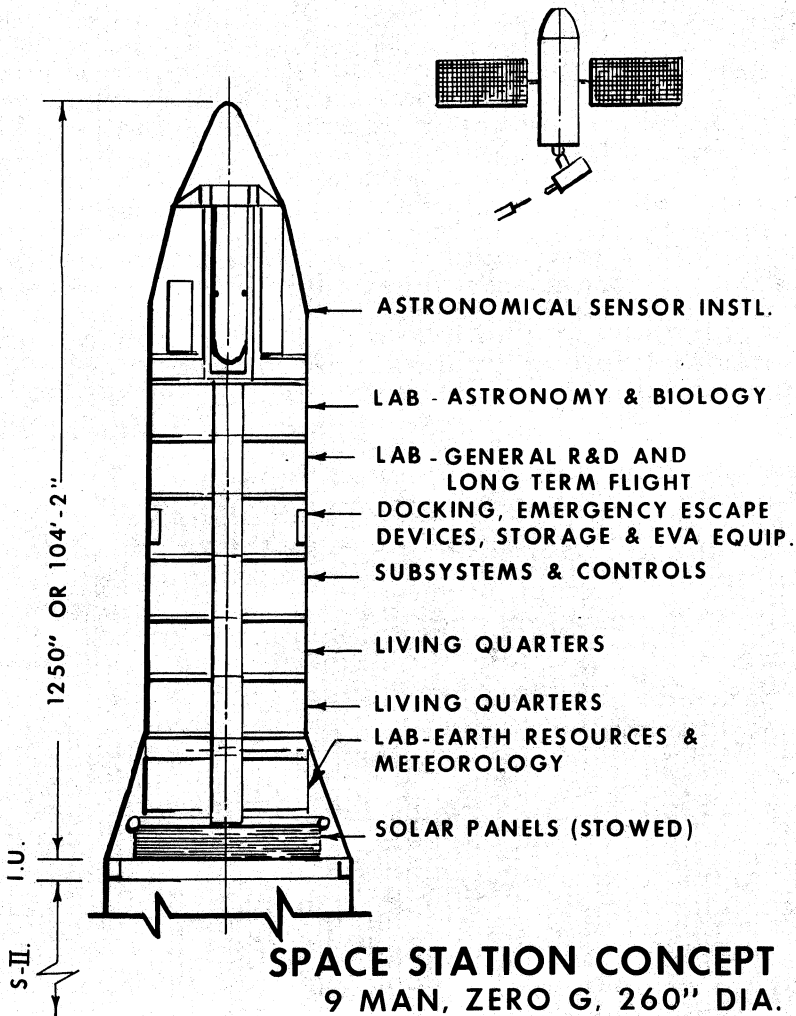


CHART 11

Beyond this, we can think of more advanced concepts of space stations such as this completely modularized unit. This station would be built of a series of modules, one atop the other. We could make the stack as long as we wish. Down through the center of the station would be a tunnel for traffic between floors. For example, on top could be an astronomical department with a swivel-mounted telescope. Next, we could have an astronomy and biology slice. Then we could have a general research and development station. The next lower floor may accommodate power supply and life support subsystems, then come living quarters and Earth resources and meteorology department, and down here at the bottom maybe the kitchen and food storage for the station. This is just one idea of how this modular stack concept could work and how it could grow organically and logically out of the Apollo Applications program. In other words, using the S-IVB workshop as an interim learning tool, we would ultimately wind up with a tailor-made, optimized modularized station. Several of such more advanced space station concepts are presently under study. There is no reason why this country couldn't have a second-generation space station such as this in the 1973-75 time period.

Here is a typical "slice" module several of which would make up the "stack" I just showed you. This one is a research and development laboratory for advanced space-related technologies. For instance, look at the space here: It could be evacuated (by opening valves to the vacuum outside) and repressurized (by reconnecting it to the pressurized volumes). With these remote manipulators operated from the pressurized control room, a man could perform experiments in the vacuum here. If he wanted to get back into the test chamber,

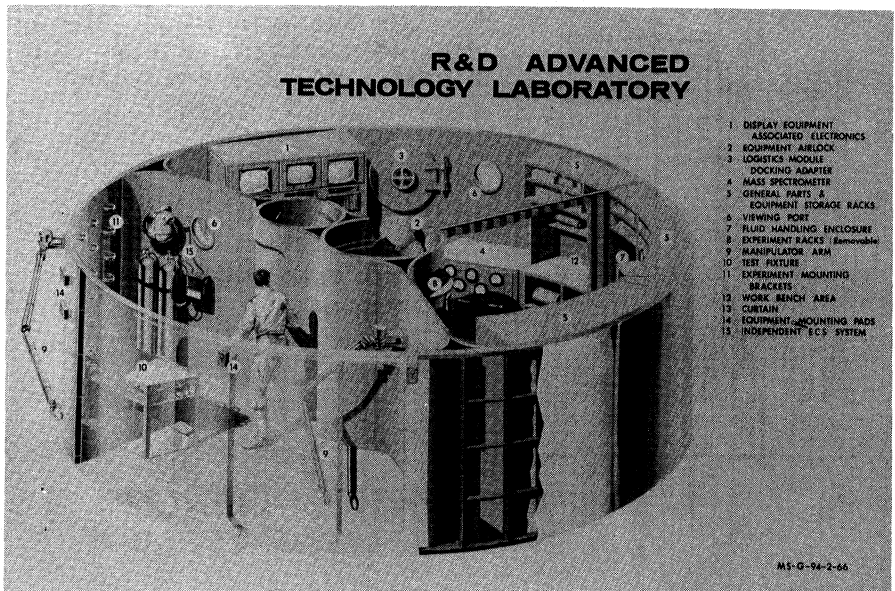


CHART 12

he would just repressurize it, open the door, and reenter. This kind of arrangement would offer an ideal physical, medical or biological laboratory that combines zero-gravity with the hard vacuum of outer space without necessitating extra-vehicular activity.

My next chart shows a more advanced astronomy laboratory. Without going into detail, you can see a great variety of instruments deployed in this concept. This is just one possible arrangement.

I would now like to discuss a few tasks we are working on which are aimed at extending manned exploration of the lunar surface under the Apollo Applications program. Our sister center in Houston has over-all responsibility for all this post-Apollo lunar surface work and the things we are doing in this area here at Marshall are in support of the Manned Spacecraft Center.

We at Marshall have been studying lunar surface transportation vehicles for quite some time. One of the fundamental problems in an intelligent post-Apollo lunar exploration program is that an area that may be safe to land on is not necessarily an area of greatest scientific interest. Just as on Earth, the places of greatest geological significance are not always suitable for landing airplanes. So we may have to land on a level surface 10 or 50 miles away and go from there up a rugged ridge to visit an interesting crater or maybe a place where

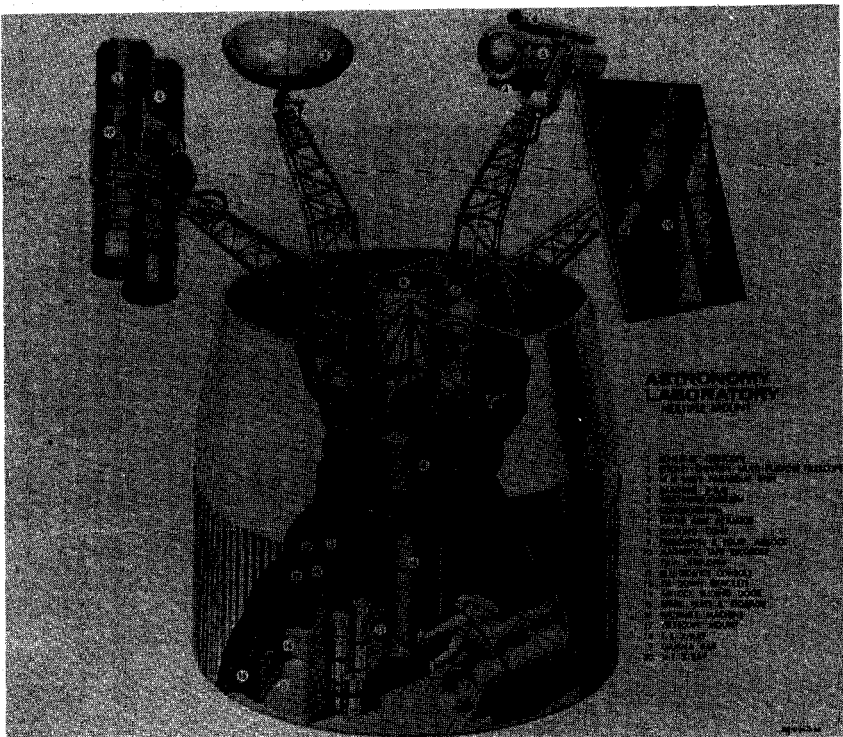


CHART 13

previously collected photographic evidence indicates occasional clouds of volcanic gases.

We have been working for some time with two contractors, Bendix and Boeing, on lunar surface vehicles for this kind of problem. Building a "lunar jeep," which is what it really amounts to, is quite an interesting problem and not nearly as straightforward as one might think. In the first place, there is no air on the Moon to burn the gasoline of a combustion engine. Secondly, there's also no air to cool the engine. Thirdly, there are great differences in surface temperatures between lunar day and night, which would be rough on rubber tires. After all, you don't want to wind up with a flat tire on the Moon and not be able to fix it.

All these considerations call for novel approaches. Metallic tires with metal elastic spokes look very attractive. In fact, in the lunar gravitational field, which is one-sixth of a g, a vehicle like this draws a lot less power than a tracklaying vehicle. Tracks may provide better traction, but the traction is not really needed. As far as the power supply of the vehicle is concerned, we believe at the moment that battery power and electromotors are attractive. Now a normal electromotor needs air cooling, and since there is no air on the moon we would have to provide the cooling in some other way.

We propose to cool these electromotors by conducting the heat from each of the wheel-mounted motors to a radiator that looks like an extra-large hubcap, but which actually does not rotate with the wheel. This gives us a short heat path. If we build the electromotors so they

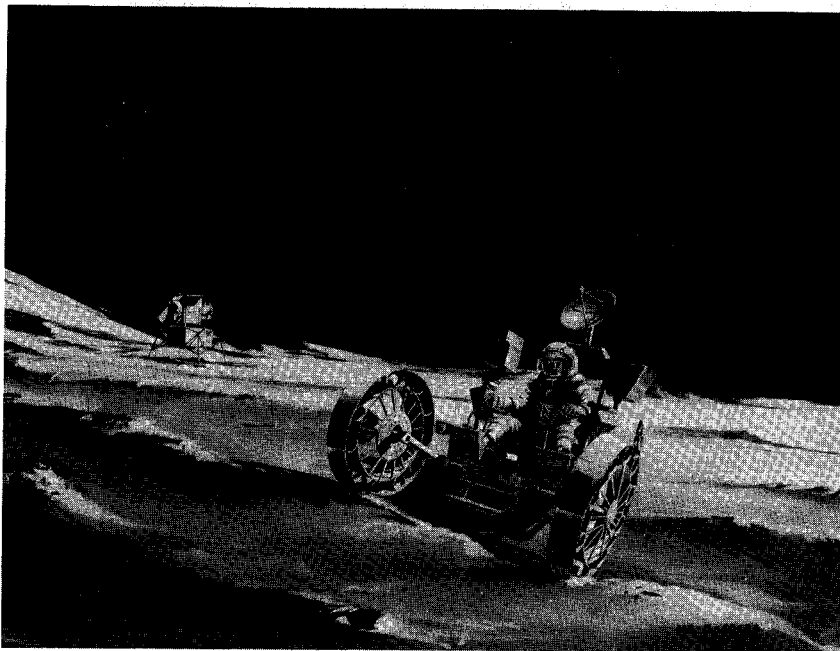


CHART 14

can run at elevated temperatures these radiators can simply radiate the extra heat away.

The batteries may be recharged after each surface trip by the LM shelter power supply system. It may be of interest that our work in this area has benefited from the electric automobile efforts which you have all heard about. I would think that the automotive activity in this field has likewise benefited from our work on the lunar jeep.

One interesting aspect of such lunar surface transportation vehicles is that due to the lack of the atmosphere, radio communications is possible only by line of sight—in other words one can radio only as long as he can see the other party. It may be feasible to maintain a degree of radio contact after line-of-sight connection has been lost by bouncing the radio waves off mountain walls. But a more reliable way of maintaining radio communication between two distant points on the Moon will be to use the service and command module in orbit around the Moon as a relay, or perhaps even a communications satellite orbiting the Earth.

Another thing we have been working on extensively here at Marshall is a Moon drill. Geologists are very interested in drilling holes and recovering complete cores from the lunar ground. A core drill means the drill doesn't cut everything up into little chips, but rather cuts a ring around the material and then lifts an entire, intact core to surface which represents geological stratification down to a depth of 10, 30, or 100 feet.



CHART 15

On the Moon, there are some difficulties in doing this, too. We cannot cool the drill with water because this would weigh too much. Also, we don't want to interfere with the composition core that we try to raise. Not being able to use water, and not having air, the question is, how do we cool? Well, it seems the smartest thing to do is to use an internal, closed-cycle air or water cooling system, and to reject the excess heat in the coolant through a radiation cooler on the surface.

Pending approval of the Voyager program by the Congress, we expect that the Marshall Center will play a major role in its development. Voyager is an unmanned spacecraft designed to go to Mars, explore the planet from orbit through photographic and remote sensor techniques, and send a lander to measure the Martian atmosphere and surface. The present plan is to fly four Voyagers, the first in 1973; the second in 1975; the third in 1977; and the fourth in 1979. Each mission would be launched by a Saturn V, and each flight will carry two independent planetary vehicles as shown here. Each of the planetary vehicles would consist of the spacecraft that goes in orbit around Mars and a lander that will soft-land, unmanned, on the Martian surface.

This chart compares the configuration of the Saturn V for Voyager with the Saturn V Apollo configuration. It is a little bit different in the nose end, that's all. You can see the two Voyagers here. The total space vehicle will fit neatly into complex 39 at the Cape and use much of the same checkout and launch equipment that we employ for the Saturn-Apollo.

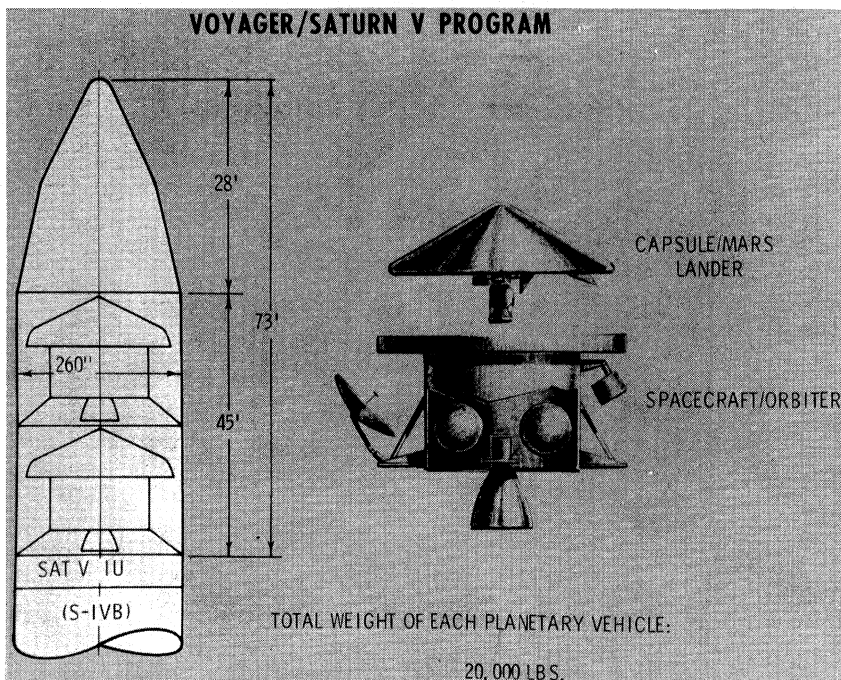


CHART 16

This chart shows a very sketchy flight profile from Earth to Mars. The third stage of Saturn V carries the payload into a parking orbit around the Earth, where the forward shroud would be shed. The two spacecraft are released separately, and are timed in such a way that due to minor velocity differences in spacecraft 1 and spacecraft 2, the two spacecraft arrive in Mars orbit about 10 days apart. This way the same set of ground stations on Earth can first handle one and then the other. In other words, rather than have the two payloads arrive simultaneously and cause a traffic-handling problem on Earth, this mode spreads them a little bit apart. From Mars orbit the two spacecraft would then dispatch their capsules, each possibly going to a different point on the Martian surface.

One last subject I would like to mention very briefly before closing is the work we have been doing toward a nuclear stage.

We have had a group of people engaged in the study of nuclear rocket propulsion systems, extending all the way back to 1957 when we were a part of the Department of the Army. Since becoming a part of NASA we have worked closely in support of the national nuclear rocket program, the ROVER project, under the leadership of Harry Finger's Space Nuclear Propulsion Office of NASA and the Atomic Energy Commission.

These studies have concentrated on the need for nuclear propulsion systems in our long-range space programs, and the most promising concepts for their application.

In view of the high cost of nuclear rocket engine and stage development, we favor what we call a modular vehicle approach. By de-

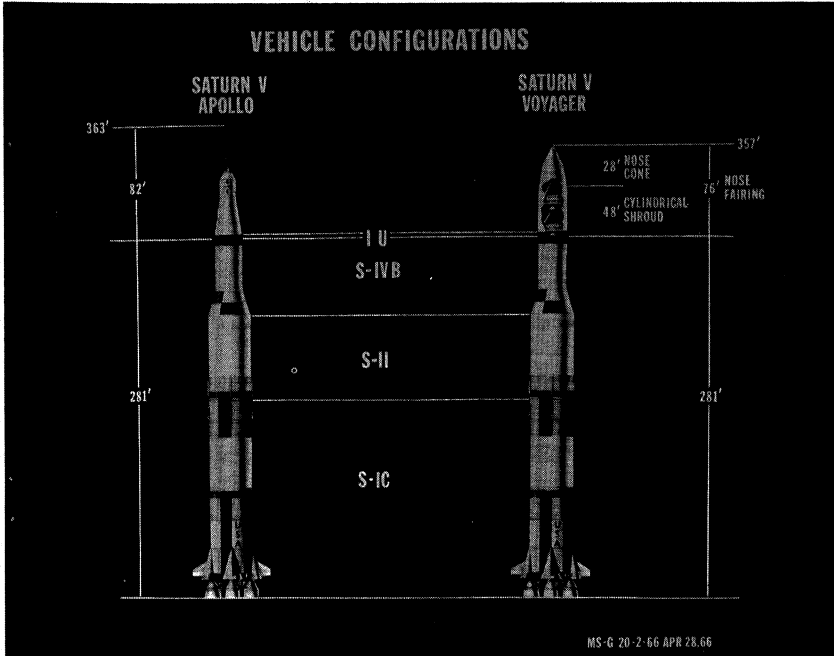


CHART 17

VOYAGER - SAT V - MISSION PROFILES

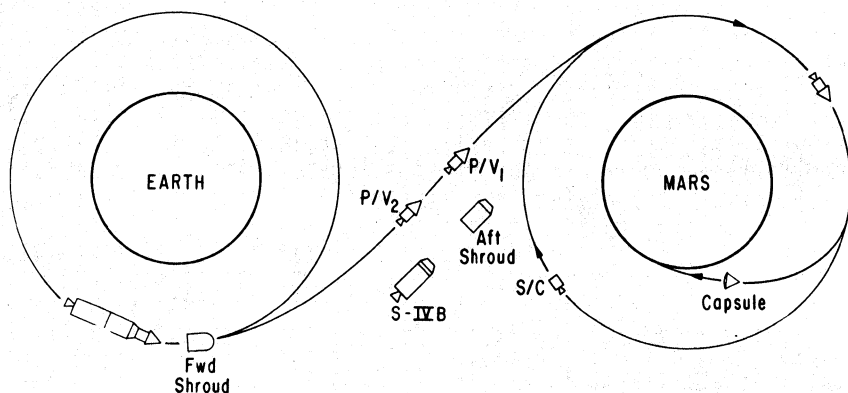


CHART 18

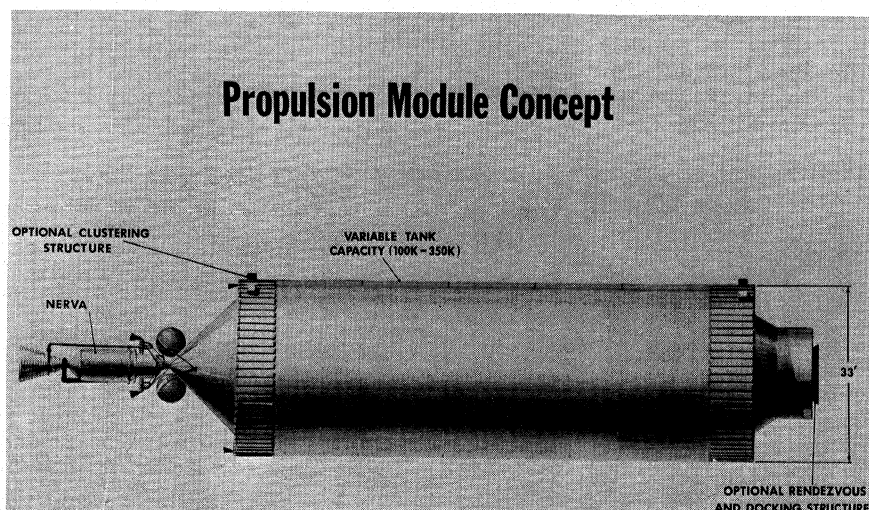


CHART 19

veloping one basic propulsion module, as shown here, with a single nuclear engine, the so-called NERVA engine, we would have the basic building block for performing a variety of space missions which exceed the capability of a single Saturn V, such as manned planetary trips.

The nuclear propulsion module would have the same diameter, 33 feet, as our Saturn V launch vehicle and could be carried aloft as a Saturn V's third stage. This is important because it would hold down the cost of such a follow-on program by getting the most out of existing hardware.

This chart illustrates how this basic nuclear propulsion module could be used. Fully loaded modules would be delivered to Earth orbit by

the Saturn V. With the configuration shown on the bottom, made up by three nuclear propulsion modules in what you might call the first stage, and a single nuclear propulsion module for both the second and third stages, we could send an expedition of 10 people to the planet Mars, land on the Martian surface, and bring them back. The first stage would drive the expedition from Earth departure orbit into a Martian trajectory, the second stage would deboost us into a Martian orbit, and the third stage would drive us, after completion of the Mars surface mission, from the Martian orbit back to Earth. The landing on the Martian surface and return to Martian orbit would be done with a separate chemical vehicle something like the Apollo lunar module.

Other possible applications of nuclear-powered modules shown on the chart would be for lunar logistics, direct ascent to the Moon, and a manned flyby of Mars.

Based on our own assessment, I am convinced that the feasibility and high-performance potential of nuclear rocket propulsion has been thoroughly demonstrated in the extensive series of successful reactor and breadboard engine system tests which have already been conducted in the Nevada desert at the Nuclear Propulsion Test Station at Jackass Flats.

I am convinced that nuclear propulsion is a must for our future space needs. And in view of the very long leadtimes this program requires, it would be most advisable that funding be made available in fiscal year 68 to continue development work on the critical engine and reactor phases of the program.

If we are willing to make this investment today, we should be able to be on the planet Mars, with man, in less than 20 years from now.

Mr. TEAGUE. I hope I'm here, Wernher. I'll find out if you're right or not. Thank you very much, gentlemen, we appreciate it.

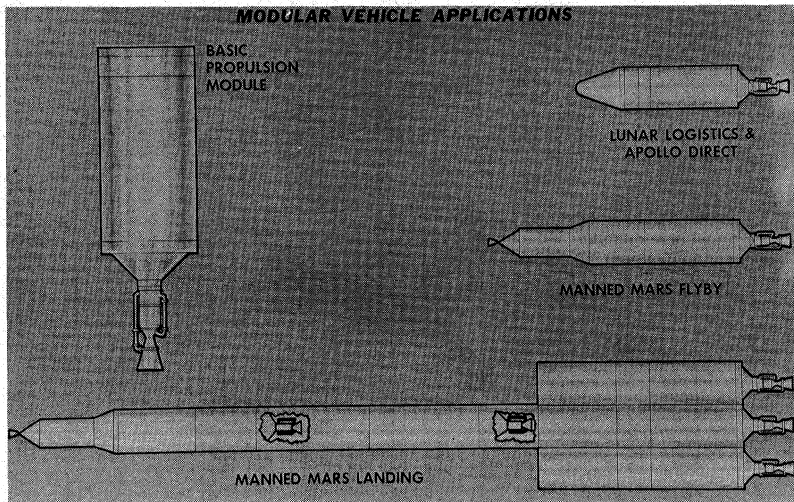


CHART 20

PROGRAM AND MANAGEMENT INFORMATION REQUESTED BY THE MANNED
SPACE FLIGHT SUBCOMMITTEE, COMMITTEE ON SCIENCE AND ASTRO-
NAUTICS, U.S. HOUSE OF REPRESENTATIVES, 90TH CONGRESS, FEBRU-
ARY 9, 1967

(By the National Aeronautics and Space Administration)

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I. PROGRAMS AND PROJECTS

(a) *Fiscal.—Project programed levels by fiscal years for manned space flight programs*

[In millions of dollars]

	Fiscal year 1965	Fiscal year 1966	Fiscal year 1967	Fiscal year 1968
Saturn I.....	35.1			
Saturn IB.....	255.5	249.0	199.8	129.9
Saturn V.....	952.9	1,106.5	1,051.8	1,019.7
Launch vehicle engine development.....	166.3	133.2	49.8	24.5
Supporting development.....	20.7	18.3	12.7	14.0
Advanced studies.....	5.5	5.7	2.6	3.1
Apollo applications.....	0	5.4	37.4	199.6
Total projects.....	1,436.0	1,518.1	1,354.1	1,390.8
Administrative operations.....	137.8	128.4	127.8	126.3
Grand total.....	1,573.8	1,646.5	1,481.9	1,517.1

GEORGE C. MARSHALL SPACE FLIGHT CENTER

Analysis of fiscal year 1967 budget realinements of manned space flight projects

[In millions of dollars]

Manned Space Flight projects	Fiscal year 1967 budget estimates		
	Requested	Anticipated	Difference
Apollo.....	1,461.8	1,314.1	-147.7
Advanced missions.....	4.5	2.6	-1.9
Apollo Applications ¹	0	37.4	+37.4
Total.....	1,466.3	1,354.1	-112.2

¹ Authorization act (adjusted) for fiscal year 1967 showed \$66,900,000 for Apollo Applications. MSF's current operating plan for Apollo Applications is \$80,000,000 as noted and described in the fiscal year 1967 reprogramming letter to Congress. This \$37,400,000 if MSFC's anticipated portion of that \$80,000,000.

Actual obligations versus planned by projects for fiscal year 1965, fiscal year 1966, and fiscal year 1967 (to Dec. 31, 1966)

[In millions of dollars]

	Fiscal year 1965		Fiscal year 1966		Fiscal year 1967	
	Planned	Actual	Planned	Actual	Annual plan	Actual to Dec. 31
Saturn I.....	35.1	32.5				
Saturn IB.....	255.5	257.8	249.0	248.9	199.8	124.3
Saturn V.....	952.9	955.6	1,106.5	1,105.5	1,051.8	684.5
Engines.....	166.3	166.3	133.2	133.2	49.8	68.9
Supporting development.....	20.7	22.5	18.3	18.2	12.7	6.3
Advanced studies.....	5.5	5.6	5.7	3.3	2.6	0
Apollo applications.....			5.4	1.5	37.4	11.2
Total.....	1,436.0	1,440.3	1,518.1	1,510.6	1,354.1	895.2

Fiscal year 1968 MSFC budget for NASA manned space flight R. & D. projects

[In millions of dollars]

Project	Requested	Change	Anticipated
Saturn I.....			
Saturn I-B.....	140.9	-11.0	129.9
Saturn V.....	1,074.1	-54.4	1,019.7
Launch vehicle engine development.....	24.5		24.5
Supporting development.....	34.0	-20.0	14.0
Apollo applications.....	204.9	-5.3	199.6
Advanced studies.....	14.0	-10.9	3.1
Total.....	1,492.4	-101.6	1,390.8

Fiscal year 1968 MSFC budget for NASA manned space flight construction of facilities projects

[In thousands of dollars]

Project	Requested by MSFC, August 1966	Change	Anticipated
Huntsville:			
Water pollution control.....	357	-7	350
Fire and security surveillance system.....	666	-146	520
Michoud Assembly Facility:			
Extend Saturn Blvd. to State road system.....	1,130	0	1,130
Repair, rehabilitation, and improvements.....	1,100	-220	880
Mississippi Test Facility: Facilities to support S-II and S-IC stage testing program.....	2,000	-2,000	0
Various locations:			
Upgrading and modifications, test and manufacturing facilities.....	2,000	-2,000	0
Total.....	7,253	-4,373	2,880

Carryover funds by R. & D. projects for fiscal years 1965 and 1966, carryover funds for fiscal years ending as of Dec. 31, 1966

[In thousands of dollars]

	fiscal year 1966	fiscal year 1965
Saturn I.....	0	0
Saturn I-B.....	0	18
Saturn V.....	578	255
Engines.....	0	2
Supporting development.....	2	61
Advanced studies.....	1,589	174
Total.....	2,169	510

Compiled information in reply to inquiries

[Listed in order of dollar value]

Contract No.	Contractor	Location	Project/description	Contract amount
NAS7-200.....	NAA/S. & I.D.	Downey, Calif.	S-II	\$901,262,000
NAS8-5608, Sch. I.....	Boeing Co.	New Orleans, La.	S-IV/R. & D. production.	867,156,437
NAS7-101.....	Douglas Aircraft Co.	Santa Monica, Calif.	S-IV/R. & D. production.	765,009,000
NAS8-19.....	NAA/Rocketdyne.	Canoga Park, Calif.	J-2/R. & D.	581,546,000
NASw-16.....	do.	do.	F-1/R. & D.	338,226,000
NAS8-4016, Sch. I.....	Chrysler (CCSD).	New Orleans, La.	S-1/IB/R. & D. production.	325,718,115
NAS7-1.....	Douglas Aircraft Co.	Santa Monica, Calif.	S-IV/R. & D. production.	239,672,000
NAS8-5604.....	NAA/Rocketdyne.	Canoga Park, Calif.	F-1 production.	233,764,000
NAS8-14000.....	IBM.	Huntsville, Ala.	Instrument units.	188,499,000
NASw-410, Sch. II.....	GEC/ASD.	do.	GSE (IRACO).	163,682,251
NAS8-18734.....	NAA/Rocketdyne.	Canoga Park, Calif.	R. & D. production.	141,223,000
NAS8-5608, Sch. II.....	Boeing Co.	Huntsville, Ala.	S.E. & I. and GSE.	135,986,659
NASw-408, Sch. I.....	GEC/MTF.	Huntsville, Ala., and Bay St. Louis, Miss.	MTF P. & T.S. FAS Phase II and III.	124,778,263
NAS8-2690.....	Pratt & Whitney.	Florida, Conn.	RL-10/R. & D. production.	97,574,000
NAS7-190.....	NAA/Rocketdyne.	Canoga Park, Calif.	H-1 production sustaining engr.	49,902,000
NAS8-11562.....	IBM.	Rockville, Md.	S-V/computer/data adapter prod.	46,260,000
NAS8-13005.....	Bendix Corp.	Teterboro, N.J.	ST-124M platform sys.	43,639,000
NAS8-2577.....	Boeing Co.	New Orleans, La.	S-IC/R. & D.	42,297,000
NAS8-11561.....	IBM.	Rockville, Md.	S-V/computer/data adapter div.	38,627,000
NAS7-3.....	NAA/Rocketdyne.	Canoga Park, Calif.	H-1/R. & D. production.	38,553,000
NAS8-5609(F).....	do.	do.	Facilities engine program.	36,637,101
NAS8-13007.....	RCA.	Van Nuys, Calif.	GSE/computers.	35,384,533
NAS8-5399.....	Bendix Corp.	Teterboro, N.J.	S-V/ST-124M platform.	32,985,234
NAS7-162.....	NAA/Rocketdyne.	Canoga Park, Calif.	H-1 production.	32,276,000
NAS8-5623.....	Pratt & Whitney.	West Palm Beach, Fla.	RL-10/R. & D.	30,447,984
NAS8-5576.....	Aetron.	Covina, Calif.	Phase I-TS.	28,070,464
NAS8-5615.....	Fairchild Hiller.	Hagerstown, Md.	Pegasus.	27,633,376
NAS8-5606.....	Boeing Co.	New Orleans, La.	S-IC/facilities.	25,198,345
NAS8-14017.....	Mason-Rust.	do.	Support services.	21,902,571
NAS8-5423.....	RCA.	Van Nuys, Calif.	GSE/110 computers.	20,334,534
NAS8-4004.....	Mason-Rust.	New Orleans, La.	Michoud/support.	17,100,000
NAS8-15486.....	Thiokol Chemical Corp.	Denville, N.J.	Development phase II, Cl.	16,146,000
NAS8-4016, Sch. II.....	Chrysler (CCSD).	New Orleans, La.	Systems Engr & Integration.	14,779,897
NAS8-2576.....	do.	do.	S-1/R. & D.	13,795,000
NAS8-14009.....	Sanders Assoc.	Nashua, N.H.	Sat V operational display sys.	10,760,000
NAS8-5602(F).....	Chrysler (CCSD).	New Orleans, La.	Facilities.	10,419,819
NAS8-13000.....	Air Products.	Allentown, Pa.	Gov. requirements for LNH, east coast.	8,389,477
NAS8-4016, Sch. III.....	Chrysler (CCSD).	New Orleans, La.	I-IB/GSE.	8,389,552
NAS8-5469.....	IBM.	Rockville, Md.	S-IB/N/I. & C.	7,560,084
NAS8-5616(F).....	Douglas Aircraft.	Santa Monica, Calif.	Facilities stages program.	7,199,610
NAS8-15476.....	Aero SpaceLines.	Van Nuys, Calif.	Air transportation service.	7,060,760

R. & D. CONTRACTS ADMINISTERED BY CONTRACTS OFFICE, INDUSTRIAL OPERATIONS—Continued

Compiled information in reply to inquiries—Continued

[Listed in order of dollar value]

Contract No.	Contractor	Location	Project/description	Contract amount
NAS8-15496	RCA	Van Nuys, Calif.	Logistics and maintenance	\$6,800,000
NAS8-17203	LTV Range Sys. Div.	Slidell, La.	Computer service	5,194,000
NAS8-5624(F)	GEC/MTF	Huntsville, Ala.	MTF facilities	4,862,835
NAS8-15479	Brown Engineering	do	Discrete control system	4,769,839
NAS8-5614	Telecomputing	New Orleans, La.	Computer services	4,346,000
NAS8-180(F)	Douglas Aircraft	Santa Monica, Calif.	Facilities stages program	3,815,443
NAS8-5489	ECL	Petersburg, Fla.	S-1B/control computer	3,609,000
NAS8-11750	Hamilton Standard	Windsor Locks, Conn.	S-1V/BAPS fuel service	3,539,226
NAS8-3444	Sverdrup & Parcel	St. Louis Mo.	Design criteria	3,494,441
NAS8-14014	Aetron	Covina, Calif.	GSE	2,966,112
NAS8-5433	RCA	Van Nuys, Calif.	GSE/displays	2,931,000
NAS8-5474	Greer Hydraulics	Los Angeles, Calif.	S-1C/hydraulic sup.	2,846,081
NAS8-4019	Mason-Rust	New Orleans, La.	Michoud support	2,702,613
NAS8-15048	Pittman Const.	Orlando, Fla.	Contractors service building	2,020,928
NAS8-11620	Martin-Marietta	St. Petersburg, Fla.	S-1B/control signal processor	2,016,000
NAS8-5486	ECL	Birmingham, Ala.	S-V/control computer	2,007,000
NAS8-11628	Hayes International	New Orleans, La.	IU/pneumatic console	1,811,000
NAS8-15477	New Orleans Public	do	Public utilities	1,758,900
NAS8-5041	American Science Inc.	Cambridge, Mass.	Engr. model of X-ray optical systems for advanced orbiting solar observatory	1,574,000
NAS8-15026	Quinn Const. Co.	New Orleans, La.	Extend and alter central	1,336,779
NAS8-11582	RCA	Van Nuys, Calif.	GSE Data Link	1,253,000
NAS8-21003	Lockheed Aircraft	Sunnyvale Calif.	Saturn/Apollo applications payload	1,247,948
NAS8-21004	Martin-Marietta	Denver, Colo.	do	1,236,762
NAS8-14016(F)	NAA/S. & ID.	Downey, Calif.	Facilities	1,071,480
NAS8-5296	IBM	Rockville, Md.	S-V/data adapters	1,020,667
NAS8-14024	Motorola, Inc.	Scottsdale, Ariz.	S-Band transponders	1,009,967
NAS8-3949	President of Harvard	Cambridge, Mass.	Study and experiment for a high resolution ultraviolet telescope	991,796
NAS8-5377	Bunker Ramo Corp.	Canoga Park, Calif.	S-V/horizon sensors	911,211
NAS8-17216	A. L. Meelching Barge	Joliet, Ill.	Barge service	863,880
NAS8-11569	Pall Corp.	Long Island, N.Y.	GSE/cooling units	848,000
NAS8-14001	General Labs	Norwich, N.Y.	IU/exploding bridge	765,099
NAS8-14118	Southern Bell	Jackson, Miss	Telephone service	741,989
NAS8-3950	Univ. Corp. for ATM	Boulder, Colo.	White light coronagraph for advanced orbiting solar observatory	717,822
NAS8-12769	Roll Ramp Corp.	King of Prussia, Pa.	Actuators	678,691
NAS8-11541	Hamilton Standard	Windsor Locks, Conn.	S-V/Thermal system	666,040
NAS8-11025	General Dynamics	Fort Worth, Tex	S-V/shell structure	665,000
NAS8-11607	Walter Kidde & Co.	Belleville, N.J.	S-1C/flush and purge unit	663,831
NAS8-14681	Mississippi Power Co.	Gulport, Miss	Electric service	554,446
NAS8-17218	The Boeing Co.	New Orleans, La.	Static firing sup.	525,218
NAS8-14020(F)	IBM	Rockville, Md	Acquisition of facilities	441,022
NAS8-17201	Scientifics Data Sys.	Santa Monica, Calif	Maintenance service dee sys.	400,675
NAS8-17142	Johnson Services Co.	New Orleans, La.	Plant utilities monitoring sys.	381,072
NAS8-14004	General Lab Assoc.	Norwich, N.Y.	IU/exploding bridge	345,177
NAS8-15486	Gulf Coast Towing	New Orleans, La.	Towing maint of Govt. barges	310,236
NAS8-4358	Brown Engineering	Huntsville, Ala.	S-V/umbilical assemblies	308,143
NAS8-11560	Walter Kidd & Co.	Belleville, N.J	S-1C/Inert profil unit	

NAS-5571	Esasco Services	Vancouver, Oreg.	Barge service	284,755
NAS-14011	Pacific Inland	New York, N.Y.	LN-6 or MTF	279,616
NAS-18730	Air Reduction	do	LN-6 or MTF	278,261
NAS-18731	do	Denver, Colo.	S-V control relay	252,000
NAS-5620	ECI	St. Petersburg, Fla.	S-V control relay	238,824
NAS-5466	Board of New Orleans	New Orleans, La.	Midland service	224,000
NAS-4018	Northrop	Nashville, Tenn.	S-V food storage	194,000
NAS-11535	Avco Corp.	Stockton, Calif.	Cold storage	172,000
NAS-13004	Parsons Corp. of California	Stockton, Calif.	Manufacturing of light weight pallets and adapters	149,848
NAS-18740	NAA Atomic	New Orleans, La.	Thermal panels	109,681
NAS-14013	Chrysler (CCSD)	Nashua, N.H.	Hazardous gas analyzers and spares	98,657
NAS-17217	Sanders Associates	Long Island, N.Y.	Supplies and services	89,000
NAS-18744	Pall Corp.	Los Angeles, Calif.	Space parts	76,000
NAS-17200	Greer Hydraulics	New Orleans, La.	Space parts GSE	73,929
NAS-18728	DeLaurel & Moses, Inc.	Birmingham, Ala.	Plant monitoring sys. engr.	72,418
NAS-15079	Hayes Int. Corp.	Jupiter, Fla.	Mod. and repair of RJ-1 sodium nitrite servicing units	57,548
NAS-17214	Technic Instruments	Long Island City, N.Y.	Florida	56,875
NAS-18732	Pall Corp.	Huntsville, Ala.	Space parts for ground support	54,795
NAS-17223	Fromherz Engr. & Assoc.	Stockton, Calif.	Facilities	49,389
NAS-15042	Brown Engineering	St. Louis, Miss.	S-VIU disconnect	47,975
NAS-5459	Parsons Corp. of Cal.	Belleville, N.J.	Repair Gov. owned pallets	44,163
NAS-18736	Hancock County Supv.	New York, N.Y.	Protective services	38,018
NAS-18727	Walter Kidde & Co.	Jewett City, Iowa	Space parts GSE	34,853
NAS-18729	TelePro Ind. Inc.	Birmingham, Ala.	Integrated group com. system	31,329
NAS-13538	Plastic Wire & Cable	do	Cables	26,724
NAS-15490	Hayes International	New York, N.Y.	Spares for RJ-1/ethylene glycol SVCB	26,000
NAS-18738	U.S. Salvage Assoc.	Hartford, Conn.	Marine survey service	25,550
NAS-15495	do	Los Angeles, Calif.	Wind tunnel testing	15,050
NAS-15478	United Aircraft Corp.	Huntsville, Ala.	Technical Support for S-IC hydraulic supply check-out units	13,750
NAS-17222	Greer Hydraulics	Jackson, Mich.	Spares parts for SAT-V	13,387
NAS-18733	Chrysler Corp.	Marlinton, Md.	Repair retro-fit control signal process	13,082
NAS-18730	Aeroquip Corp.	Melbourne, Fla.	Spares parts for DCS	9,952
NAS-17215	Radation, Inc.	Dallas, Tex.	Technical purge & services support for S-IC flush	8,769
NAS-17212	Walter Kidde Co. Inc.	Sacramento, Calif.	Facilities use	(1)
NAS-19527	Lang-Teneco-Vought	Pasadena, Calif.	Facilities	(1)
NAS-5561	Wyle Laboratories	Dorsey, Calif.	Facilities use	(1)
NAS-12096	Wallace O. Leonard	Seattle, Wash.	Facilities in connection with space propulsion system project	(1)
NAS-14012	North American Aviation	Rockville, Md.	Use of IU facilities	(1)
NAS-14006	Boeing	Teterboro, N.J.	Facilities	(1)
NAS-14021	IBM	Dallas, Tex.	Accountability of industrial facilities in related contract NAS-9-17203	(2)
NAS-15491	Bendix Corp.	St. Petersburg, Fla.	Retro-fit and repairs on computers	(2)
NAS-17213	ECI	Teterboro, N.J.	Repair retro-fit and/or modify bendix material	(1)
NAS-18726	Bendix Corp.	Huntsville, Ala.	Facilities in support of SAT-V system mission and S-IC stage program	(1)
NAS-18737	The Boeing Co.	Birmingham, Ala.	Supplies and services	(2)
NAS-18735	Hayes International			
NAS-18746				

1 No contract.

2 Basic order agreement.

R. & D. CONTRACTS ADMINISTERED BY PURCHASING OFFICE, MSFC

[Listed in order of dollar value]

Contractor	Contract	Description	Date	Amount
Brown Engineering Co., Huntsville, Ala.	NAS8-20073	Engineering, operation, and fabrication services in support of the propulsion and vehicle engineering laboratory, MSFC.	Mar. 9, 1965	\$21,541,835
Federal Mogul Bower Bearings, Inc., Los Alamitos, Calif.	NAS8-5097	Design, development, fabrication, testing, and documentation of 6 items of ducting for the Saturn S-IC.	June 25, 1962	20,790,977
Sperry Rand Corp. (space support), Huntsville, Ala.	NAS8-20055	Engineering, operation, and fabrication services in support of the astronautics laboratory, MSFC.	Mar. 1, 1965	18,833,533
General Electric Co., Phoenix, Ariz.	NAS8-11209	Engineering services in the areas of scientific computations, analog simulation and data reduction.	Mar. 30, 1964	16,565,930
Management Services, Oak Ridge, Tenn.	NAS8-14109	General support services to the MSFC technical services office.	Mar. 25, 1965	15,208,196
Spaco, Inc., Huntsville, Ala.	NAS8-20081	Mission support services for the quality and reliability laboratory.	Apr. 1, 1965	11,096,033
Vitro Corp. of America, Fort Walton Beach, Fla.	NAS8-20070	Engineering operation and fabrication services in support of test laboratory.	Mar. 16, 1965	10,745,484
Hayes International Corp., Birmingham, Ala.	NAS8-20083	Engineering, operations, and fabrication services in support of manufacturing engineering laboratory.	do	10,049,443
Computer Sciences, El Segundo, Calif.	NAS8-18405	Mission support services for the computation laboratory, MSFC.	July 1, 1966	5,854,454
Northrop Corp., Huntsville, Ala.	NAS8-20082	Mission support services for the aerostrodynamics laboratory.	Mar. 16, 1965	5,421,156
Allis Chalmers Manufacturing Co., Milwaukee, Wis.	NAS8-20096	Research and development of open cycle fuel cell system for space vehicles.	May 14, 1962	4,834,180
The Garrett Corp., Phoenix, Ariz.	NAS8-5107	Development of fuel and LOX preheaters.	June 20, 1962	4,570,211
Scientific Data System, Santa Monica, Calif.	NAS8-11869	Digital events evaluator.	June 25, 1964	4,477,571
Armc Research Corp., Washington, D. C.	NAS8-11087	Research and development engineering services in support of the Saturn reliability program.	Aug. 12, 1963	4,064,425
Vitro Corp. of America, Fort Walton Beach, Fla.	NAS8-5178	Support services MSFC test division.	Oct. 29, 1962	3,643,810
United Aircraft Corp., West Palm Beach, Fla.	NAS8-11714	Design, fabricate, and test breadboard liquid hydrogen pump.	June 19, 1964	2,841,233
Motorola, Inc., Scottsdale, Ariz.	NAS8-11835	Design, development, fabrication, and delivery of AROD system test model hardware.	Nov. 30, 1964	2,769,829
Calumet & Hecla, Inc., Bartlett, Ill.	NAS8-5401	Manufacturing of tooling and S-IC LOX and fuel pressure volume ducting.	May 20, 1963	2,437,955
Federal Electric, Paramus, N. J.	NAS8-20412	Technical support for the MSFC reliability program.	July 11, 1966	2,205,557
Douglas Aircraft Co., Santa Monica, Calif.	NAS8-11648	Investigate methods of fabricating and joining sandwich segments for forming domes.	June 11, 1964	2,036,645
Calumet & Hecla, Inc., Bartlett, Ill.	NAS8-5400	Design, develop, manufacture, and test outboard LOX and fuel pressure volume ducting.	Mar. 20, 1963	2,001,316
Aero Corp., Cincinnati, Ohio.	NAS8-5381	Design, develop, fabricate, and furnish 2 prototype secure digital decodes.	May 9, 1963	1,877,915
Marin Marietta Corp., Baltimore, Md.	NAS8-11903	Design, fabricate, test, hydrodynamic support system for Saturn II.	Feb. 15, 1965	1,865,842
General Electric Co., Fitchfield, Mass.	NAS8-2418	Development of a cryogenic gyro.	June 29, 1961	1,646,238
Brown Engineering Co., Huntsville, Ala.	NAS8-11985	Fabricate, test, and deliver 11 items of telemetry equipment.	May 15, 1965	1,501,235
North American Aviation, Inc., Canoga Park, Calif.	NAS8-4013	Feasibility evaluation of toroidal hoop combustion chamber.	Mar. 16, 1962	1,495,204
Bendix Corp., Ann Arbor, Mich.	NAS8-11287	Apollo logistics support systems payloads.	June 27, 1964	1,370,000
Western Engineering Co., Huntsville, Ala.	NAS8-20166	Engineering and operation services in support of the research projects.	May 3, 1965	1,250,390
United Aircraft Corp., West Palm Beach, Fla.	NAS8-11436	Evaluation of the plug multichamber.	June 29, 1965	1,167,311
North American Aviation, Los Angeles, Calif.	NAS8-20550	Development of a titanium S-IC skin section.	June 29, 1965	1,156,502

General Dynamics, Fort Worth, Tex.	NAS8-2450	Investigation of combined effects of radiation and vacuum on engineering materials.	Nov. 9, 1961	1,134,266
Interstate Electron, Anaheim, Calif.	NAS8-11650	Design, develop, fabricate, and deliver 2 tracking receivers, 2 demodulator systems.	May 15, 1964	1,087,508
Parker Hannifin Corp., Los Angeles, Calif.	NAS8-11833	Design, develop, and test 10-inch 10X vent and relief valve.	Dec. 8, 1964	1,062,619
Northrop Corp., Norwood, Mass.	NAS8-5238	Design, develop, fabricate, and deliver 8 hermetically sealed switching gyros.	Mar. 26, 1963	1,052,644
Perkin Elmer Corp., Norwalk, Conn.	NAS8-11603	Design, develop, and deliver 6 automatic laying theodolites.	Mar. 22, 1964	1,052,201
Cornell Aero Lab, Inc., Buffalo, N.Y.	NAS8-20027	Research related to application of shock tube techniques.	Feb. 10, 1965	994,938
Aerojet-General Corp., Sacramento, Calif.	NAS8-11741	Fabricate hardware and perform studies to determine rocket combustion.	June 30, 1964	978,709
Moog Servocontrols, East Aurora, N.Y.	NAS8-11663	Fabricate and deliver servo actuators.	June 30, 1964	944,161
North American Aviation, Inc., Canoga Park, Calif.	NAS8-2654	Aerodynamic nozzle investigation.	June 1, 1962	922,498
Lockheed Aircraft, Sunnyvale, Calif.	NAS8-20282	Study of mission modes and systems analysis for lunar exploration.	Jan. 3, 1966	897,000
Electronic Associates, Inc., Long Branch, N.J.	NAS8-15103	Hybrid computing system.	June 30, 1965	894,250
Electronic Associates, Inc., West Long Branch, N.J.	NAS8-16788	Analog computer system.	Nov. 1, 1965	881,361
North American Aviation, Canoga Park, Calif.	NAS8-20349	Advanced engine design study.	Nov. 26, 1966	879,054
General Electric Co., Philadelphia, Pa.	NAS8-4012	Design criteria of zero leakage connectors for launch vehicles.	Mar. 16, 1962	842,660
Electronic Communications, Inc., St. Petersburg, Fla.	NAS8-5450	Manufacture prototype and production switch selectors.	June 4, 1963	833,070
Parker Hannifin Corp., Los Angeles, Calif.	NAS8-26572	Develop and qualify improved fluid connectors.	June 29, 1966	809,901
United Aircraft Corp., West Palm Beach, Fla.	NAS8-11427	Design study of engine system.	June 22, 1964	803,886
Wyle Labs, Huntsville, Ala.	NAS8-5384	Acoustic research.	June 1, 1963	802,993
Lockheed Aircraft, Sunnyvale, Ala.	NAS8-11728	Model No. 410 digital multiplexer.	June 29, 1964	798,520
Lockheed Aircraft, Sunnyvale, Calif.	NAS8-20007	Study of modular nuclear vehicles.	Dec. 31, 1964	792,861
Sperry Rand Corp., Huntsville, Ala.	NAS8-20422	Univac 1107 computer in support of Comp Lab, MSFC.	Nov. 17, 1966	784,720
Avco Corp., Cincinnati, Ohio	NAS8-15111	Secure range safety decoders.	Dec. 15, 1965	784,300
Moog Servocontrols, East Aurora, N.Y.	NAS8-11959	Fabricate and deliver 30 servo actuators.	Apr. 12, 1965	779,360
Goodyear Aerospace, Akron, Ohio.	NAS8-11747	Develop materials applications concepts for pint use as cryogenics.	June 30, 1964	779,061
Space Technology Laboratory, Inc., Redondo Beach, Calif.	NAS8-5371	Mission-oriented study of advanced nuclear system parameters.	June 29, 1963	778,702
General Electric Co., Philadelphia, Pa.	NAS8-11523	Investigate, research, and develop materials.	June 29, 1963	761,060
Dynatronics, Inc., Orlando, Fla.	NAS8-11763	Design, develop, and test instrumentation test system.	June 30, 1964	747,395
Lockheed Aircraft Corp., Sunnyvale, Calif.	NAS8-5110	Advanced telemetry systems with adaptive capability.	June 29, 1962	746,161
Westinghouse Electric, Baltimore, Md.	NAS8-11682	Research and develop microminiature techniques.	June 25, 1964	732,931
Midwest Research Institute, Kansas City, Mo.	NAS8-1540	Conduct research on bearing for use in high vacuum.	Feb. 23, 1961	728,381
Lockheed Aircraft Corp., Marietta, Ga.	NAS8-5332	Fabricate and related services to support the Marshall Space Flight Center RLFT program.	May 11, 1963	715,539
Wisconsin University, Madison, Wis.	NAS8-21015	Develop and construct X-ray astronomy.	Sept. 30, 1966	679,101
Thompson & Ramo World, Cleveland, Ohio.	NAS8-11573	Instrument unit coolant pumps.	June 17, 1964	663,654
Douglas Aircraft Co., Santa Monica, Calif.	NAS8-11698	Develop all wetched bulkhead.	June 30, 1964	637,222
United Aircraft Corp., West Palm Beach, Fla.	NAS8-1068	Survey of suppression of combustion oscillations with mechanical devices.	June 28, 1963	638,545
Aerojet-General, Sacramento, Calif.	NAS8-20219	Demonstration of a solid propellant motor detection and combustion termination system.	June 30, 1965	619,061
Westinghouse Electric, Baltimore, Md.	NAS8-20547	Development of drill system for post Apollo missions.	July 29, 1966	570,624
Operations Research Inc., Silver Spring, Md.	NAS8-5321	Computational and analytical support services.	Apr. 30, 1963	561,735
United Aircraft Corp., West Palm Beach, Fla.	NAS8-20540	Liquid oxygen turbopump study.	June 29, 1966	539,373
Westinghouse Electric Corp., Huntsville, Ala.	NAS8-5112	Design and development of a solid state image converter for space vehicles.	June 29, 1962	544,710
Northrop Corp., Huntsville, Ala.	NAS8-20537	Development of a subsurface drill system for post-Apollo missions.	July 16, 1965	541,694

R. & D. CONTRACTS ADMINISTERED BY PURCHASING OFFICE, MSFC—Continued

(Listed in order of dollar value)

Contractor	Contract	Description	Date	Amount
Bomac Laboratories, Inc., Beverly, Mass.	NASS-2604	Construction and delivery of two hydrogen masers and to improve removing hydrogen from maser.	Feb. 1, 1962	\$538,129
Motorola Inc., Scottsdale, Ariz.	NASS-15107	Manufacture and delivery of command receivers.	June 30, 1965	534,084
The Regents of University of Michigan, Ann Arbor, Mich.	NASS-20232	Program for measuring the structure and variability of the upper atmosphere of the earth.	do.	530,000
Wyle Lab, Huntsville, Ala.	NASS-11217	Design, procedures, and techniques for ground support structures.	June 30, 1964	512,196
Chrysler Corp., New Orleans, La.	NASS-20256	Study for an optical technology Apollo extension system.	Nov. 8, 1965	500,000
Bendix Corp., Ann Arbor, Mich.	NASS-20334	Lunar surface mobility systems comparison and evolution study.	Feb. 1, 1966	499,888
The Bendix Corp., South Bend, Ind.	NASS-5407	Design, layout, fabrication, and testing of a pneumatic actuation system.	June 29, 1963	499,220
Aerojet-General Corp., Sacramento, Calif.	NASS-20672	The stability characteristics and testing of an advanced injector.	Dec. 29, 1966	494,118
Systems Engr. Lab. Inc., Fort Lauderdale, Fla.	NASS-18759	Digital arbitrary function generator system.	June 30, 1966	494,000
Perkin Elmer Corp., Norwalk, Conn.	NASS-20255	Study for an optical technique Apollo extension system.	Nov. 16, 1965	492,288
Bell Aerospace Corp., Buffalo, N.Y.	NASS-20226	Study for an optical flying system.	June 25, 1965	489,898
Statham Instruments, Los Angeles, Calif.	NASS-11806	Fabrication and delivery of 87 model A324 accelerometer.	June 30, 1964	481,601
Martin Marietta Corp., Orlando, Fla.	NASS-11684	Research and development of microminiaturization techniques.	June 30, 1964	478,062
General Motors Corp., Santa Barbara, Calif.	NASS-20251	Mobility test article.	June 30, 1965	475,225
Telecomputing Corp., San Diego, Calif.	NASS-5053	Research and development of improved gasket materials for cryogenic application in space.	June 21, 1962	474,632
Space Craft Inc., Huntsville, Ala.	NASS-11591	Develop, fabricate, and deliver 2 prototypes and 4 production model radar altimeters.	Sept. 30, 1964	473,102
Telecomputing Corp., San Diego, Calif.	NASS-11068	The development of structural adhesive systems suitable for use with liquid oxygen.	June 29, 1963	471,330
Defense Electronics, Rockville, Md.	NASS-16578	Telemetering equipment.	June 30, 1965	460,767
Cosmo-dyne Corp., Hawthorne, Calif.	NASS-11594	High pressure reciprocating positive displacement liquid nitrogen-liquid hydrogen pump and vaporizer.	June 17, 1964	457,934
Parker Hannifin Corp., Los Angeles, Calif.	NASS-11796	Design, development, fabrication, assembly, and testing of a helium flow control regulator assembly.	June 26, 1964	455,676
Hayes International Corp., Birmingham, Ala.	NASS-5307	Research and development engineering services.	Apr. 1, 1963	454,282
Mesa Scientific, Inglewood, Calif.	NASS-14392	Computer programming. Investigative and analysis study.	June 27, 1964	453,240
Scientific Data System, Santa Monica, Calif.	NASS-20637	Digital events analyzer (DEF-3) modification.	June 2, 1966	450,000
Sperry Gyroscope Co., Great Neck, N.Y.	NASS-4003	Rocket engine analyzer and decision instrumentation.	Feb. 5, 1962	448,137
Sperry Farragut Co., Bristol, Tenn.	NASS-812	Engineering and fabrication services for testing instrumentation systems and components for Saturn.	Oct. 21, 1960	445,890
North American Aviation, Canoga Park, Calif.	NASS-11402	Toroidal system analysis.	Aug. 28, 1964	445,196
Motorola, Inc., Scottsdale, Ariz.	NASS-20546	Design, development, fabrication, and delivery of model command and communication.	Dec. 3, 1965	442,104
General Electric Co., Philadelphia, Pa.	NASS-11372	Design criteria for planetary spacecraft to be sterilized by heating.	June 30, 1964	440,364
General Dynamics, San Diego, Calif.	NASS-11968	Design of a cylindrical thrust structure.	Apr. 8, 1965	433,851
Bell Aerospace Corp., Burbank, Calif.	NASS-11980	Fabrication and delivery of 20 servos actuators.	Apr. 26, 1965	423,870
Beckman Instruments, Inc., Fullerton, Calif.	NASS-11510	Development of techniques and instrumentation for detection of hydrogen gas.	June 29, 1963	419,337
Boeing Co., Huntsville, Ala.	NASS-20266	Studies of improved Saturn vehicles and intermediate payload Saturn vehicle.	Dec. 6, 1965	400,000
North American Aviation, Downey, Calif.	NASS-18025	Study of manned planetary flyby missions based on Saturn-Apollo systems.	Aug. 3, 1966	400,000

Allis Chalmers Manufacturing Co., Milwaukee, Wis.	NAS8-20573	Development of reliable long life, high-performance fuel cell systems.	Feb. 23, 1966	399, 907
Bendix Corp., Ann Arbor, Mich.	NAS8-20252	Mobility test article.	June 30, 1965	399, 500
Martin-Marietta Corp., Denver, Colo.	NAS8-068	Advanced control system for Saturn C-5 configuration.	June 29, 1962	399, 462
Texas Instruments, Dallas, Tex.	NAS8-11925	Design, development, and delivery of 1 breadboard model and units of an integrated static inverter.	Apr. 27, 1965	394, 069
Honeywell, Inc., Huntsville, Ala.	NAS8-17430	Scanner computer system.	June 29, 1966	389, 778
Spaco, Inc., Huntsville, Ala.	NAS8-11314	Study of research and development in the field of physical determination for mass properties.	June 12, 1964	384, 756
Republic Aviation Corp., Farmingdale, N. Y.	NAS8-11514	Experimental determination of system parameters for thin-walled cylinders.	June 29, 1963	383, 890
General Dynamics, San Diego, Calif.	NAS8-11304	Electron shielding studies.	June 29, 1964	371, 803
Lockheed Aircraft Corp., Sunnyvale, Calif.	NAS8-6257	Study to derive and define a technique to assure satisfactory disposal of Saturn orbital hardware.	Feb. 18, 1963	370, 090
Auburn University, Auburn, Ala.	NAS8-11184	Research work pertaining to telemetering, measuring, and radio frequency systems.	Mar. 1, 1964	362, 980
Sperry Rand Corp., Washington, D. C.	NAS8-18404	3d generation of computers for MSFC, Huntsville, and MSFC, Michoud-Slidel.	Aug. 1, 1966	362, 949
North American Aviation, Los Angeles, Calif.	NAS8-20533	Research and development for fabricating a simulated titanium alloy "y" segment for the S-IC fuel tank.	June 30, 1965	350, 000
Bendix Corp., Ann Arbor, Mich.	NAS8-20378	do.	June 29, 1966	350, 000
Boeing Co., Seattle, Wash.	NAS8-20340	Design, fabrication, and delivery of S band power amplifiers.	June 30, 1966	350, 000
Watkins Johnson Co., Palo Alto, Calif.	NAS8-11867	Design and fabricate a prototype 120-channel digital measuring system.	June 30, 1965	348, 087
Trans Sonics Inc., Lexington, Mass.	NAS8-11957	A study on earth orbital experiments for low gravity fluid mechanics.	April 26, 1965	345, 212
Douglas Aircraft Co., Santa Monica, Calif.	NAS8-18053	Design, fabrication, delivery, and installation of vacuum pumping system.	Aug. 1, 1966	344, 005
Pennsalt Chemical, Philadelphia, Pa.	NAS8-20648	Development of a micrometeoroid simulation device.	June 30, 1966	343, 339
Canadian Corp., Ottawa, Canada	NAS8-20529	Acoustic and vibration measuring program for solid propellant.	June 25, 1965	340, 347
Datascraft Inc., Gardena, Calif.	NAS8-11760	Beryllium fabrication methods and development.	June 19, 1964	339, 000
Lockheed Aircraft, Sunnyvale, Calif.	NAS8-11798	Studies of improved Saturn V vehicles and intermediate payload Saturn vehicles.	June 30, 1964	337, 132
North American Aviation, Downey, Calif.	NAS8-20265	Determine the serselastic.	Dec. 6, 1965	329, 624
Lockheed Aircraft, Sunnyvale, Calif.	NAS8-11238	Development of a high weight cryogenic insulating system.	June 19, 1964	328, 992
Goodyear Aerospace, Akron, Ohio.	NAS8-11761	Evaluation of structural reinforced plastics at cryogenic temperatures.	June 30, 1964	324, 349
Goodyear Aircraft Corp., Akron, Ohio.	NAS8-1070	Development of improved semi-organic structural adhesives for elevated temperature applications.	June 29, 1963	318, 673
Monsanto Research, Everett, Mass.	NAS8-11371	Development of vulcanizable elastomers suitable for use in contact with liquid oxygen.	June 29, 1964	318, 516
Peninsular Chemresearch, Inc., Gainesville, Fla.	NAS8-5352	Development of vulcanizable elastomers suitable for use in contact with liquid oxygen.	May 10, 1963	316, 408
Armour Research Foundation, Chicago, Ill.	NAS8-5251	System design and installation of vibration and acoustic equipment.	Mar. 5, 1963	309, 436
LTV Ling Altco, Inc., Anaheim, Calif.	NAS8-11961	Analytical study and mathematical research for development and implementation of the path-adaptive guidance mode.	June 28, 1965	309, 060
Northrop Corp., Huntsville, Ala.	NAS8-11221	Portable automatic tracking antenna systems.	May 20, 1964	308, 240
Scientific Atlanta, Atlanta, Ga.	NAS8-18298	Design, development, fabrication, delivery, and installation of a fluid power package.	June 9, 1966	305, 440
Greer Hydraulics, Inc., Los Angeles, Calif.	NAS8-5373	Design, development, fabrication, delivery, and installation of a fluid power package.	May 29, 1963	302, 977
International Telephone & Telegraph, San Fernando, Calif.	NAS8-11673	Development, design, manufacturing, and delivery of a prototype guidance system.	June 26, 1964	302, 578
Astradisa, Inc., Anaheim, Calif.	NAS8-17443	Analog to digital recording system.	June 23, 1966	301, 400
Douglas Aircraft Co., Santa Monica, Calif.	NAS8-21023	Orbital astronomy support facility.	Dec. 8, 1966	300, 000
General Electric Co., Lynchburg, Va.	NAS8-16550	Video transmission system.	June 23, 1965	299, 200

R. & D. CONTRACTS ADMINISTERED BY PURCHASING OFFICE, MSFC—Continued
[Listed in order of dollar value]

Contractor	Contract	Description	Date	Amount
Southwest Welding & Manufacturing, Alhambra, Calif.	NAS8-18026	Liquid hydrogen tank	June 30, 1966	\$293,720
Astro Space Laboratory, Inc., Huntsville, Ala.	NAS8-5350	Development of a pressure and force transducer calibration procedure for hypersonic shock tunnel	May 14, 1963	291,315
Martin Marietta Corp., Denver, Colo.	NAS8-5322	Design criteria relative to wind-induced oscillations of Saturn Booster	Apr. 29, 1963	291,053
North American Aviation, Anaheim, Calif.	NAS8-11973	Development of a compatible family of microcircuits (silicon monolithic integrated circuits)	June 23, 1965	290,745
Illinois Institute of Technology, Chicago, Ill.	NAS8-5379	Investigation of environmental effects on coatings for thermal control of vehicles	May 20, 1963	286,989
Motorola Inc., Scottsdale, Ariz.	NAS8-13860	Transponders and test sets	Feb. 8, 1965	281,663
ITT Research Institute, Chicago, Ill.	NAS8-11258	Optical measurement with a high temporal and spatial resolution	June 16, 1964	279,722
Harvey Aluminum Inc., Torrance, Calif.	NAS8-11568	Development of ultrahigh strength, low density, aluminum plate composites	June 29, 1963	278,731
General Electric Co., Cincinnati, Ohio	NAS8-11803	Development of a plasma electron beam welding system	June 29, 1964	278,267
Dalto Electronics, Norwood, N.J.	NAS8-17446	Computer display system	June 30, 1966	277,770
Martin-Marietta Corp., Baltimore, Md.	NAS8-1387	A study program in organic insulation research	June 27, 1964	277,200
General Dynamics, San Diego, Calif.	NAS8-18118	Large space structures experiments for AAP	Sept. 15, 1966	276,000
Lockheed Aircraft Corp., Palo Alto, Calif.	NAS8-11525	Development of zero G heat transfer modes	June 29, 1965	274,843
Avco Corp., Cincinnati, Ohio	NAS8-15390	Test coders	May 20, 1963	273,600
North American Aviation, Downey, Calif.	NAS8-11097	A study of propellant behavior at zero gravity	Oct. 4, 1963	270,727
Battelle Memorial Institute, Columbus, Ohio	NAS8-11403	Analytical studies and investigation in areas of stabilized platform and gyro gimbal design and manufacture	June 27, 1964	268,700
General Electric Co., Johnson City, N.Y.	NAS8-5408	Performance of research and development effort to determine feasibility of utilization of fluid amplifiers	May 15, 1963	261,683
Giannini Controls, Caldwell, N.J.	NAS8-11706	Digital measurement recording system	June 2, 1964	261,549
California Computer Products, Anaheim, Calif.	NAS8-18760	Data recording system	June 30, 1966	255,000
Northrop Corp., Hawthorne, Calif.	NAS8-20025	Analytical and experimental determination of localized structure to be used in lab vibration testing of shell structure	Apr. 23, 1965	250,620
Martin Marietta Corp., Baltimore, Md.	NAS8-11277	Study of wind induced oscillation effects on cylinders	June 27, 1964	247,096
Planning Research Corp., Los Angeles, Calif.	NAS8-20367	An airborne evaluating equipment study	May 9, 1966	246,592
Astrodata Inc., Anaheim, Calif.	NAS8-17051	A doppler system	Mar. 9, 1966	246,422
Boeing Co., Huntsville, Ala.	NAS8-20121	Assessment of test program alternative large	Dec. 7, 1966	245,000
Auburn University, Auburn, Ala.	NAS8-20104	Analytical study of problems involving control of large space vehicles	Apr. 6, 1965	245,000
Hadley Co., Pomona, Calif.	NAS8-17644	Valves	Mar. 1, 1966	242,840
Thompson Ramo Wooldridge, Inc., Cleveland, Ohio	NAS8-4006	Investigation to determine an improved inducer design for high-speed, high-flow pumps	Feb. 12, 1966	240,806
Lockheed Aircraft, Burbank, Calif.	NAS8-20294	Reusable aerospace passenger transport system study	Dec. 10, 1965	237,100
Energy Systems Inc., Palo Alto, Calif.	NAS8-11877	Supplying UHF transmitters	Mar. 5, 1965	235,305
Ex-Cell-O Corp., Detroit, Mich.	NAS8-16386	Machine, milling	June 26, 1965	234,916
General Dynamics, San Diego, Calif.	NAS8-20016	Simulation of selected discrete networks, Saturn instrument unit	Apr. 5, 1965	234,677
Resistoflex Corp., Roseland, N.J.	NAS8-11983	Flexible hose assembly	Apr. 21, 1965	233,742
Northrop Corp., Hawthorne, Calif.	NAS8-20670	Definition of the phase change thermal radiator flight experiment	Sept. 23, 1965	233,250
General Dynamics, San Diego, Calif.	NAS8-11469	Development of structural panel	June 29, 1964	228,201
North American Aviation, Canoga Park, Calif.	NAS8-5356	Investigation of current degradation phenomenon in superconducting solenoids	May 14, 1963	228,088

Whittaker Corp., San Diego, Calif.	NAS8-11938	Optimization of the performance of a polyurethane adhesive system over the temperature range.	May 14, 1965	227, 853
University of Alabama, University, Ala.	NAS8-20172	Study and analysis of the FM/FM and SS/FM telemetry systems for the Saturn vehicle.	June 10, 1965	226, 971
Westinghouse Electric, Pittsburgh, Pa.	NAS8-11929	Light weight, versatile, nonvacuum-electron beam welding unit.	June 15, 1965	225, 935
North American Aviation, Canoga Park, Calif.	NAS8-20287	System analysis of plug multichamber configuration.	June 23, 1965	225, 857
Ling Temco Vought, Dallas, Tex.	NAS8-11100	Wind tunnel testing of Saturn I-B launch vehicle static longitudinal stability.	Sept. 27, 1963	223, 835
IIT Research Institute, Chicago, Ill.	NAS8-11333	Research study on development of lightweight thermal insulation materials for rigid heat shields.	June 26, 1964	221, 852
Avco Corp., Everett, Mass.	NAS8-5279	Experimental investigation of advanced superconducting magnets.	May 13, 1963	221, 097
Applied Dynamics, Inc., Ann Arbor, Mich.	NAS8-20622	Models of four AD-2-64 PBC analog computers.	June 2, 1966	219, 152
Heat Technology Lab, Huntsville, Ala.	NAS8-11850	Study of thermal environment problems of Saturn vehicles.	Oct. 13, 1964	218, 863
Mechanical Tech, Latham, N.Y.	NAS8-11678	Analysis, design, and prototype development of squeeze film bearings for AB-5 gyro.	June 18, 1964	217, 529
Astrodata, Inc., Anaheim, Calif.	NAS8-15108	Statistical correlation computer system.	June 30, 1965	216, 953
Lockheed Aircraft, Sunnyvale, Calif.	NAS8-11498	Delay lock techniques for AROD system.	Oct. 15, 1964	216, 474
General Applied Science Lab, Westbury, Long Island, N.Y.	NAS8-11082	Experimental investigation of combustion phenomena in the base region of vehicles caused by upstream injection.	June 26, 1963	215, 509
Lockheed Aircraft Corp., Sunnyvale, Calif.	NAS8-11476	Investigation and development of an R-F liquid level sensing techniques.	June 30, 1964	215, 292
North American Aviation, Los Angeles, Calif.	NAS8-11733	Development of nondestructive testing techniques for honeycomb heat shields.	June 29, 1964	215, 271
Ampherol Borg Electric, Chicago, Ill.	NAS8-11832	Design, development and manufacture of flat cable connectors.	Apr. 16, 1965	212, 700
North American Aviation, Downey, Calif.	NAS8-20289	Study of Impact on S-II stage of Improved J-2 engine.	Dec. 20, 1965	210, 440
Fairchild Hiller, Rockville, Md.	NAS8-20343	Satellite control center (Satcon) operation.	Feb. 15, 1966	207, 800
Raytheon Co., Norwood, Mass.	NAS8-11604	Design and development, fast-scan infrared detection and measuring instrument.	June 19, 1964	207, 460
IIT Research Institute, Chicago, Ill.	NAS8-20107	Survey of optical components for fluctuation measurements on Saturn models.	June 4, 1965	207, 447
Systems Engineering Lab, Inc., Fort Lauderdale, Fla.	NAS8-11911	Manufacture, documentation, delivery, installation, and checkout of plotter interface system.	Apr. 16, 1965	207, 280
Applied Dynamics, Inc., Ann Arbor, Mich.	NAS8-15112	System analog computing.	June 30, 1965	206, 010
General Cable Corp., Birmingham, Ala.	NAS8-17671	Cable.	June 9, 1966	205, 565
Douglas Aircraft Co., Huntington Beach, Calif.	NAS8-13369	Design study of MS-IVB stage for mod. launch vehicle Saturn V.	June 30, 1964	205, 432
Parker-Hannifin Corp., Los Angeles, Calif.	NAS8-11694	Design, development, manufacturing, and preflight certification testing of submerged shuttloff valve.	do.	204, 775
Perkin-Elmer Corp., Norwalk, Conn.	NAS8-20115	Optical technology experiments for a satellite.	Apr. 29, 1965	204, 300
Electro-Optical Systems, Pasadena, Calif.	NAS8-11694	Study and investigation, design, development and fabrication of cryogenic pressure transducer.	Apr. 9, 1965	200, 012
Lockheed Aircraft, Sunnyvale, Calif.	NAS8-20377	Design requirements for reactor power system for lunar exploration.	June 30, 1966	200, 000
TRW, Inc., Redondo Beach, Calif.	NAS8-18056	Alternative mission modes study.	Aug. 23, 1966	200, 000
Garrett Corp., Los Angeles, Calif.	NAS8-20261	Early lunar shelter design and comparison study.	Feb. 17, 1966	200, 000
American Machine & Foundry, Alexandria, Va.	NAS8-11168	Development of lightweight magnesium alloys for low-temperature applications.	June 19, 1964	196, 736
Raytheon Co., Santa Ana, Calif.	NAS8-17431	Central processor system.	Mar. 16, 1966	196, 641
North American Aviation, Los Angeles, Calif.	NAS8-11108	Development of high-strength, low-density composite materials for Saturn applications.	Sept. 27, 1963	196, 014
Battelle Memorial Institute, Columbus, Ohio	NAS8-11837	Processing, development, and pilot plant production of silane polymers and diols.	Nov. 27, 1964	195, 360
Tulane University, New Orleans, La.	NAS8-11135	Development of data analysis methods for high intensity sound propagation.	Nov. 7, 1963	195, 258
North American Aviation, Downey, Calif.	NAS8-20258	Scientific mission support study for extended lunar exploration.	Dec. 13, 1965	195, 060
Oak Ridge Technical Enterprises, Oak Ridge, Tenn.	NAS8-11080	Study of surface barrier silicon detector.	June 29, 1963	194, 795

R. & D. CONTRACTS ADMINISTERED BY PURCHASING OFFICE, MSFC—Continued

[Listed in order of dollar value]

Contractor	Contract	Description	Date	Amount
Princeton University, Princeton, N.J.	NASS-5343	Application of feedback techniques to transducers	June 15, 1963	\$193,491
Electronic Communications, Inc., St. Petersburg, Fla.	NASS-20443	Finalize electrical design, construct and deliver complete set of system bread-board circuits	May 31, 1966	193,300
Benson, R. W., and Associates, Nashville, Tenn.	NASS-20268	Develop nondestructive methods determining residual stress and fatigue damage in metals	July 9, 1965	193,008
Auburn University, Auburn, Ala.	NASS-11274	Investigate digital compensation thrust vector feedback control system for Saturn-type space vehicles	May 28, 1964	192,573
Douglas Aircraft Co., Huntington Beach, Calif.	NASS-20242	Saturn I-B improvement study (solid 1st stage), phase II	June 30, 1965	191,479
Minneapolis-Honeywell, Minneapolis, Minn.	NASS-11206	Research study of large, flexible launch booster control	May 9, 1964	188,746
Lockheed Aircraft, Sunnyvale, Calif.	NASS-11453	Gust criteria study	May 27, 1964	188,598
Auburn University, Auburn, Ala.	NASS-20154	Study of phase variation characteristics of very low frequency transmission	Oct. 14, 1965	187,901
Bell Aerosystems Co., Buffalo, N.Y.	NASS-5491	Instrumentation, development, fabrication, and furnishing techniques to measure vehicle engine performance	June 29, 1963	186,940
Lockheed Aircraft, Sunnyvale, Calif.	NASS-20362	Study on cryogenic container thermodynamics during propellant transfer	June 30, 1966	186,682
Brown Engineering Co., Huntsville, Ala.	NASS-20233	Verification of criticality data	June 29, 1965	186,220
Measurement Analysis, Los Angeles, Calif.	NASS-20020	Improvement of techniques for derivation of vibration test specification	Apr. 30, 1965	185,937
Martin-Marietta Corp., Denver, Colo.	NASS-20223	Acoustic scale model tests of high speed flows	June 30, 1965	185,479
Motorola, Inc., Scottsdale, Ariz.	NASS-11922	Design, develop, and deliver 20 prototype units for production of high reliability microminutized d.c. amplifier	June 29, 1965	185,241
Eskew, H. L., & Sons, Birmingham, Ala.	NASS-15078	Air-conditioning modifications	June 22, 1965	184,598
General Dynamics, Fort Worth, Tex.	NASS-11943	Development of heavy gage bonded honeycomb	May 4, 1965	183,312
General Electric Co., Philadelphia, Pa.	NASS-20872	Mission engineering study of electrically propelled manned planetary vehicles	June 27, 1966	182,300
Republic Aviation Corp., Farmingdale, Long Island, N.Y.	NASS-20130	Research on celestial mechanics and optimization	June 30, 1965	180,698
Hughes Aircraft Co., El Segundo, Calif.	NASS-20244	Environmental effects on AES scientific instruments	do.	180,000
Litton Precision Products, Blacksburg, Va.	NASS-20578	Design, investigation, and development of design improvements for ST-124M stabilized platform slipping capsules	Mar. 31, 1966	179,968
North American Aviation, Canoga Park, Calif.	NASS-11656	Design, development and fabrication of upper stage fire detection system Saturn vehicle	June 19, 1964	179,941
Martin-Marietta Corp., Denver, Colo.	NASS-11328	Cryogenic liquid experiments in orbit	Sept. 8, 1964	179,712
Northrop Corp., Huntsville, Ala.	NASS-20116	Lunar dust removal/prevention techniques for radiators (AES) payloads	Mar. 8, 1966	179,000
Wyle Laboratories, Huntsville, Ala.	NASS-11312	Environmental research	June 30, 1964	178,903
Sperry Rand Co., Phoenix, Ariz.	NASS-20080	Study applications of tracking filter to stabilize large flexible launch vehicles	May 7, 1965	176,622
North American Aviation, Downey, Calif.	NASS-20320	Electronic packages environmental control system and vehicle thermal system integration	Apr. 20, 1966	176,120
General Dynamics, San Diego, Calif.	NASS-20146	Study of zero-gravity, vapor-liquid separators	June 7, 1965	175,634
Battelle Memorial Institute, Columbus, Ohio.	NASS-11983	Design, development and fabrication of prototype high temperature, high frequency response pressure transducer	Mar. 30, 1965	174,700
General Dynamics, San Diego, Calif.	NASS-11486	Design criteria for theoretical and experimental dynamic analysis	Oct. 15, 1964	173,945
Adcom, Inc., Cambridge, Mass.	NASS-20728	Special studies of AFOD system concepts and designs	June 18, 1965	173,512
Oklahoma State University, Stillwater, Okla.	NASS-11009	Study of filtration mechanics and sampling techniques	June 12, 1963	173,361

Adcom, Inc., Cambridge, Mass.	NAS8-20001	Engineering studies analyses of communications telemetry radio frequency probes related vehicle system instrumentation.	Nov. 19, 1965	172, 100
Electro Technical Corp., West Caldwell, N.J.	NAS8-5082	Development of highly reliable capsule-type slipring assemblies.	June 30, 1962	171, 965
Bryson Construction Co., Oceanport, Ala.	NAS8-17892	Construction of elevator for test stand and airborne tape recorders.	May 17, 1966	171, 146
Kinledge Corp., Pasadena, Calif.	NAS8-20310	Design, development, and fabrication of airborne tape recorders.	June 23, 1965	171, 063
Boeing Co., Huntsville, Ala.	NAS8-20334	Research and development for fabricating simulated titanium alloy base gore segment lower bulkhead S-IC fuel tank.	June 30, 1965	170, 500
North American Aviation, Downey, Calif.	NAS8-11495	Design criteria, guidance flight mechanics and trajectory optimization.	June 29, 1965	168, 704
Boeing Co., Huntsville, Ala.	NAS8-20900	Research on passive instrumentation and stimuli generation for Saturn V equipment checkout.	June 26, 1965	168, 354
IIT Research Institute, Chicago, Ill.	NAS8-20640	Development of continuous scanning laminograph nondestructive inspection multilayer printed circuit boards.	June 20, 1966	166, 715
Honeywell Inc., Huntsville, Ala.	NAS8-17448	Analog magnetic tape recording system.	June 30, 1966	166, 250
Radiation, Inc., Melbourne, Fla.	NAS8-18011	Design, fabrication, and delivery, telemetry redundancy analyzer.	do.	166, 176
Radio Corp., Teterboro, N.J.	NAS8-11885	ST-124M platform system resolvers.	Feb. 26, 1964	165, 803
Stanford Research Institute, Menlo Park, Calif.	NAS8-20220	Investigation of reactivity launch vehicle materials with liquid oxygen.	June 23, 1965	164, 722
Westinghouse Electric, Pittsburgh, Pa.	NAS8-20678	Self-contained electron beam welding gun to conduct an "in orbit" welding experimentation.	Nov. 29, 1966	164, 342
Southwest Research Institute, San Antonio, Tex.	NAS8-11045	Study of nonlinear dynamic behavior of liquids in cylindrical elastic containers.	June 29, 1963	164, 186
Alabama, University of, University, Ala.	NAS8-11202	Study of measurement of Earth tremors produced as result of large rocket firings.	Mar. 21, 1964	164, 191
American Machine & Foundry, Stamford, Conn.	NAS8-5184	Design, fabrication, and installation of a gimbaled engine simulator.	Aug. 6, 1962	162, 869
Westinghouse Electric, Baltimore, Md.	NAS8-20245	Study of emplaced lunar scientific station for Apollo extension systems.	June 28, 1965	162, 594
United Aircraft Corp., Norwalk, Conn.	NAS8-11961	Design, manufacture, test, and delivery prototype semiconductor integrated circuits.	Apr. 23, 1965	155, 682
Vanderbilt University, Nashville, Tenn.	NAS8-2559	Research and numerical integration of 2d order differential equations.	Dec. 28, 1961	155, 456
Teddyne Inc., Hollister, Calif.	NAS8-11839	Design development fabrication testing of type B high temperature detonating fuse assembly tee and ordnance manifold.	June 29, 1965	154, 819
Metrophysics Inc., Santa Barbara, Calif.	NAS8-20516	Design fabrication test delivery portable prototype tube flare inspection instruments.	June 24, 1965	156, 204
North American Aviation, Downey, Calif.	NAS8-11490	Study longitudinal oscillations propellant tanks wane propagations fuel lines.	Jan. 6, 1965	153, 593
Smith Electronics, Brecksville, Ohio.	NAS8-11592	Design of short term stability.	Mar. 16, 1964	153, 300
Westinghouse Electric, Huntsville, Ala.	NAS8-11914	Design, manufacture test, and delivery prototype semiconductor integrated circuits.	Apr. 23, 1965	151, 818
Arde Inc., Paramus, N.J.	NAS8-11977	Research and development cryogenic stretch-form helium bottles for Saturn V-S-IC vehicle.	June 24, 1965	151, 652
Bendix Corp., Teterboro, N.J.	NAS8-11916	Design development fabrication delivery microelectric circuits stabilization of gas bearing gyro servoloops.	Apr. 14, 1965	151, 362
Southern Research Institute, Birmingham, Ala.	NAS8-20190	Study of polymers containing silicon nitrogen bonds.	May 4, 1965	150, 047
Midwest Research Institute, Kansas City, Mo.	NAS8-11012	Study for indicational load effects on multistage missile systems.	June 21, 1963	150, 043
General Electric Co., Philadelphia, Pa.	NAS8-20360	Derivation analytical methods rapid convergence to solution optionized trajectories.	Apr. 27, 1966	150, 000
Johns Hopkins University, Baltimore, Md.	NAS8-5253	Investigation of behavior dielectric material at high field strengths in vacuum environment.	Apr. 1, 1963	149, 998
Boeing Co., Seattle, Wash.	NAS8-20156	Study of dissimilar metal joining by solid state welding.	May 20, 1965	162, 275
Lockheed Aircraft, Sunnyvale, Calif.	NAS8-11410	Dev empirical model estimating statistical charics unsteady pressure field.	June 27, 1964	162, 168
Raytheon Co., Inc., Bedford, Mass.	NAS8-11007	Optimization multistage three dimsl boost trajectories	June 27, 1963	162, 013
Sylvania Electric Products, Waltham, Mass.	NAS8-11588	Dev optical superheterodyne receiver.	Mar. 10, 1964	160, 768

R. & D. CONTRACTS ADMINISTERED BY PURCHASING OFFICE, MSFC—Continued
[Listed in order of dollar value]

Contractor	Contract	Description	Date	Amount
Aluminum Co. of America, Pittsburgh, Pa.	NAS8-5340	Investigation stress corrosion high strength aluminum alloys.	May 6, 1963	\$160,236
Borders Electric Co., Camden, N.J.	NAS8-20177	Studies and invests application random noise modtm advanced tracking sys.	June 25, 1965	158,491
Fairchild Hiller, Farmingdale, NY	NAS8-20663	Measurement of electric fields in ionosphere.	June 25, 1966	158,409
Melpar Inc., Falls Church, Va.	NAS8-11263	Permeability engr material to all wind tunnels.	Aug. 30, 1964	158,083
Space Tech Lab Inc., Redondo Beach, Calif.	NAS8-5051	Adaptline control sys for Saturn-type vehicles.	June 28, 1962	157,884
Electro Mech Res Inc., Sarasota, Fla.	NAS8-20243	Study lunar geomorphic surface as substrate for Apollo extensm sys.	June 30, 1965	157,570
Midwest Research, Kansas City, Mo.	NAS8-11338	Synthesis and evaluation of new high temp polymers coating applications.	June 25, 1964	157,300
Union Carbide Corp., Tonawanda, NY	NAS8-11740	Super insulation sys for cryogenic test tanks.	June 25, 1964	157,115
Mississippi State University, State College, Miss.	NAS8-11334	Res determin of liquid surface profile in cryogenic tank during gas injection.	June 25, 1964	157,085
Ball Bros. Research Corp., Boulder, Colo.	NAS8-18119	Designs for satellite and material recovery from orbit.	June 30, 1966	149,985
TRG Inc., Melville, N.Y.	NAS8-11773	Experiment fab testing and delivery of frequency stabilized gas laser.	June 30, 1964	149,600
International Business Machine, Rockville, Md.	NAS8-10971	Development of room temperature coherent gas laser arrays.	June 30, 1964	149,454
Aveco Corp., Everett, Mass.	NAS8-20310	Study of plasma radiation shielding.	Mar. 24, 1966	149,031
ITT Research Institute, Chicago, Ill.	NAS8-20325	Study vibration induced in thin-walled pipes under varying flow conditions.	Apr. 30, 1966	148,251
North American Aviation, Canoga Park, Calif.	NAS8-20143	Study of pump discharge pressure oscillations.	Apr. 30, 1965	147,316
Varian Associates, Palo Alto, Calif.	NAS8-16689	Magnetic resonance spectrometer system.	May 30, 1965	146,622
ITT Research Institute, Chicago, Ill.	NAS8-20363	Material preparation and instrumentation for welding S-IC component.	May 25, 1966	145,693
General Electric Co., Philadelphia, Pa.	NAS8-11423	Study of low acceleration space transportation systems.	May 30, 1964	145,359
General Dynamics, University of Berkeley, Calif.	NAS8-20287	Research on motions of artificial satellites.	June 16, 1965	144,472
General Dynamics, San Diego, Calif.	NAS8-18754	Digital/TV generator.	June 30, 1966	144,329
Lang-Temco-Vought, Anaheim, Calif.	NAS8-18296	Acoustic data acquisition system.	June 30, 1966	144,200
Kollsman Instrument, Syosset, N.Y.	NAS8-20132	Optical system for Apollo extension system.	June 24, 1965	144,000
Cutler-Hammer Inc., Deer Park, N.Y.	NAS8-20604	Improvement in control of automated stage checkout test conductor date system study.	Mar. 2, 1966	144,000
Douglas Aircraft Co., Long Beach, Calif.	NAS8-20318	Research study on vehicle structural damping.	May 9, 1966	143,379
Garrett Corp., Los Angeles, Calif.	NAS8-11291	Research study instrument unit thermal conditioning heat sink concepts.	Mar. 11, 1966	143,134
Rohr Corp., Chula Vista, Calif.	NAS8-11955	Research and development program, bonded cylindrical structure.	June 24, 1965	142,225
Georgia Technical Research Institute, Atlanta, Ga.	NAS8-2473	Development of new methods and applications to analog computations.	Sept. 12, 1961	140,350
General Dynamics, San Diego, Calif.	NAS8-20165	Development analytical methods of predetermining residual cryogenic propellant behavior orbital vehicles.	June 10, 1965	140,220
Baker Thompson, Inc., Decatur, Ala.	NAS8-17894	Atmospheric Research Building 4614.	May 25, 1966	139,966
United Aircraft Corp., Windsor Locks, Conn.	NAS8-20630	Nondestructive testing space application feasibility and preliminary design study.	June 21, 1966	139,930
TRW Inc., Redondo Beach, Calif.	NAS8-20054	Investigation of techniques of improving Saturn radar altimeter.	Apr. 19, 1965	139,852
General Electric Co., Philadelphia, Pa.	NAS8-20814	Design criteria for flight evaluation.	June 22, 1966	139,750
Systems Engineering Lab, Inc., Ft. Lauderdale, Fla.	NAS8-11207	Study of electrically propelled cargo vehicle, lunar supply operations.	June 3, 1964	139,660
Oklahoma State University, Stillwater, Okla.	NAS8-17689	Plotter interface system.	Mar. 31, 1965	138,840
Dynamics Research Corp., Stoneham, Mass.	NAS8-20052	Design analysis performance evaluation on Electrical contacts for space vehicles.	Feb. 1, 1965	138,481
Sylvania Electric Products, Williamsville, N.Y.	NAS8-11890	Transducer with direct digital output pressure transducers with digital output.	Apr. 26, 1965	138,044
Northrop Corp., Newburg Park, Calif.	NAS8-20399	One prototype 100-milliwatt Ka band solid state transmitter/driver.	June 22, 1966	137,072
Martin-Marietta Corp., Denver, Colo.	NAS8-11400	Shielding vortex subsolites flow around rigid cylinder.	June 27, 1964	136,214
Lockheed Aircraft, Sunnyvale, Calif.	NAS8-20224	Optimization of thrust vector control systems.	June 17, 1965	136,212
Shook Hydrodynamics Corp., Sherman Oaks, Calif.	NAS8-20353	Research study, high performance insulation thermal design criteria.	Mar. 25, 1966	136,100
Hughes Aircraft Co., Los Angeles, Calif.	NAS8-20235	Theoretical studies of hypervelocity impact.	June 29, 1965	135,910
Bendix Corp., Baltimore, Md.	NAS8-20601	One prototype Ka band power amplifier.	June 7, 1966	135,572
Russell Engineer Works, Boston, Mass.	NAS8-20532	Absolute type pressure switch.	June 28, 1965	135,453
Electronic Communications, St. Petersburg, Fla.	NAS8-18649	Semitrailer.	June 30, 1966	135,248

NASS-20222	Purdue University, Lafayette, Ind.	Improved fluid dynamics similarity analysis and verification.	June 22, 1965	134, 865
NASS-11406	Hughes Aircraft Co., Culver City, Calif.	Development of structural foams for ergonomic applications.	June 22, 1965	134, 484
NASS-17907	McBurn and Co., Dallas, Tex.	Fiscal year 1967 paving, drainage and railroads.	Oct. 30, 1966	134, 146
NASS-20316	LTV Aerospace Corp., Dallas, Tex.	Extravehicular manipulators.	Mar. 23, 1966	134, 000
NASS-11250	Marquardt Corp., Van Nuys, Calif.	Feasibility study of oxygen-hydrogen powdered metal ignition.	Sept. 16, 1964	132, 910
NASS-11435	Lockheed Aircraft, Marietta, Ga.	Study inert gas tungsten arc welding process transmissibility setup parameters.	June 27, 1964	132, 154
NASS-11346	Lockheed Aircraft, Marietta, Ga.	Research study of random process theory and physical application.	June 29, 1964	131, 641
NASS-11855	ITT Research Institute, Chicago, Ill.	Design and development of a fast neutron spectrometer.	May 4, 1965	131, 621
NASS-11488	Lockheed Aircraft, Sunnyvale, Calif.	Guidance system study.	Dec. 8, 1964	130, 300
NASS-20023	Honeywell, Inc., Minneapolis, Minn.	Research computational and display requirements, human control of space vehicle boosters.	June 22, 1965	129, 690
NASS-18724	Cryo-Tec, Louisville, Ky.	Expansion joints.	Aug. 24, 1966	129, 408
NASS-11290	Litton Systems, St. Paul, Minn.	Study of base flow and base heating.	June 27, 1964	129, 387
NASS-2508	Defense Electronics, Inc., Rockville, Md.	Design, develop, and fabricate telemetry predetection recording system.	Oct. 19, 1961	129, 088
NASS-17998	Teledyne, Inc., Seattle, Wash.	Amplifiers.	Mar. 18, 1966	128, 400
NASS-11419	Systems Technology, Inc., Redwood, Calif.	Control study reduced bending frequencies, coupling of rigid and elastic modes.	June 30, 1964	128, 362
NASS-11282	Internal Harvester, San Diego, Calif.	Design, fabrication, and testing services.	May 28, 1964	128, 282
NASS-20674	Federal-Mogul Corp., Los Angeles, Calif.	Pressure volume compensators.	Oct. 28, 1966	125, 000
NASS-8673	Massachusetts Institute of Technology, Cambridge, Mass.	Research on nonspinning multistage spacecraft performing bending oscillations.	Mar. 20, 1961	125, 450
NASS-11459	General Co., Seattle, Wash.	Investigate electro-optical techniques for controlling direction of laser beam.	June 29, 1964	125, 132
NASS-20667	Boeing Co., Seattle, Wash.	Classified requirement known as Project Able.	July 28, 1966	125, 000
NASS-20666	Westinghouse Electric, Baltimore, Md.	do.	Aug. 1, 1966	125, 000
NASS-11494	General Dynamics, San Diego, Calif.	Design criteria for control of space vehicles during launch phase of flight.	June 9, 1965	125, 000
NASS-20326	Cornell Aro Lab., Buffalo, N.Y.	Investigation Saturn V shroud and fin interference-free static.	Jan. 25, 1966	124, 877
NASS-20502	Electric, Inc., Waltham, Mass.	Design, fabrication, testing, and delivery of SS-DS demultiplexer.	May 17, 1966	124, 108
NASS-20404	Avco Corp., Wilmington, Mass.	Development of typical Mars landing capsule sterilization container.	June 28, 1965	123, 950
NASS-11272	Pratt Institute, Philadelphia, Pa.	EBW firing unit detonator compatibility testing and statistical analysis.	Nov. 23, 1966	123, 487
NASS-20404	Radio Corp. of America, Camden, N.J.	Study of high-field superconductors at elevated temperature.	June 26, 1964	123, 185
NASS-20514	Marin-Marietta, Denver, Colo.	Study addressable time division data system. Design, construct, and deliver breadboard model to demonstrate feasibility.	June 24, 1965	122, 438
NASS-20019	North American Aviation, Downey, Calif.	Study mass loading effects on localized vibratory rocket vehicle environments.	June 30, 1965	121, 650
NASS-20257	Ryan Aeronautical Co., San Diego, Calif.	Study to step recovery diode frequency multiplier characteristics.	Aug. 19, 1965	121, 202
NASS-11623	Thiokol Chemical Co., Denver, N.J.	Design, development testing and delivery of fine accelerometer assemblies.	June 25, 1964	120, 764
NASS-11622	Technique, Inc., West Chester, Pa.	Ultrasonic tube connection tool or device.	May 14, 1965	120, 548
NASS-15094	Snyder Manufacturing Co., Birmingham, Ala.	Bldg. 4491, computer addition.	Oct. 11, 1965	120, 440
NASS-17425	Electronic Associates, Inc., West Long Branch, N.J.	Memory bank.	Feb. 10, 1966	120, 120
NASS-20209	TRW Space Technical Labs, Redondo Beach, Calif.	Body fixed axis inertial reference system, application analytic platform to future missions.	June 29, 1965	119, 926
NASS-11964	Battelle Memorial, Inc., Columbus, Ohio	Fabrication and delivery 6 beryllium ST 124 M stabilized platform inner gim-bals and perform.	June 17, 1965	119, 829
NASS-11471	Lockheed Aircraft, Sunnyvale, Calif.	Statistical characterization of Saturn vibration data.	June 29, 1964	119, 228
NASS-20240	Boeing Co., Huntsville, Ala.	Advanced systems checkout design.	June 29, 1965	118, 547
NASS-20060	University of Michigan, Ann Arbor, Mich.	Analytical study of launch vehicle component level simulation.	Mar. 27, 1965	117, 700
NASS-20228	Fred D. Wright Co., Nashville, Tenn.	Investigation and study of transient heat transfer.	June 30, 1965	117, 450
NASS-19205	Douglas Aircraft Co., Huntington Beach, Calif.	Nose cone rings and hoisting stations.	Sept. 20, 1966	116, 761
NASS-20259	Systems Engineering Lab., Inc., Fort Lauderdale, Fla.	Saturn I-B improvement studies.	Dec. 6, 1965	116, 346
NASS-20021	University of Alabama, University, Ala.	Design, fabricate, and install a telemetry digitizing system.	Mar. 26, 1965	115, 800
NASS-526	Brayco Construction, Decatur, Ala.	Research on molecular surface interactions at space probe escape velocities.	May 23, 1963	114, 998
NASS-17908	Radiation Research Associates, Fort Worth, Tex.	Addition to A wing, Bldg. 4663.	Oct. 28, 1966	114, 971
NASS-11047	Goodyear Aerospace, Akron, Ohio.	Study transport of neutrons from proton-induced nuclear evaporation and intranuclear cascades.	June 20, 1963	114, 824
NASS-11376	Battelle Memorial, Inc., Columbus, Ohio.	Flexible vacuum jacket development.	June 30, 1964	114, 702
NASS-20309	Battelle Memorial, Inc., Columbus, Ohio.	Study and investigate behavior of high-speed angular ball bearings under dynamic load.	June 30, 1966	114, 338

R. & D. CONTRACTS ADMINISTERED BY PURCHASING OFFICE, MSFC—Continued

[Listed in order of dollar value]

Contractor	Contract	Description	Date	Amount
Lockheed Aircraft, Sunnyvale, Calif.	NAS8-11901	Design, manufacture, test, evaluate, and deliver specimens for cryogenics build test program.	June 30, 1965	\$114, 041
Massachusetts Institute of Technology, Cambridge, Mass.	NAS8-2504	Establish guidelines for Random and Sinesoidal vibration correlation.	June 30, 1961	113, 891
Honeywell, Inc., Minneapolis, Minn.	NAS8-2006	Man-system criteria for extraterrestrial surface roving vehicles.	Feb. 11, 1965	113, 605
Electro-Mechanical Research, Inc., Minneapolis, Minn.	NAS8-19083	Central processor.	Oct. 6, 1966	113, 600
North American Aviation, Canoga Park, Calif.	NAS8-20225	Investigate cooling problems at high chamber pressures.	June 29, 1965	113, 227
Northrup Corp., Huntsville, Ala.	NAS8-11440	Computer solutions of the Phase II equations.	June 29, 1964	113, 044
Westinghouse Electric, Pittsburgh, Pa.	NAS8-20567	Self-contained electron beam welding device.	Mar. 2, 1966	113, 000
Space Craft, Inc., Huntsville, Ala.	NAS8-15552	Modules.	May 26, 1965	113, 441
Auburn University, Auburn, Ala.	NAS8-20633	Study in digitized seroelectronics for use in stabilized platform system.	June 17, 1965	111, 314
Allied Research Association, Concord, Mass.	NAS8-11294	Photomechanical investigations of structural behavior of gyroscope components.	June 11, 1964	110, 851
IBM, Bethesda, Md.	NAS8-11092	Investigation of cryogenic propellant level sensor.	Nov. 23, 1964	110, 580
Illinois Institute of Technology, Chicago, Ill.	NAS8-11015	Analysis for deriving mathematical mass-spring models of propellant tanks.	Aug. 20, 1963	109, 580
Bolt, Beranek, Newman, Cambridge, Mass.	NAS8-20026	Study of structural response to high acoustic environment.	June 21, 1963	108, 471
Packard Bell Electronics, Corp., Los Angeles, Calif.	NAS8-576	Automatic checkout system for S-IV vehicle Saturn.	June 31, 1961	108, 356
University of Alabama, University, Ala.	NAS8-5411	Study of "parameter optimization," finite element.	Jan. 8, 1963	108, 351
General Dynamics, San Diego, Calif.	NAS8-11181	Study of stability of pressurized shell structures under static loading.	May 20, 1965	108, 374
Perkin-Elmer Corp., Norwalk, Conn.	NAS8-16689	Development and fabrication of ring laser systems.	May 20, 1965	106, 905
Bendix Corp., Teletoro, N.J.	NAS8-11586	Develop improved performance high speed spin bearings and gyro wheels.	Aug. 24, 1964	106, 851
Chrysler Corp., Henterville, Ala.	NAS8-13857	Eds Q-ball angle of attack sensor system.	June 23, 1964	106, 822
North American Aviation, Los Angeles, Calif.	NAS8-13857	R-1 test wader.	June 23, 1965	105, 190
Grumman Aircraft, Inc., Bethpage, N.Y.	NAS8-20405	Study of lunar surface scientific mission simulation.	June 23, 1965	105, 190
University of Tennessee, Knoxville, Tenn.	NAS8-20152	Study of bubble growth in an oscillating pressure field.	June 22, 1965	105, 604
Industrial Nucleonic, Columbus, Ohio.	NAS8-20154	Performance of studies to determine test gear for measuring propellant.	June 22, 1965	105, 500
Sperry Rand Corp., Great Neck, N.Y.	NAS8-11646	Development and fabrication of ring laser systems.	Nov. 1, 1966	104, 724
Universal Match Corp., Phoenix, Ariz.	NAS8-11778	Design, development, and fabrication testing of remote control safety/arming device.	May 30, 1964	104, 717
General Dynamics, San Diego, Calif.	NAS8-11405	Hydrogen-oxygen reaction studies.	Dec. 22, 1964	104, 027
Honeywell, Inc., Minneapolis, Minn.	NAS8-11902	Gas bearing gyros with hydrodynamic spin motors.	June 30, 1964	103, 907
P. E. C. Corp., Boulder, Colo.	NAS8-1210	Theoretical study of the radiative emissivity of materials.	Mar. 30, 1965	103, 753
North American Aviation, Downey, Calif.	NAS8-20283	Human factors visual simulation study.	Mar. 30, 1965	103, 753
Douglas Aircraft Co., Huntington Beach, Calif.	NAS8-11570	Saturn I-B improvement study (solid first stage).	Apr. 1, 1963	103, 250
Lockheed Aircraft, Marietta, Ga.	NAS8-20518	Design, development, test, and fabrication of rotors and productive units.	Dec. 22, 1965	102, 925
Virginia Polytechnic Institute, Blacksburg, Va.	NAS8-11433	Studies and investigations on slip rings and gas bearing components.	June 30, 1965	102, 237
General Applied Science Laboratory, Westbury, N.Y.	NAS8-20066	Investigation of combustion of hydrogen in hypersonic airstream.	June 30, 1964	102, 200
General Dynamics, Fort Worth, Tex.	NAS8-11995	Design, development, fabrication, test 2 flight modes.	May 7, 1965	101, 720
Texasco Experiments, Richmond, Va.	NAS8-20085	Study of lunar geophysical surface and subsurface probes.	June 29, 1965	101, 477
Bendix Corp., Sidney, N.Y.	NAS8-11893	Design, fabrication, and delivery of 4 exploding bridgewire firing units.	June 29, 1965	101, 435
Chrysler Corp., Huntsville, Ala.	NAS8-17610	Redundant EDS Q-Ball sensor systems.	May 21, 1965	101, 430
Hydronautics, Inc., Laurel, Md.	NAS8-20625	Investigation of a tandem row-high head pump inducer.	Feb. 10, 1966	101, 290
Auburn University, Auburn, Ala.	NAS8-11234	Environmental effects on multiphase genesis.	Sept. 8, 1966	101, 170
North American Aviation, Downey, Calif.	NAS8-18031	Feasibility of modifying the S-II stage as injection stage.	Apr. 23, 1964	100, 381
ITT Research Institute, Chicago, Ill.	NAS8-20337	Experimental hypervelocity impact research program.	Aug. 19, 1966	100, 000
			June 28, 1966	100, 000

Construction contracts for facilities (current contracts over \$100,000 as of Jan. 1, 1967)

[List of construction contracts with estimated completion dated and total costs. Additional information furnished is the contract number and the contractor.]

HUNTSVILLE			
Contract No.	Title	Amount (thousands)	Contractor—Name, city, and State
ENG NAS-2929	Roadnet modifications, phase II	\$1,753.0	Ashburn & Gray, Huntsville, Ala.
NAS-17137	Extension to load test stand	175.1	D & A Equipment, Pensacola, Fla.
NAS-17382	Elevator for test stand and addition to steamplant	171.1	Bryson Construction Co., Decatur, Ala.
NAS-17388	Modifications to 187 foot B wing, building 4663	219.1	Bagby Elevator & Electric Co., Huntsville, Ala.
NAS-17903	Addition to building 4481	217.4	Bryson Construction Co., Decatur, Ala.
NAS-17908	Addition to A wing, building 4663	115.0	do.
MICHOU D ASSEMBLY FACILITY			
NAS-17142	Plant utilities monitoring system	\$385.0	Johnson Services Co., New Orleans, La.
NAS-17881	Modifications to potable water systems, and plant utility system modifications	905.0	South Central Heating & Plumbing, Inc., Jackson, Miss.
MISSISSIPPI TEST FACILITY			
ENG (NASA) 2876	S-II test complex, test position A-1	\$10,068.3	Koppers Co., Inc., and Malan Construction Department, New York, N.Y.
ENG (NASA) 2899	S-IC test stand, test position B-1	5,633.5	Blount Bros. Construction Co., Montgomery, Ala.
ENG (NASA) 2900	Components service facility	3,498.3	Mike Bradford Co., Inc., Miami, Fla.
ENG (NASA) 2904	Widening and improvement of Mississippi State Highway No. 43 in connection with NASA, Mississippi Test Facility	1,250.0	Yates & Patterson, Picaune, Miss.
ENG (NASA) 9006	Addition to heating system for S-IC test stand, position B-2	178.1	Carpenter Bros., New Orleans, La.
NAS-w-410	Phases II and III technical system	23,206.7	General Electric, Bay St. Louis, Miss.
NAS-19528	Equipment interface modifications and additions to the S-IC test stand	200.0	Boeing Co., New Orleans, La.
1-10-5(19)276	NASA funding for bridge for U.S. Interstate 10	5,430.0	Fairchild & Snowden, Hattiesburg, Miss.
VARIOUS LOCATIONS			
NAS-5808(F)	Relocation and rehabilitation plating and processing facility	\$410.6	Texarkana Construction Co., Texarkana, Tex.
NBY-69607	Construction of the subassembly building, Saturn S-II facility	1,596.1	Santa Fe Engineers, Inc., Lancaster, Calif.
DACA-46-67-C-904	Rehabilitation of access roads and reservoir site slopes (Edwards Air Force Base, Calif.)	275.0	do.

July 1967.
February 1967.
April 1967.

(b) *Procurement for research and development*

Purchasing office, MSFC

Number of procurement plans submitted to Center Director (less than \$5 million) : Four.

Number submitted to NASA headquarters (more than \$5 million) : One.

Exceptions to (1) and (2) above: None.

Contracts office, MSFC

Number of procurement plans submitted to Center Director (less than \$5 million) : Six.

Number submitted to NASA headquarters (more than \$5 million) : None.

Exceptions to (1) and (2) above: None.

(c) *Contracts (calendar year 1966)*

Contracts officer, I.O.

Number of competitive participants in each R&DO negotiated contract.

Contract No :	<i>Number of participants</i>
(a) NAS8-18732	3
(b) NAS8-17221	4
(c) NAS2-17205	2
(d) NAS8-17216	2
(e) NAS8-18725	3
(f) NAS8-17217	4
(g) NAS8-18740	1

Purchasing office, MSFC

Number of competitive participants in each R&DO negotiated contract.

Contract No :	<i>Number of participants</i>	Contract No.—Continued	<i>Number of participants</i>
NAS8-18405	5	NAS8-20320	6
NAS8-20412	6	NAS8-17892	3
NAS8-20262	8	NAS8-17448	5
NAS8-20334	5	NAS8-18011	6
NAS8-20672	2	NAS8-20663	11
NAS8-18759	2	NAS8-20363	12
NAS8-18025	5	NAS8-18296	1
NAS8-17439	2	NAS8-20318	7
NAS8-18404	6	NAS8-11291	5
NAS8-18053	7	NAS8-17894	8
NAS8-20648	3	NAS8-20630	4
NAS8-18298	2	NAS8-20314	4
NAS8-17443	6	NAS8-20601	2
NAS8-21023	7	NAS8-18649	2
NAS8-18926	3	NAS8-17907	2
NAS8-17446	3	NAS8-20316	7
NAS8-18118	9	NAS8-17698	2
NAS8-18760	3	NAS8-20667	4
NAS8-17051	3	NAS8-20666	4
NAS8-21021	3	NAS8-20605	4
NAS8-20622	2	NAS8-19205	3
NAS8-17671	1	NAS8-17908	4
NAS8-20377	3	NAS8-20309	1
NAS8-18056	4	NAS8-20567	2
NAS8-20261	7	NAS8-21014	13
NAS8-20362	14	NAS8-20625	6
NAS8-20372	5	NAS8-20337	4
NAS8-20116	4		

Contracts office, I.O.

Fixed price contracts converted to CPIF: None.

Purchasing office, MSFC

Fixed price contracts converted to CPIF: None.

Contracts office, I.O.

Contracts scheduled to be converted to CPIF:

Contract No. and contractor:

Description

NASS-5608, schedule II: The Boeing Co., Huntsville, Ala. Systems engineering, integration, and GSE.

NASS-4016, schedule II: Chrysler Corp., CCSD, New Orleans, La. Systems engineering, and integration.

NASS-4016, schedule III: Chrysler Corp., CCSD, New Orleans, La. I-I/IB/GSE.

Purchasing office, MSFC

Contracts scheduled to be converted to CPIF: None.

Contracts office, I.O.

Contracts to a review board to determine final fee: None.

Purchasing office, MSFC

Contracts to a review board to determine final fee: None.

MSFC—OFFICE OF THE DIRECTOR

Delegation of contracting officer authority

Name	Monetary limitation of signature authority	Monetary limitation of approval authority
Harry H. Gorman.....	(1)	\$2,500,000
Wilbur S. Davis.....	(1)	2,500,000
David H. Newby.....	(1)	2,500,000

¹ Unlimited.

MSFC—PURCHASING OFFICE

Delegation of contracting officer authority

Name	Monetary limitation of signature authority	Monetary limitation of approval authority
Garland G. Buckner.....	(1)	\$1,000,000
Andrew Wood.....	(1)	500,000
J. R. Jones.....	(1)	100,000
W. J. McKinney.....	(1)	100,000
L. Garrison.....	(1)	100,000
James W. Fletcher.....	(1)	100,000
C. M. O'Bryant.....	\$250,000	100,000
Jack Grosser.....	250,000	25,000
Gerald Ridgeway.....	250,000	25,000
Edward Harper.....	250,000	25,000
H. M. McCullough.....	250,000	25,000
Fred Boles.....	(1)	100,000
Duron Crider.....	250,000	25,000

¹ Unlimited.

DELEGATION OF CONTRACTING OFFICER AUTHORITY

Contracts Office, I.O.

[MSFC 3-4, dated July 7, 1966]

Name of contracting officer	Project	Monetary limit of signature authority	Monetary limit of approval authority ¹
O. M. Hirsch	All	None	\$1,000,000
John R. McCombs	do	do	500,000
Marion S. Hardee	Michoud (all)	do	1,000,000
T. L. Burton	Engines	do	100,000
Earl H. Eubanks	Stages	do	100,000
Elbert B. Craig	IU/GSE	do	100,000
John H. Hyer	Logistics and liaison	do	100,000
Charles K. Hatch, Jr.	MTF	do	100,000
John E. Sharkey	MTF	do	1,000,000
William L. Goodrich	MTF	do	100,000
William D. Goldsby	NAA stages	do	100,000
Harold F. McMillan	SII stage	do	100,000
Melvin B. Sundstrom	DAC stages	do	100,000
Thomas B. Swaggerty	NAA engines	do	100,000
Burch H. Aldridge	Michoud (all)	do	100,000
Paul B. McCutcheon	Property	do	100,000
Ross W. Hunter	AMR	do	100,000

¹ Notwithstanding the herein specified limits, and in accordance with NASA PR 50.105, the following categories of actions shall be submitted to the Director of Procurement for approval: (1) certain utility service contracts re PR 4.5006, (2) architect-engineering service contracts when the total dollar value is \$250,000 or the work to be performed under a cost-plus-fixed-fee or fixed-price contract includes services of the type described in 4.201(b) (ii), (iii), or (iv), and the fee, inclusive of the architect-engineer's costs, to be paid to the architect-engineer for the performance of such services exceeds 6 percent of the estimated cost of the related construction project, exclusive of the amount of such fee, (3) facilities contracts providing facilities having total acquisition value exceeding \$250,000, or which provide real property regardless of amount, (4) all leases for real property where annual rental exceeds \$25,000 or where certificate of necessity under 40 U.S.C. 278b is required, (5) each negotiated contract or modification which by itself obligates the Government of \$2.5M.

Contracts office, I.O.

Contracts renegotiated: None.

Purchasing Office, MSFC

Contracts renegotiated: None.

Contracts Office, I.O.

Percentage of contracts to small businesses: 15 percent.

Purchasing office, MSFC

Percentage of contracts to small businesses: 55 percent.

(d) Facilities

The attached summary indicates the overall status of the C of F program by fiscal year, FY 1965 through FY 1968. The project amount and unobligated balance are also shown.

*Construction of facilities—Status of facility planning, design, and construction
(as of Jan. 1, 1967)*

HUNTSVILLE

[Amounts in thousands]

Project No.	Project title	Percent complete			Project amount ¹	Unobligated balance
		Plan-ning	Design	Con-struction		
	FISCAL YEAR 1965					
6256	Extension of propulsion and vehicle engineering.....	100	100	98	2,221.0	36.0
6252	Extension of utility systems.....	100	100	50	3,066.7	² 1,029.9
6255	Saturn support test area.....	100	100	96	3,417.0	71.4
6236	Extensions to Saturn V GSE test facility.....	100	100	100	2,435.0	28.8
6221	Expansion of components test facility.....	100	100	100	1,907.0	20.5

See footnotes at end of table.

*Construction of facilities—Status of facility planning, design, and construction
(as of Jan. 1, 1967)—Continued*

HUNTSVILLE

[Amounts in thousands]

Project No.	Project title	Percent complete			Project amount ¹	Unobligated balance
		Plan-ning	Design	Con-struction		
	FISCAL YEAR 1966					
6234	Test engineering building extension.....	100	100	91	493.5	41.2
6258	Addition to materials laboratory.....	100	100	95	890.6	41.0
6259	Nondestructive testing laboratory.....	100	100	85	649.0	117.6
	FISCAL YEAR 1968					
6271	Fire surveillance system.....	100	0	0	580.0	(²)
6274	Water pollution control.....	100	0	0	388.0	(²)

MICHOU D ASSEMBLY FACILITY

FISCAL YEAR 1965						
6313	Alterations to Saturn 1st stage (S-IC) production facilities.....	100	100	90	350.1	50.0
6314	Utility extension, alteration, and rehabilitation to support Saturn S-IV and S-IC production...	100	100	85	1,507.7	61.0
6315	Facility additions, extensions, and alterations to Saturn S-IB and S-IC production.....	100	100	100	3,285.0	25.8
6316	Central computer facility extensions and alterations.....	100	100	100	1,435.3	10.4
FISCAL YEAR 1966						
6319	Improvement to storm drainage system.....	100	100	100	346.7	11.2
FISCAL YEAR 1967						
6320	Modification of chemical waste disposal system...	100	100	0	750.8	705.5
FISCAL YEAR 1968						
63XX	Repair, rehabilitation, and improvements.....	100	0	0	900.0	(²)
6322	Extension of Saturn Bld. to State road system...	100	0	0	1,184.0	(²)
FISCAL YEAR 1965						
6422	Saturn V 1st stage (S-IC) static test facility.....	100	100	95	15,879.9	367.1
6423	Saturn V 2nd stage (S-II) static test facility.....	100	100	98	27,562.6	3.1
6425	Addition to utility installations and support facilities.....	100	100	99	10,942.0	53.0
6421	Components service facilities.....	100	100	99	6,593.5	11.4
FISCAL YEAR 1967						
6427	Facilities to support S-IC and S-II test program.....	100	0	0	1,700.0	1,700.0
FISCAL YEAR 1965						
9109	Facilities for F-1 engine program.....	100	100	99	3,417.4	350.0
9118	Facilities for S-II stage program.....	100	100	90	2,217.0	380.2
9130	Facilities for S-IVB stage program.....	100	100	99	5,247.0	74.8
9131	Facilities for J-2 engine program.....	100	100	97	3,037.3	0
FISCAL YEAR 1966						
9109	Facilities for F-1 engine program.....	100	100	50	735.0	62.3
9118	Facilities for S-II stage program.....	100	100	90	2,090.0	7.0
9131	Facilities for J-2 engine program.....	100	100	25	711.9	16.0

¹ Includes facility planning and design funds.² Transferred to Bureau of Public Roads. Planned obligation, 3d quarter, fiscal year 1967.³ Not available.

Construction of facilities—Cost-plus-fixed-fee contracts (as of Jan. 1, 1967)

MISSISSIPPI TEST FACILITY

Contract No.	Contractor	Category	Purpose
NASw-410-----	General Electric-----	Procurement-----	To provide for design, procurement fabrication, installation, and checkout of technical systems for S-II test stand A-1, S-IC dual test stands B-1 and B-2, electronics instrumentation and materials laboratory, sonic-measuring facilities, components service facility, data handling center, data acquisition facility, and S-II checkout and storage building at Mississippi Test Facility.
NAS8-19528----	Boeing Co.-----	Construction-----	To provide equipment interface modifications and additions to the S-IC test complex (excluding position B-1).

Construction of facilities, Michoud Assembly Facility.—Estimate of future year funding required for projects submitted in the President's C of F budget: Approximately \$.5 million per year will be required for continuing rehabilitation, additions and improvements to the Michoud Assembly Facility. These are essential to the operation of the plant and the protection of the Government investment in this facility.

II. MANAGEMENT

(a) *Changes in organization chart from 1966*

Changes to organization

The MSFC Organization chart as of March 1, 1966 is enclosed as Attachment A. The organization chart as of February 1, 1967 is enclosed as Attachment B.

Changes to the organization chart include the following:

(a) The Associate Deputy Director, Administrative, has been assigned, in addition to his present duties, as the Assistant Director for Scientific and Technical Analysis to provide a Center focal point for Voyager Program assignment which MSFC may receive. (Block B-1)

(b) The Patent Counsel (Block B-5) has been established as an entity separate from Chief Counsel. (Block B-3)

(c) The Technical Staff Office (Block A-18) in Research & Development Operations has been abolished, and the responsibilities absorbed by other R&D offices.

(d) The Experiments Office (Block B-18) has been created to assist the Director, Research and Development Operations in the identification, definition and development of the flight experiments program carried out by our laboratories, and to manage the ART/SRT program.

(e) The Saturn IB/Centaur Program Office (Block A-34) was abolished due to the cancellation of the program.

(f) The Saturn/Apollo Applications Program Office (Block B-34) has been created in Industrial Operations. It is responsible for the overall planning, coordination and direction of all AAP activities assigned to the Marshall Space Flight Center, just as the other program offices are for mainstream Apollo activities.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GEORGE C. MARSHALL SPACE FLIGHT CENTER

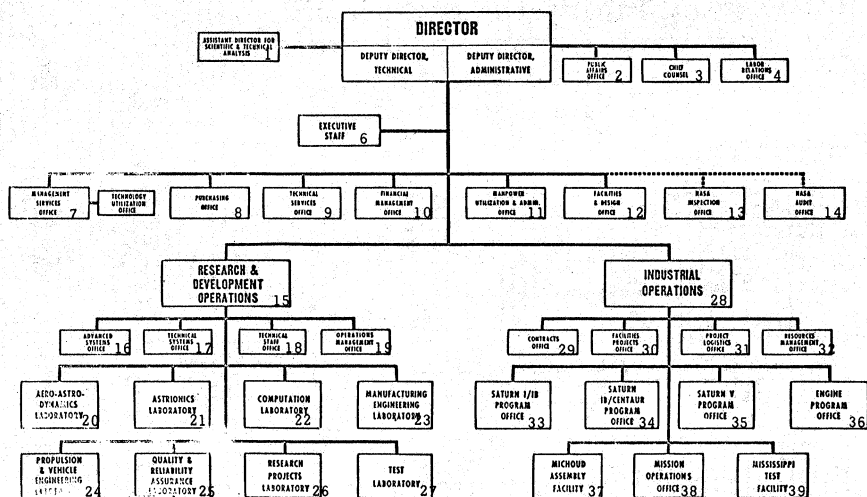


CHART 1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GEORGE C. MARSHALL SPACE FLIGHT CENTER

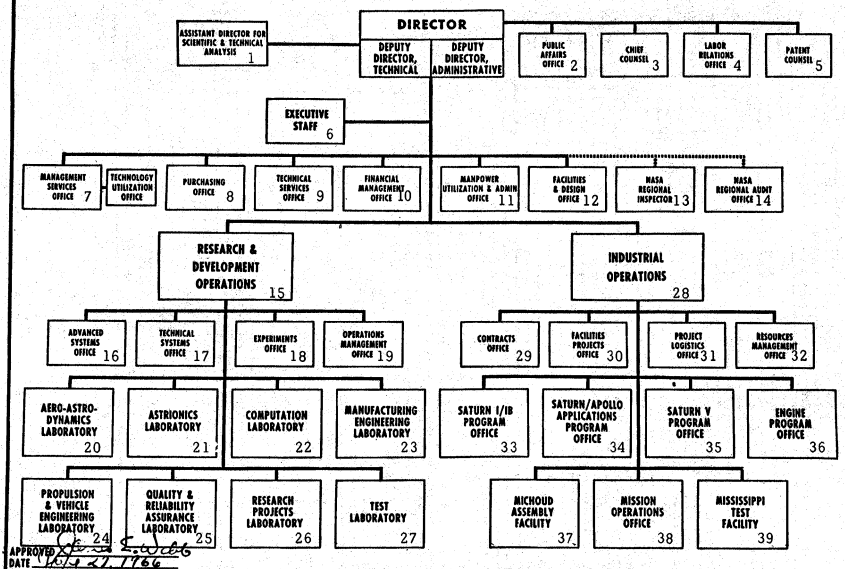


CHART 2

(b) *Number and cost of contracts administered by other Government agencies
Purchasing office, MSFC**Primary administration by other Government agencies of contracts for MSFC*

Category and agency	Number of contracts	Amount (thousands)
Under \$100,000:		
Atomic Energy Commission.....	3	\$110.5
Army.....	59	1,177.7
Air Force.....	32	1,284.3
Commerce Department.....	7	468.4
Corps of Engineers.....	10	307.0
GSA.....	12	218.4
Navy.....	8	232.8
Interior Department.....	3	83.4
\$100,000 to \$500,000:		
Army.....	10	2,142.5
AEC.....	1	145.0
Air Force.....	10	1,771.5
Navy.....	2	602.0
Interior Department.....	1	165.0
Department of Commerce.....	10	1,221.5
Corps of Engineers.....	7	2,341.0
Over \$500,000:		
Air Force.....	5	5,652.0
Army.....	6	8,651.9
Navy.....	2	2,048.0
AEC.....	1	728.5
Corps of Engineers.....	13	38,166.1

Contracts office, I.O.

Under \$100,000 : None.

From \$100,000 to \$500,000 : None.

Over \$500,000 : None.

(c) *Percent of overtime of total time on individual projects or programs over \$50,000**Percentage of overtime hours worked to total hours for major MSFC projects/programs for period July 1, 1965, through Dec. 31, 1966*

Project	Actual fiscal year 1966			Actual fiscal year 1967 through Dec. 31, 1966		
	Total hours worked	Overtime hours worked	Percent of overtime to total	Total hours worked	Overtime hours worked	Percent of overtime to total
Saturn I.....	148,233	6,728	4.5	5,604	349	6.1
Saturn I-B.....	1,961,581	122,083	6.2	789,868	30,347	3.8
Saturn V.....	5,845,307	436,082	7.5	2,788,507	139,405	5.0
Launch vehicle engineering development.....	381,337	18,447	4.8	148,165	5,136	3.5
MSF other.....	601,689	14,802	2.5	401,622	10,520	2.6
All other.....	518,343	14,031	2.7	313,552	4,984	1.6
Grand total.....	9,456,490	612,173	6.5	4,447,408	190,741	4.3

(d) *Average annual salaries for civil service employees (with comparison to previous year)**MSFC average annual salaries for civil service employees fiscal years 1967 through fiscal year 1968*

	Fiscal year 1967	Fiscal year 1968
Total permanent civil service employees.....	7,030	7,030
Average annual salary.....	\$11,661	\$11,805

(e) *Listing of each support contract pertaining to the facility*

CONTRACT NAS8-14017

General support services to the Michoud Assembly Facility

1. The annual estimated cost and the duration of the current contract:
 - (a) FY 67 estimated cost: \$10,451,092.
 - (b) Duration of current contract: Mar 1, 1965 thru Dec 31, 1967 with one (1) additional one (1) year option.
2. Name and corporate address of contractor:

Mason and Rust, Mason Hanger Silas Mason Company, 200 East Main Street, Lexington, Kentucky; Rust Engineering Company, 930 Fort Duquesne Boulevard, Pittsburgh, Pennsylvania.
3. Number of personnel employed by contractor under support contract: 773.
4. Functions performed by contractor under support contract.
 - (a) Transportation & Michoud Port Operations.
 - (b) Security & Safety Purposes.
 - (c) Fire Protection Services.
 - (d) Photographic Services.
 - (e) Medical Services.
 - (f) Food Services.
 - (g) Supply, Messenger & Mail Services.
 - (h) Communication Services.
 - (i) Custodial Services.
 - (j) Plant Maintenance & Repair Services.
 - (k) Engineering Services.
 - (l) Reproduction & Documentation Services.
5. Amount of overtime involved annually: 45,000 hours.
6. Amount of subcontracts placed annually by support contractor: \$6,030,540.

CONTRACT NASW-410, MSFC-1

General support services to the Mississippi Test Facility

1. The annual estimated cost and the duration of the current contract:
 - (a) FY 67 estimated cost: \$33,163,600.
 - (b) Duration of current contract: June 3, 1963 thru June 30, 1968 including options.
2. Name and corporate address of contractor: General Electric Company, 570 Lexington Avenue, New York, N.Y. 10022.
3. Number of personnel employed by contractor under support contract: 1349.
4. Functions performed by contractor under support contract:
 - (a) Transportation Service (Exclusive of Marine).
 - (b) Security.
 - (c) Fire Protection Service.
 - (d) Mail and Messenger Service.
 - (e) Marine Operations.
 - (f) Custodial and Refuse Service.
 - (g) Logistic and Material Service.
 - (h) Plant Maintenance and Land Management Service.
 - (i) Reproduction and Graphic Arts Service.
 - (j) Food Service.
 - (k) Communications Service.
 - (l) Industrial Health Service.
 - (m) Industrial Safety.
 - (n) Technical Library.
 - (o) Test Support Operations.
 - (p) Data Systems Operations.
 - (q) Quality Assurance.
 - (r) Project Management.
 - (s) Engineering Support.
 - (t) Program Visibility.
5. Amount of overtime involved annually: 208,501 hours.
6. Amount of subcontracts placed annually by support contractor:

(a) Subcontracts -----	\$6, 162, 400
(b) Materials and supplies -----	8, 101, 500
(c) Leases -----	552, 400
 Total -----	 14, 816, 300

CONTRACT NAS8-18405

Support contract for the MSFC Computation Laboratory

1. Annual Estimated Cost: \$5,455,104. Duration of Current Contract: July 1, 1966 through 30, 1967 with option for 4 one year periods.
2. Name and Address of Contractor: Computer Sciences Corporation, 650 North Sepulvedo Boulevard, El Segundo, California 90245.
3. Number of Personnel Employed by Contractor under Support Contract: 529.
4. Functions Performed: Resources Management, Data Systems Engineering, Digital Projects, Data Reduction, Simulation, Engineering Systems, Industrial Systems, and Special Projects.
5. Amount of Overtime Involved Annually: Estimated 87,280 manhours.
6. Amount of Subcontracts placed annually by Support Contractor: \$559,000.

CONTRACT NAS8-14109

Support contract for the MSFC Technical Services Office

1. Annual Estimated Cost: \$5,560,941. Duration of Current Contract: April 1, 1965 through March 31, 1967 with option for one additional year.
2. Name and Address of Contractor: Management Services Inc. of Tennessee, Post Office Box B, Oak Ridge, Tennessee 37832.
3. Number of Personnel Employed by Contractor under Support Contract: 421 Prime, 34 Sub.
4. Functions Performed: Motor Vehicle Support, Photo Support, Maintenance and Repair of Instrumentation, Chemical, Hydraulic and Ultra-Sonic Purging, Miscellaneous Crafts Effort, Grounds and Landscape Maintenance, Logistics Support, Operations and Maintenance of Government-Owned Aircraft.
5. Amount of Overtime Involved Annually: Estimated 59,404 manhours.
6. Amount of Subcontracts placed annually by Support Contractor: \$1,832,162.

CONTRACT NAS8-14110

Support contract for the MSFC Management Services Office

1. Annual Estimated Cost: \$5,689,067. Duration of Current Contract: April 1, 1965 through March 31, 1967 with option for one additional year.
2. Name and Address of Contractor: RCA Service Company, Division of Radio Corporation of America, Cherry Hill, Delaware Township, Camden, New Jersey 08101.
3. Number of Personnel Employed by Contractor under Support Contract: 397 Prime, 368 Sub.
4. Functions Performed: Telecommunications, Reproduction, Graphic Arts, Technical Publications, Technical Documentation, Protective Services, Custodial Services, Maintenance and Repair of Photographic equipment, Safety Engineering, Laundry Services, Refuse collection, Medical Services, Technology Utilization.
5. Amount of Overtime Involved Annually: Estimated 38,600 manhours.
6. Amount of Subcontracts placed annually by Support Contractor: Estimated \$2,522,500.

CONTRACT NAS8-14108

Support contract for the MSFC Facilities & Design Office

1. Annual Estimated Cost: \$657,954. Duration of Current Contract: March 1, 1965 through February 28, 1967 with option for one additional year.
2. Name and Address of Contractor: Rust Engineering Company, P.O. Box 101, 1130 South 22nd Street, Birmingham, Alabama 35202.
3. Number of Personnel Employed by Contractor under Support Contract: 49.
4. Functions Performed: Engineering Design, Master Planning and Construction Inspection of Facilities.
5. Amount of Overtime Involved Annually: Estimated 4,540 manhours.
6. Amount of Subcontracts placed annually by Support Contractor: \$36,512.

CONTRACT NAS8-20083

Support contract for the MSFC Manufacturing Engineering Laboratory

1. Annual Estimated Cost: \$6,324,303. Duration of Current Contract: March 9, 1965 through March 15, 1967.

2. Name and Address of Contractor: Hayes International Corporation, P.O. Box 1568, Huntsville, Alabama 35801.
3. Number of Personnel Employed by Contractor under Support Contract: 314.
4. Functions Performed: Engineering services such as tool modification and maintenance, process engineering, reliability assessment, tool design, documentation processing, plant processing, manufacturing development, and research and fabrication of components and tooling.
5. Amount of Overtime Involved Annually: 38,607 manhours.
6. Amount of Subcontracts placed annually by Support Contractor: \$324,432.61.

CONTRACT NAS8-20070

Support contract for the MSFC Test Laboratory

1. Annual Estimated Cost: \$6,783,337. Duration of Current Contract: March 15, 1967 plus 3 additional 1 year options.
2. Name and Address of Contractor: Vitro Services, Division of Vitro Corporation of America, Patton Building, Fort Walton Beach, Florida 32548.
3. Number of Personnel Employed by Contractor under Support Contract: 617.
4. Functions Performed: Engineering services in support of the Test Laboratory such as operation and maintenance of test equipment, evaluation of data, analysis of tests and fabrication in support of test equipment.
5. Amount of Overtime Involved Annually: 110,689 manhours.
6. Amount of Subcontracts placed annually by Support Contractor: \$3,813,696.

CONTRACT NAS8-20073

Support contract for the MSFC Propulsion and Vehicle Engineering Laboratory

1. Annual Estimated Cost: \$14,801,679. Duration of Current Contract: April 1, 1965 through March 31, 1967, with 3 additional 1 year options April 1, 1967 through March 31, 1970.
2. Name and Address of Contractor: Brown Engineering Company, Incorporated, 300 Sparkman Drive, Huntsville, Alabama 35805.
3. Number of Personnel Employed by Contractor under Support Contract: 956.
4. Functions Performed: Engineering, operation and fabrication services in support of P&VE Laboratory to include design studies; systems engineering; propulsion, mechanical, material, and structural research and development; program coordination; engineering and documentation; fabrication; and systems, subsystem and component testing.
5. Amount of Overtime Involved Annually: Estimated 72,000 manhours.
6. Amount of Subcontracts placed annually by Support Contractor: \$228,000.

CONTRACT NAS8-20055

Support contract for the MSFC Astrionics Laboratory

1. Annual Estimated Cost: \$12,000,000. Duration of Current Contract: Expires February 28, 1967 plus 3 additional 1 year options.
2. Name and Address of Contractor: Sperry Rand Corporation, 1290 Avenue of the Americas, New York, New York 10019.
3. Number of Personnel Employed by Contractor under Support Contract: 820.
4. Functions Performed: Engineering services in support of the Astrionics Laboratory including design, qualification documentation, fabrication, evaluation and testing of electronic components and systems.
5. Amount of Overtime Involved Annually: Estimated 80,000 manhours.
6. Amount of Subcontracts placed annually by Support Contractor: \$1,000,000.

CONTRACT NAS8-20166

Support contract for the MSFC Research Projects Laboratory

1. Annual Estimated Cost: \$963,872. Duration of Current Contract: May 3, 1965 through May 2, 1967 with 3 additional 1 year options—May 3, 1967 through May 2, 1970.
2. Name and Address of Contractor: Brown Engineering Company, Incorporated, 300 Sparkman Drive, Huntsville, Alabama 35805.

3. Number of Personnel Employed by Contractor under Support Contract: 53.
4. Functions Performed: Experimental research activities and documentation and engineering and scientific services in support of the Research Projects Laboratory.
5. Amount of Overtime Involved Annually: Estimated 1,433 manhours.
6. Amount of Subcontracts placed annually by Support Contractor: None.

CONTRACT NAS8-20081

Support contract for the MSFC Quality Laboratory

1. Annual Estimated Cost: \$6,284,901. Duration of Current Contract: Expiration date—March 31, 1967 plus 3 additional 1 year options.
2. Name and Address of Contractor: Spaco, Incorporated, 3022 University Drive, Huntsville, Alabama 35805.
3. Number of Personnel Employed by Contractor under Support Contract: 415.
4. Functions Performed: Conduct quality and reliability training, maintenance, calibration and testing of instruments, compilation of data, documentation, quality analysis and fabrication of special tooling and test equipment.
5. Amount of Overtime Involved Annually: 80,684 manhours.
6. Amount of subcontracts placed annually by Support Contractor: \$2,308,994.

CONTRACT NAS8-20082

Support contract for the MSFC Aero-Astroynamics Laboratory

1. Annual Estimated Cost: \$4,074,490. Duration of Current Contract: Through March 15, 1967 plus 3 additional one year options.
2. Name and Address of Contractor: Northrop Norair, Northrop Corporation, 3901 West Broadway, Hawthorne, California 90250.
3. Number of Personnel Employed by Contractor under Support Contract: 251.
4. Functions Performed: Engineering services for the Aero-Astroynamics Laboratory including conducting R&D studies in aero-dynamics, astrophysics, flight evaluation, dynamics, maintenance and operation of aerodynamics facilities.
5. Amount of Overtime Involved Annually: 19,111 manhours.
6. Amount of subcontracts placed annually by Support Contractor: \$1,537,000.

CONTRACT NAS8-20412

Support contract for the MSFC Reliability Laboratory

1. Annual Estimated Cost: \$1,788,000. Duration of Current Contract: Through July 10, 1967 plus 2 additional 1 year options.
2. Name and address of Contractor: Federal Electric Corporation, Industrial Park, Paramus, New Jersey 07652.
3. Number of Personnel Employed by Contractor under Support Contract: 102.
4. Function Performed: Engineering services in support of the MSFC Reliability Program to review, evaluate and recommend corrective changes in the overall program and to develop reliability management techniques.
5. Amount of Overtime Involved Annually: 10,132 manhours.
6. Amount of subcontracts placed annually by Support Contractor: \$500,000.

APPENDIX G

HEARINGS OF THE SUBCOMMITTEE ON MANNED SPACE FLIGHT, KENNEDY SPACE CENTER, CAPE KENNEDY, FLORIDA. FEBRUARY 24, 1967.

OPENING REMARKS BY CONGRESSMAN OLIN E. TEAGUE AND
DR. KURT H. DEBUS

INTRODUCTION BY CHAIRMAN TEAGUE

I understand I am to make an opening statement. We are glad to be here, and we have with us Mr. Waggonner, Mr. Cabell, Mr. Gurney, and Mr. Winn, a new member.

We have been out to North American, Douglas, down to Mississippi, and up to Huntsville.

I think that's all I have, Kurt.

Dr. DeBUS. Mr. Chairman, members of the committee, it is my great pleasure to welcome you to the Kennedy Space Center and to the hearing. I would like, briefly, to go through the proposed schedule with you.

We have presentations to be given here in this room. First, I will make some general remarks.

The Director of Launch Operations, Mr. Petrone, will talk about the role of launch operations at KSC.

Mr. Siepert, my deputy, will talk about management aspects of our work.

The Manager of the Apollo Program Office, Mr. Shinkle, will talk about the Apollo program at KSC.

The Acting Director of the Apollo Applications program, Mr. Hock, will talk about the Apollo Applications program at KSC.

Mr. Miller, who joined us a half year ago, will talk about institutional support. He is the Director of our Resources Management Office.

Then, Mr. Siepert will talk about a point that might be of interest to you, which is the status of the Visitor Information Center.

Later on we will have lunch in this room and then start a guided tour of the facilities. We will go by some of the satellites that are presently being prepared for launch. Mr. Neilon, Bob Gray's deputy, will talk about them.

Then we will go to Launch Complex where presently the Apollo-Saturn 206 is in preparation for launch. It will carry a lunar module. Then we end the tour, possibly at Launch Complex 39. At both Launch Complexes 37 and 39, there will be briefings by Mr. Petrone.

Tomorrow morning we will visit some of our contractors. As you

may recall, we have two types of contractors working here at Kennedy: "Mission" contractors; that is stage contractors, who prepare (for launch) the Saturn stages and spacecraft, and the support contractors who help us operate the facilities here and bring in the necessary support for launching.

That gives you a full schedule; if you desire this can be changed, Mr. Chairman.

I would like to submit for the record a statement, a copy of which is in front of you. Also, Mr. Chairman, we have answers to the questions that you directed to the institution. We are ready and willing to answer any questions you may have as to these two statements.

I would like to address myself to a broad overview of KSC. May I have the first Vu-graph, please? (See fig. A-1.)

This is a listing of our responsibilities. You have visited the Marshall Space Flight Center and its ancillary institutions at Michoud and Mississippi Test Facility and you plan to visit the Houston facility, the Manned Spacecraft Center.

The Marshall Space Flight Center, of course, is charged with the development of the launch vehicles. The Manned Spacecraft Center in Houston has as its responsibility the development of Apollo spacecraft and also, of course, for the control of flight missions. They were also responsible for the development of the Mercury and Gemini spacecraft.

The KSC, (Kennedy Space Center), responsibility is an operational one. Also it has a development responsibility. As far as the total overall Manned Space Flight mission goes, we are to prepare here, check out, and launch, the assigned NASA space vehicles. This is in response to the manned space program requirements as well as those relating to unmanned space flight or the scientific effort which is carried out on a series or family of vehicles that we will talk about a little later.

PRINCIPAL KSC RESPONSIBILITIES

1. PREPARE, CHECKOUT, AND LAUNCH ASSIGNED NASA SPACE VEHICLES.
2. ASSURE FLIGHT HARDWARE CONFIGURATION CONTROL BY DEVELOPMENT CENTERS.
3. DEVELOP NEW LAUNCHING CONCEPTS AND PROVIDE LAUNCH REQUIREMENTS AFFECTING LAUNCH VEHICLE AND S C DESIGN.
4. DESIGN, INSTALL, AND OPERATE LAUNCH FACILITIES, INCLUDING GSE.
5. FURNISH ON-SITE TECHNICAL AND ADMINISTRATIVE SUPPORT FOR ALL NASA PROGRAMS.
6. PROVIDE NASA A SINGLE CHANNEL FOR OBTAINING LAUNCH SUPPORT FROM THE EASTERN TEST RANGE.
7. ASSURE GROUND SAFETY COMPLIANCE FOR ALL NASA MISSIONS.

FIGURE 1

We are to assure that the flight configuration is managed under the overall control of the development centers. It is, of course, unthinkable that we would make modification not in the sense or intent of the developers. Our part of this job here is to make absolutely sure any changes that are needed are under the overall configuration control of the responsible Manned Space Flight installation; also that the intent of the developer, as far as launch vehicles go, and as far as spacecraft go, are fully preserved. Any changes, therefore, that are needed are done with the concurrence of the development center.

We are, of course, specialists here in launch concepts. Therefore, we are continuously overseeing the concepts that are being applied in the launch preparation, and we provide launch preparation requirements as a feedback into the vehicle. In other words, at a very early point of a design of a launch vehicle or a spacecraft, the way in which it will have to be operated here, and the means which are available to operate and prepare it must be built into the vehicle that is to be flown. Therefore, early inputs into the design of the flight hardware are defined by the concept which will prevail for the checkout, assembly, and launch preparations.

The development job we have here is to design, install, and operate launch facilities, including that type of launch support equipment which is not an integral part of the flight hardware and not developed at the development centers.

We furnish on-site technical and administrative support for all NASA programs and we provide NASA a single channel for obtaining launch support from the Eastern Test Range. Here we are a close neighbor and also a tenant as an agency that uses the Eastern Test Range.

The Eastern Test Range (formerly the Atlantic Missile Range, and before that the Joint Proving Ground) as a national range facility provides data acquisition, telemetry, tracking, and similar instrumentation services, as well as support in ground safety, propellants, some logistics, et cetera. We operate as tenants in the Cape Kennedy area and also provide a single entry channel for obtaining any support for NASA's requirements from Eastern Test Range.

Now, as to the geography, a few words.

Next slide, please. (See Figure A-2.)

You see outlined here in red, or orange, the old Cape Canaveral or Cape Kennedy area. This is, if I remember right, something like 15,000 square acres. The early guided missile programs at the cape were started with facilities to the southeast in this area, and there you will find launch pads for the Redstone, for the Thor, for the Pershing, and for the Polaris missiles in this area. General firing direction is 105 to 110 degrees down this area into the Atlantic.

Some of these islands carry all kinds of instrumentations.

As the size of these ballistic missiles grew, the intercontinental ballistic missile pads went up on this north shore. Here you find four pads for the Atlas and four pads for the Titan.

So this is the overall geography. Let me point out, it has some considerable growth potential for future launch configurations that might be decided upon.

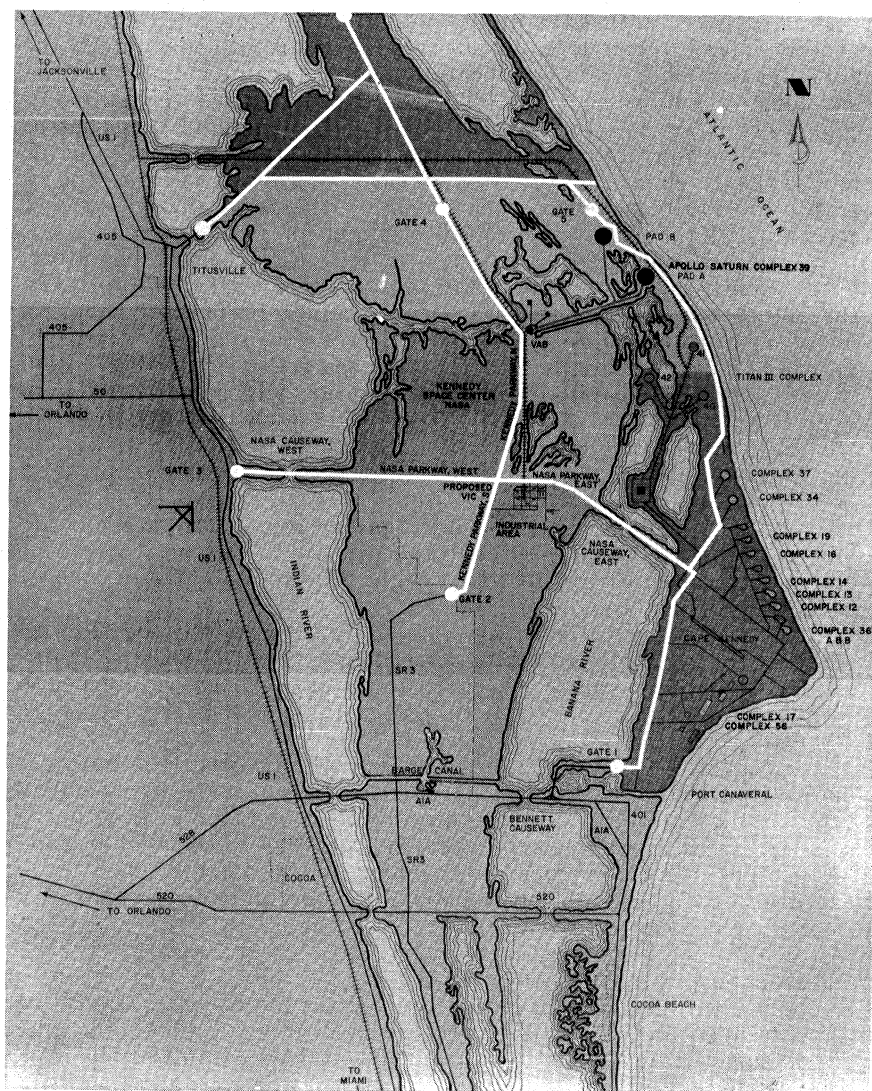


FIGURE A-2.—Kennedy Space Center location map.

Now, to give you a description of some of the types of vehicles that are accommodated by Kennedy Space Center:

Next slide, please. (Fig. A-3.)

This is Mercury/Redstone—utilizing the old Redstone Army vehicle with some elongated tanks—carried the first astronauts, Shepard and Grissom. This specific location we are trying to preserve as a future historical site to show the hardware that was used at the time. We are looking for ways and means to restore it to the exact configuration that it had for Alan Shepard's flight.

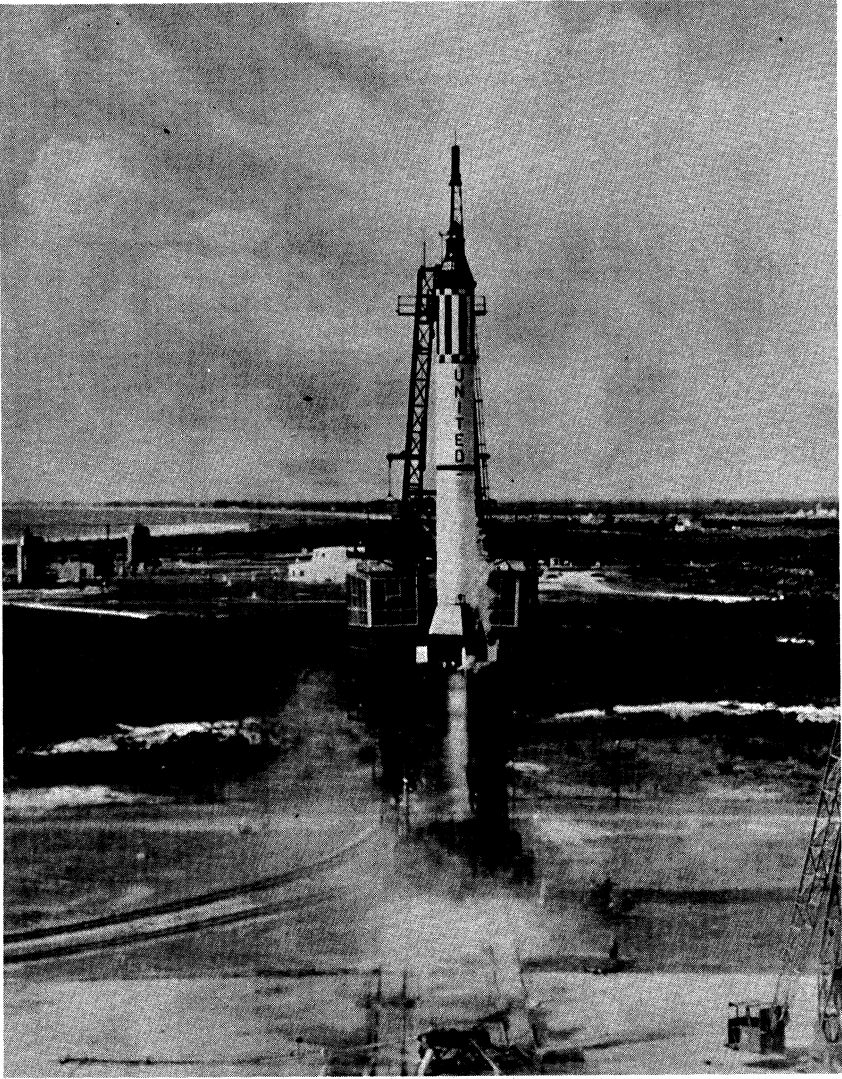


FIGURE A-3.—Mercury/Redstone No. 3 carrying Alan B. Shepard, Jr., on first suborbital flight

The Atlas/Mercury—next slide, please (fig. 4-A)—this is the configuration as it was flown here. It's well known to you. It made use of the ballistic missile Atlas sites, and with some conversion of the facility accommodated the Mercury flights.

Later there was a pad complex built for the NASA Centaur, which is now operational. Also in this area were built the first Saturn sites, pads 34 and 37.

A detailed study was made of eight potential sites, starting with Hawaii, the Pacific west coast, Texas, New Mexico, Georgia, and also



FIGURE A-4.—Launch of Mercury/Atlas carrying Gordon Cooper from launch complex 14

south to the Caribbean to determine where the Apollo/Saturn V or, at that time, NOVA, or any future larger launch vehicles would have to be accommodated.

After congressional approval and fund allocation, the green areas, plus the dark green area here, were purchased and acquisition is now almost complete. It turned out to be a parcel of 88,000 acres. This allows a potential expansion from what is now Saturn V into this northern area, so that for some time to come launches can be accommodated from this total area.

We are presently here in the industrial area, which has all been built up since the decision was made to proceed with the launch complex 39, which we will see when you visit it this afternoon.

The Air Force built its Titan III complex in this fashion here; partially on reclaimed land, partially on the old Cape Kennedy area, and partially on the newly acquired land.

Then the Gemini/Titan—next slide, please (fig. A-5)—of course, used the Air Force Titan vehicle—and launch sites that were developed for the Titan. Again, with some small configuration changes, these sites were used.

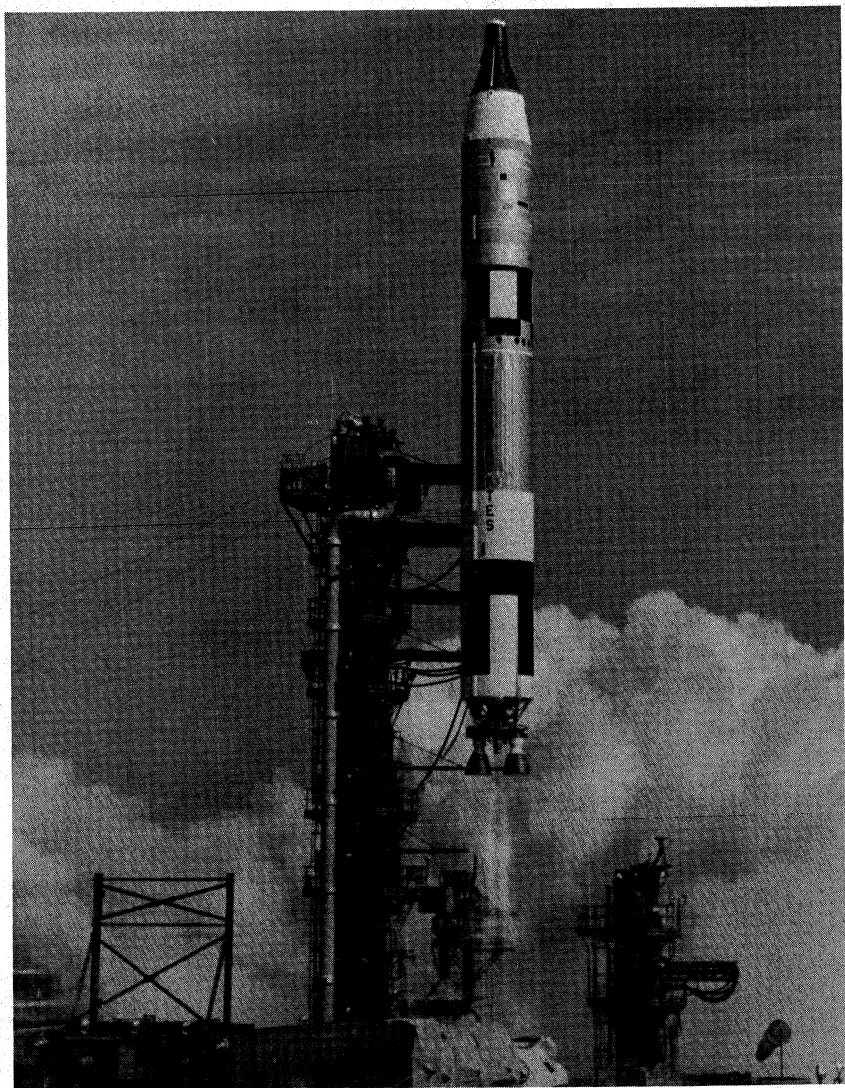


FIGURE A-5.—Gemini GT-3 launch vehicle lifts from launch complex 19 with Astronauts Virgil Grissom and John Young aboard for three-orbit flight.

After completion of our Gemini program and Mercury program, these sites were not identified for further use. One of the other Atlas sites still carries the Atlas/Agena. I believe it is planned to eventually eliminate the Atlas/Agena from unmanned flight vehicles and move all unmanned vehicles of this type to the Atlas/Centaur.

Next slide, please. (Fig. A-6.)

The Saturn I-B—this is Apollo/Saturn I-B-201—has been accommodated from pads 34 and 37. Both pads have now been converted

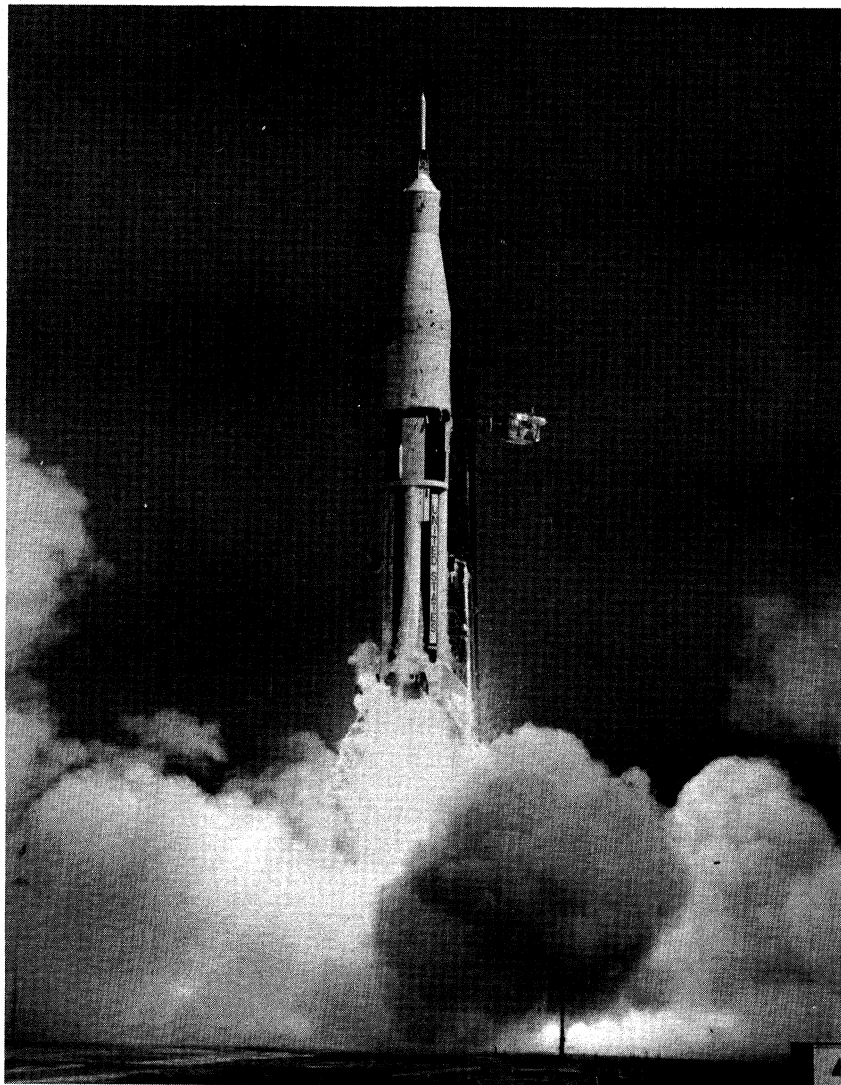


FIGURE A-6.—Apollo/Saturn 201, first of the S1-B series, liftoff at launch complex 34.

to the advanced Saturn I-B and are presently configured to accommodate the lunar module and command/service modules. The program office is presently investigating if both pads could be configured to be able to accommodate both types of Saturn I-B payloads.

The Saturn V (fig. A-7)—this is Saturn 500-F, a nonflight configuration as it was pulled out and deposited on pad A some time ago. Presently being assembled and checked out in the VAB is the first flight configuration, AS-501—this you will see this afternoon.

Now, the Thor/Delta (fig. A-8), using one of the old Thor installations, is still very active and is slated to remain active. The Thor vehicle, some augmented with solids, so-called thrust augmented Delta, have carried and will carry such satellites as the Orbiting Geophysical Observatory (OGO), Biosatellite (BIOS), and communications satellites.

The Thor/Agena (fig. A-9) has carried the Nimbus weather satellite and other payloads. This is the basic Thor vehicle again with an Agena upper stage.

Then the Atlas/Agena (fig. A-10), which uses the Atlas booster, and an Agena upper stage being launched here for the Lunar Orbiter; it also carries ATS and Mariner payloads.

The next slide, please (fig. A-11), Centaur which has carried Surveyor and will carry OAO and Mariner in 1969.

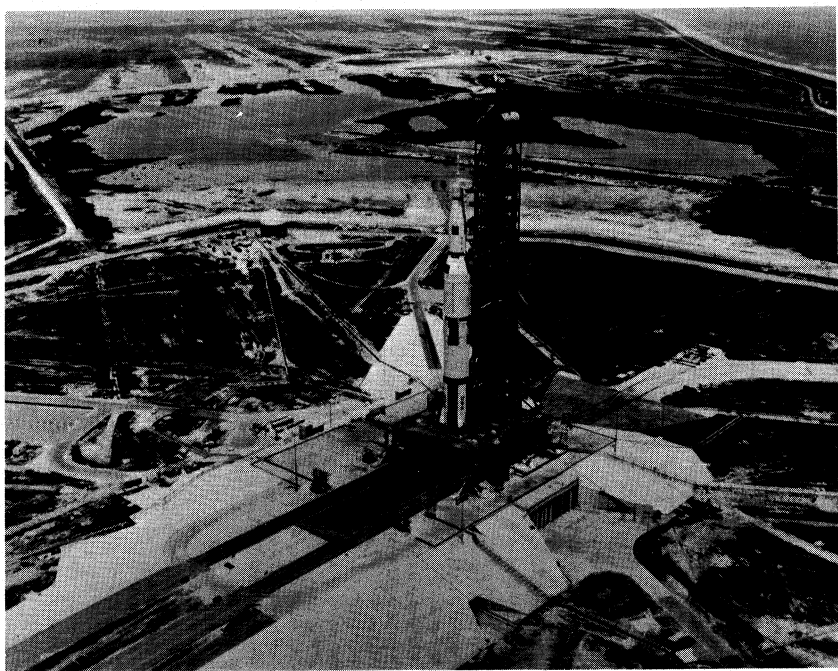


FIGURE A-7.—Saturn 500-F configuration served as a facilities checkout vehicle.

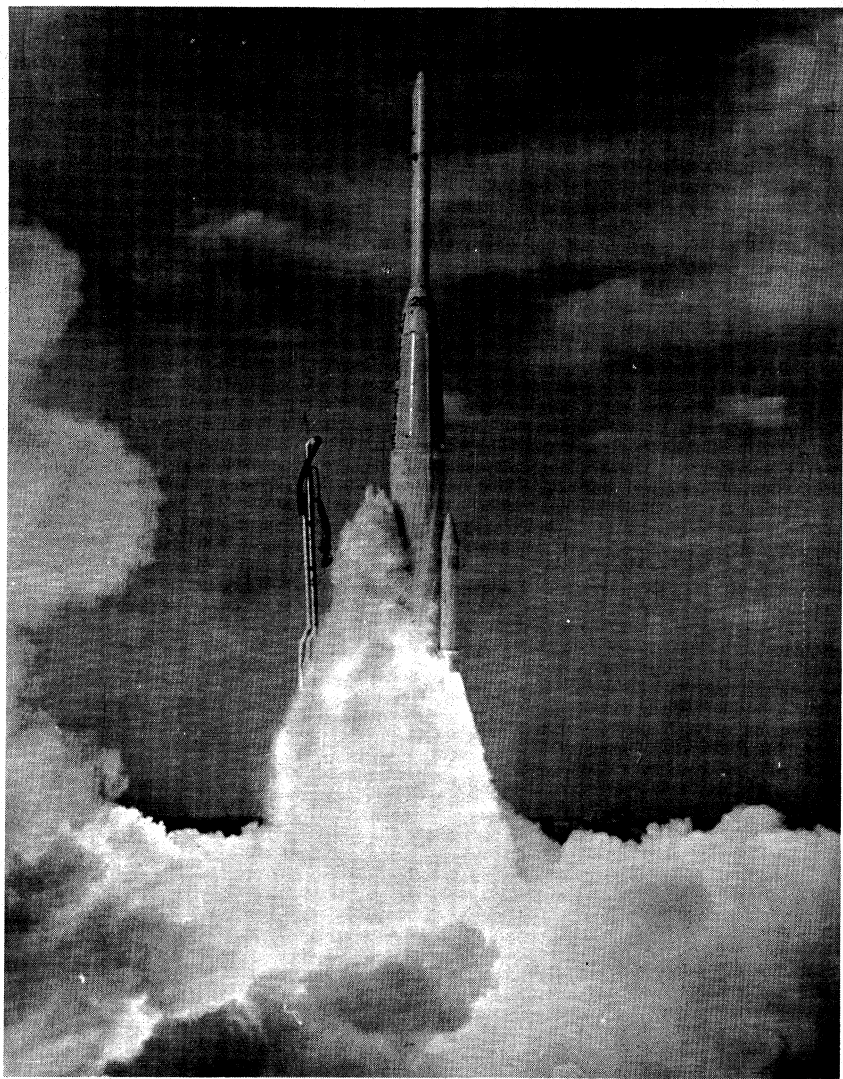


FIGURE A-8.—Launch of thrust augmented Delta from launch complex 17A.

These are the type vehicles that are being launched; the total organization here, of course, is in support of this main activity of ours, launching of unmanned and manned flight configurations.

The next slide shows the evolution of Kennedy Space Center (fig. A-12). It was originated as a missile firing laboratory in January 1953. As such it was a field activity of the Army Redstone Arsenal, 700 miles away.

After the recognition, in July 1960, that one could not continue to support launch operations at such a remote site by moving people back

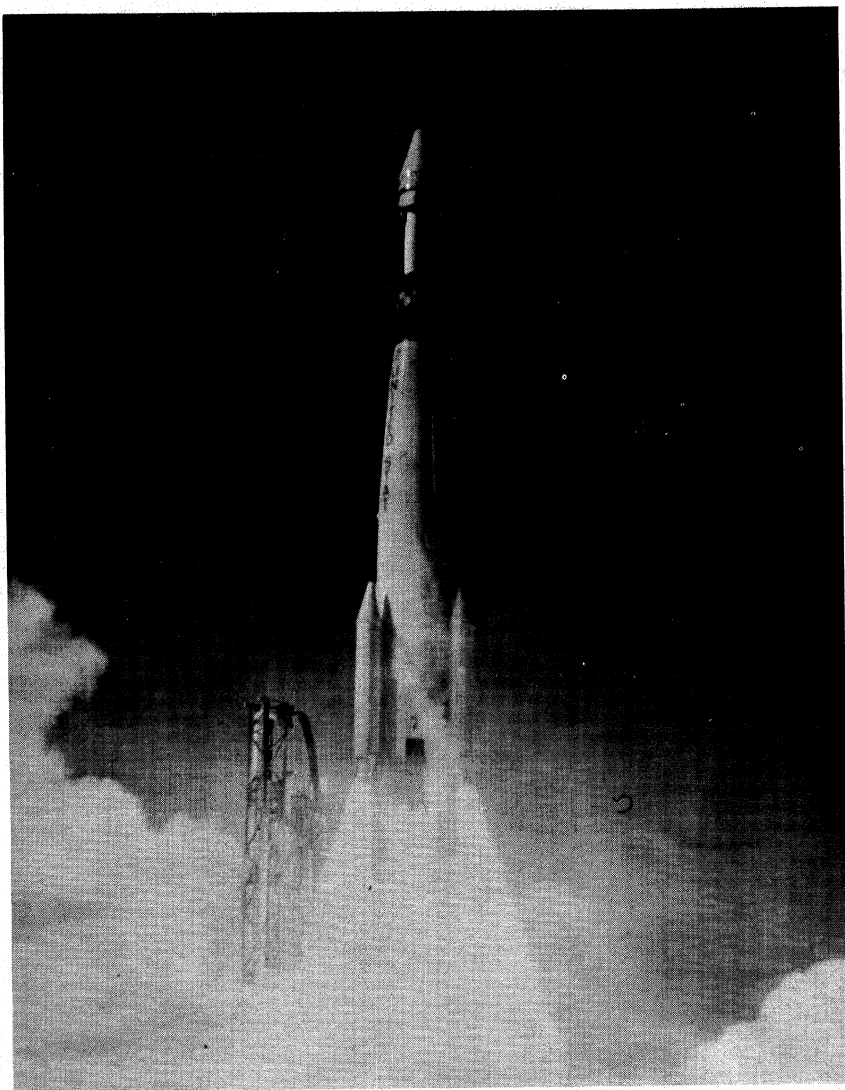


FIGURE A-9.—PAGEOS I launched by Thor/Agena-D rocket to map the Earth.

and forth continuously, the organization became a launch operations directorate under Dr. von Braun. It became a NASA institution called Launch Operations Center on July 1, 1962, and renamed after the assassination of President Kennedy, as the John F. Kennedy Space Center, NASA, on December 20, 1963.

Next slide, please (fig. A-13). This shows our current work force as compared to last fiscal year and to what we estimate to be the fiscal year 1968 numbers. We have a combined contractor work force, combined in the sense of mission and support contractors of 18,700 by the

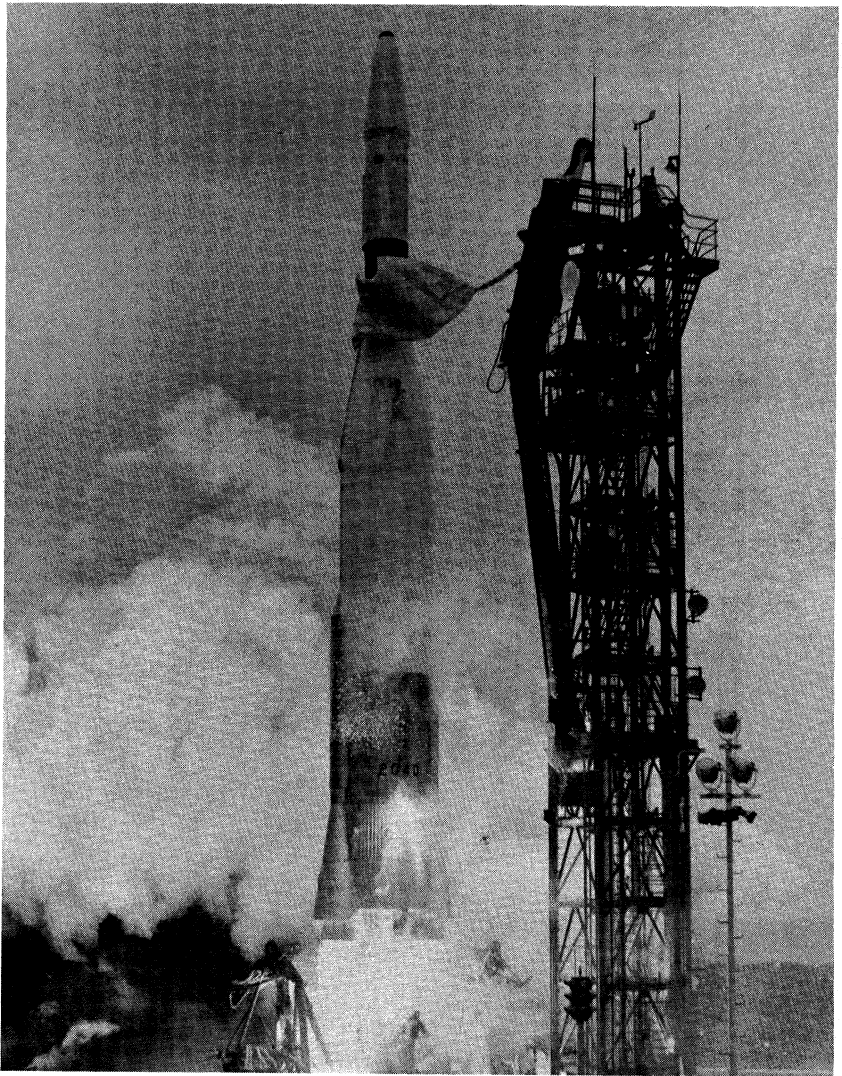


FIGURE A-10.—Range 9 launched by Atlas/Agena from launch complex 12.

end of this fiscal year. We estimate this number will be slightly decreased by the end of fiscal 1968. Over the past year it has gone from 15,000 to 18,400 the end-of-the-year figure. Only one major contractor, Grumman, is still on the buildup.

Please note the numbers of civil service compared to our contractor work force. We will have more to say later about the philosophy underlying this ratio of contractor personnel versus civil service. The civil service are the prime contractors; you might say, are the managers of this total effort. Our present strength is over 2,600 and we are

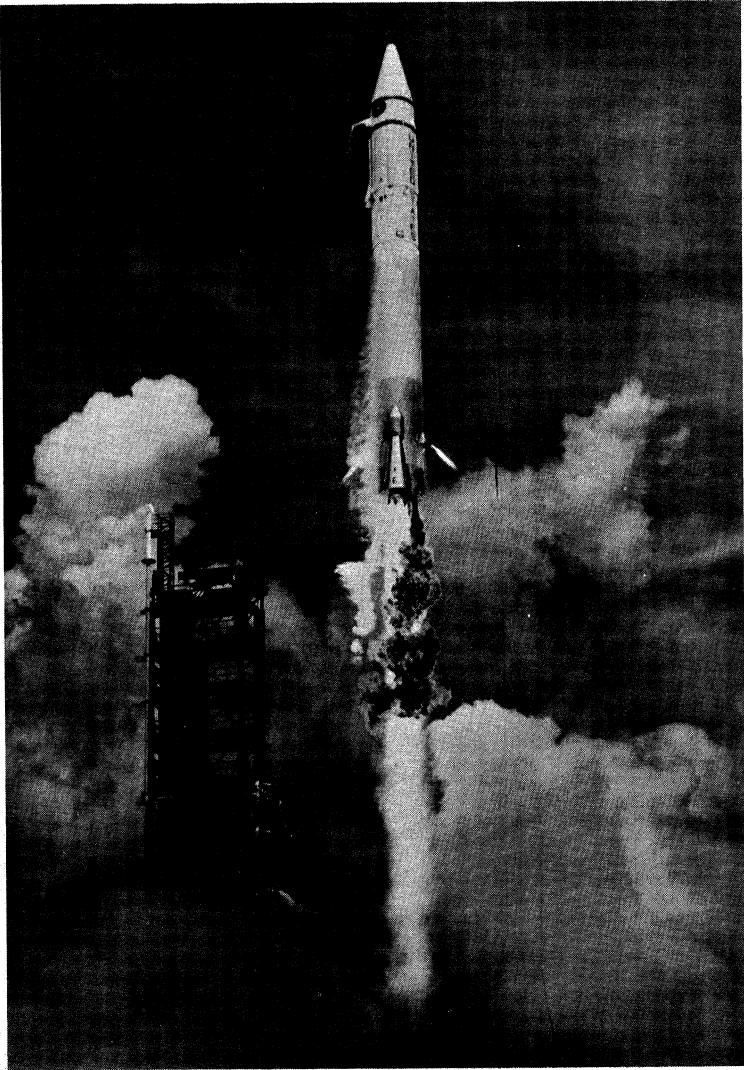


FIGURE A-11.—Atlas/Centaur 6 lift-off from launch complex 36B.

authorized up to 2,720. We are proposing to keep that figure flat through the end of fiscal year 1968. The composition of this number and the relationship between our civil service and contractors are of prime significance in the sense that the Government makes maximum use of the contractors' industrial and operational capabilities but retains full responsibility for the overall management of the total work effort at KSC. This, I believe, is proving to be very successful, and we will have more to say about it during the hearing.

As to the funding—if I may have the next slide, please (fig. A-14). This will later be shown in more detail. We have listed here R. & D., C of F, and AO as the three sources of our funds. We want to point out that the R. & D. funds that will be shown as line items for the Kennedy Space Center are not the only R. & D. funds expended here. It is important to show the relationship of the administrative operations funds to the total R. & D. expenditure. This comes into the proper perspective only if one considers the total manpower funded by R. & D. here.

EVOLUTION

MISSILE FIRING LABORATORY	JANUARY, 1953 - JUNE 30, 1960
LAUNCH OPERATIONS DIRECTORATE	JULY 1, 1960 - JUNE 30, 1962
LAUNCH OPERATIONS CENTER	JULY 1, 1962 - DECEMBER 20, 1963
JOHN F. KENNEDY SPACE CENTER, NASA	DECEMBER 20, 1963

FIGURE A-12

WORKFORCE

	<u>Actual</u> <u>End FY 66</u>	<u>Estimate</u> <u>End FY 67</u>	<u>Estimate</u> <u>End FY 68</u>
Contractor Personnel	15,450	18,700	18,400

	<u>Actual</u> <u>End FY 66</u>	<u>Authorized</u> <u>End FY 67</u>	<u>Proposed</u> <u>End FY 68</u>
Civil Service Personnel	2,589	2,720	2,720

FIGURE A-13

The total R. & D. money expended at KSC is a composite made up of Kennedy Space Center funds and moneys from other centers. It contains a share—and you can see, a considerable share—of \$69 million proposed for fiscal year 1968, of Marshall Space Flight Center funds to support work conducted at the Kennedy Space Center under the control of the Marshall Space Flight Center and covered in KSC contract supplements to the base prime stage contracts. This amounts, then, this year to \$61 or \$62 million, and almost \$70 million by next year.

A further input comes from Manned Spacecraft Center. This is shown estimated because we do not have accurate data. It is estimated on the basis of a projected manpower figure of those personnel under contract to the Manned Spacecraft Center but working here for North

American on the command and service module, and for Grumman on the lunar module.

These then are the estimated moneys spent at this Center but budgeted by the other Manned Space Flight Centers. Furthermore, there are funds from the Office of Space Science and Applications for unmanned operations in a total amount of \$43 million for next year, \$44 million for this year. Again, broken down, as from John F. Kennedy Space Center and other centers, these are moneys that are expended here in support of other than the Manned Space Flight program. Also, there is an amount for the Office of Advanced Research and Technology.

The total numbers we are talking about are \$391 million for the proposed year as compared to \$232 million that will appear as the KSC R. & D. line item. It is in support of this R. & D. effort that our "Administrative Operations" budget should be considered.

Construction of facilities will be some \$24, \$25 million for next year, compared to \$35 million for this year.

This concludes my introduction. I now call on Mr. Petrone.

JOHN F. KENNEDY SPACE CENTER

	ACTUAL FY 1966	AUTHORIZED FY 1967	PROPOSED FY 1968
<u>RESEARCH AND DEVELOPMENT</u>	<u>214,736</u>	<u>381,309</u>	<u>391,171</u>
OFFICE OF MANNED SPACE FLIGHT	<u>169,258</u>	<u>337,307</u>	<u>347,739</u>
JOHN F. KENNEDY SPACE CENTER	128,859	224,050	232,200
GEORGE C. MARSHALL SPACE FLT CTR	6,261	61,982	69,659
MANNED SPACECRAFT CENTER	34,138 (EST)	51,275 (EST)	45,880 (EST)
OFFICE OF SPACE SCIENCE & APPLICATIONS	<u>45,263</u>	<u>44,002</u>	<u>43,332</u>
JOHN F. KENNEDY SPACE CENTER	4,647	3,987	3,332
OTHER CENTERS	40,616 (EST)	40,015 (EST)	40,000 (EST)
OFFICE OF ADVANCED RESEARCH & TECHNOLOGY	<u>215</u>	<u>-0-</u>	<u>100</u>
JOHN F. KENNEDY SPACE CENTER	193	-0-	100
OTHER CENTERS	22	-0-	-0-
<u>CONSTRUCTION OF FACILITIES</u>	<u>6,917</u>	<u>35,758</u>	<u>24,885</u>
OFFICE OF MANNED SPACE FLIGHT	6,030	34,021	22,595
OFFICE OF SPACE SCIENCE & APPLICATIONS	887	1,737	2,290
<u>ADMINISTRATIVE OPERATIONS</u>	<u>81,952</u>	<u>92,658</u>	<u>99,575</u>

FIGURE A-14

BRIEFING BY NASA'S JOHN F. KENNEDY SPACE CENTER FOR THE SUBCOMMITTEE ON MANNED SPACE FLIGHT, COMMITTEE ON SCIENCE AND ASTRONAUTICS, U.S. HOUSE OF REPRESENTATIVES, FEBRUARY 24, 1967, PRESENTATION TO THE CONGRESSIONAL HEARING

Mr. PETRONE. Thank you, Dr. Debus.

Mr. Chairman, gentlemen, in a few minutes I am going to attempt to describe our role in launch operations. We are later going to see the breakdown in terms of what it costs to do the job. I am going to use the Saturn V Apollo, 500 series, since this is typical of our large operations in the future. I am going to use our Saturn V operations to show how we check out the hardware, how we interface with the development centers, and how we actually launch the vehicle.

Now, in terms of launch operations, we carry on activities at 17 of the unmanned facilities that Dr. Debus just spoke about. We also carry on Centaur operations at pad 36. We have just concluded operations at pad 19, which was, of course, Gemini. We have been and are now performing Apollo Saturn I launch operations at launch complexes 34 and 37. However, I am going to spend this time discussing Saturn V operations at complex 39 and at our spacecraft check-out facilities in the industrial area.

Figure B-1 is an artist's concept of complex 39. Shown is the VAB (vehicle assembly building), the Launch Control Center, and the pad we will be visiting this afternoon.

You might say a major part of our job is to plan far in advance. As many of you know, this all started some 5 years ago, in the summer of 1961. We must take flight hardware from the time it arrives, inspect it, assemble it completely by stage—first stage, second stage, third stage, and instrument unit—as it arrives from the manufacturing sites around the country, and marry it to the ground support equipment, a most important function.

We then have to get the vehicle from the vehicle assembly building to the launch pad, and then ready it for launch some weeks later.

Now, how do we go about concluding that cycle? The artist makes it appear very simple. With a stroke of the brush he shows it taking off. Now let me give you some insight on how we go about it.

Figure B-2 is an operation plan flow. Starting with program schedules and mission definitions out of NASA Headquarters, we at KSC have to develop master schedules. We also have to consider other Center requirements such as those from MSC and MSFC. These criteria control such things as the amount of fuel needed, tolerances, and the type of testing. KSC converts these criteria to test procedures. Every step we take is documented. The other centers are

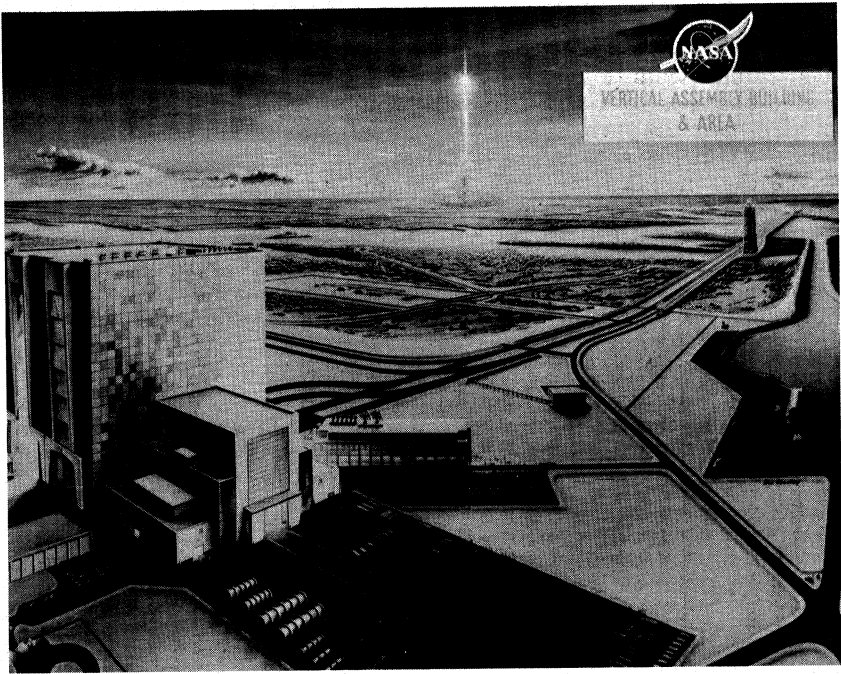


FIGURE B-1.—Artist's concept of vehicle assembly building, and area, complex 39.

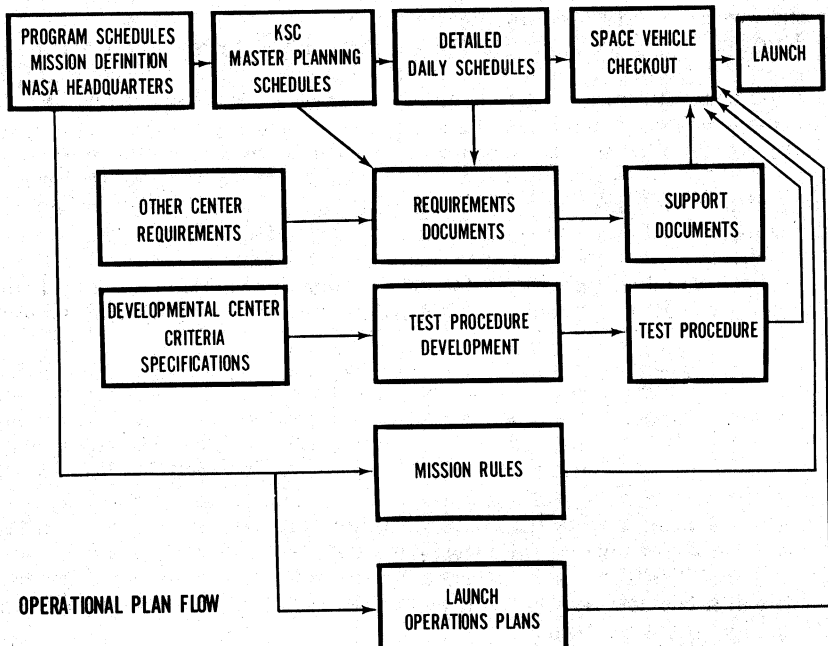


FIGURE B-2

furnished these procedures for review, procedures which we have developed from their basic criteria. We also must generate requirements documents to forecast the support we need both from the Air Force and our own resources, allowing time to plan many months in advance. In turn, support documents are produced which detail how our requirements will be fulfilled.

We then make detailed daily schedules. You will see, when we visit complex 39, our operations control room where these schedules are prepared. Let me point out what this means in terms of laying out our job; that is, of taking all these large tasks and breaking them into meaningful areas of work so that many thousands of people, not only here but in the development centers or at the factories across the country, can support this operation.

We are now ready to begin the checkout itself. In the case of Saturn V we are speaking of a period of time in the vehicle assembly building of approximately 10 to 12 weeks in a normal flow. AS-501 has not been normal in this respect, being the first Saturn V flight vehicle. Specifically, our second stage arrived later than it will on future schedules.

What is the mission of AS-501? What do we want it to do? Our mission rules provide these answers in the form of pre-thought-out actions mandatory for a successful mission. For example, if the flight is to determine certain strength characteristics or heat characteristics, obviously those measurements, that data, are mandatory for that mission. In turn, there is the question of launch conditions. For example, with what winds can we launch? What is tolerable in terms of a ceiling? This all goes into the mission rules.

With our test procedures, our mission rules, and our support documents, we are ready to commence checkout.

Figures B-3 and B-4 illustrate some major tests which are performed on the flight hardware prior to space vehicle electrical mate. The first step in launch vehicle checkout is receiving inspection. Next, certain checks are performed in the low bay of the vehicle assembly building. Following these checks, we then erect and mechanically mate each stage in the high bay. This is the first time these stages see each other. We go through compatibility checks in which we check the compatibility of the smallest modules by attempting to make systems checks. We do not want to go into the component level. They have been checked out at the factory, either at the Michoud plant, or Huntington Beach plant, or Bethpage, in the case of the Lunar Module.

Now, our job is to put these systems together. Therefore, our testing is aimed at verifying the total electrical mate of the space vehicle. These are systems tests, a series of tests that allow the checkout of the launch vehicle. We use the same checkout philosophy with the spacecraft, with one difference—the flight crew. So our tests leading up to the altitude chamber tests are much the same as those for the launch vehicle. The first tests involving the crew are performed in the altitude chamber, where we take the spacecraft being tested to an altitude of over 200,000 feet. These tests are laid out jointly between our test people and the astronauts themselves. Normally, these tests run from 12 to 16 hours at altitude.

LAUNCH VEHICLE CHECKOUT PRIOR TO SPACE VEHICLE ELECTRICAL MATE

1. RECEIVING INSPECTION ALL STAGES
2. LOW BAY CHECKOUT, S-II AND S-IVB
3. ERECTION, MECHANICAL MATE ALL STAGES - S-1C, S-II, S-IVB, IU
4. COMPATIBILITY CHECKS WITH GROUND SUPPORT EQUIPMENT
5. INDIVIDUAL STAGE CHECKOUT - MECHANICAL, ELECTRICAL SYSTEMS
6. LAUNCH VEHICLE ELECTRICAL MATE
7. SWITCH SELECTOR FUNCTIONAL TEST
8. GUIDANCE & CONTROL SYSTEM CALIBRATION & FUNCTIONAL TESTS
9. PROPELLANT DISPERSION TEST
10. GUIDANCE COMMAND CHECKS
11. POWER TRANSFER & FLIGHT SEQUENCE TEST
12. SEQUENCE MALFUNCTION TEST
13. PLUGS-IN TEST
14. INTEGRATED SWING ARM TEST

FIGURE B-3

When the altitude tests are finished, certain hardware items are installed to complete assembly of the spacecraft. It is then moved to the vehicle assembly building and made ready for integrated testing with the launch vehicle.

Please notice that I use the words "spacecraft" and "launch vehicle" until the spacecraft and launch vehicle are mated. Then I use the term "space vehicle."

SPACECRAFT CHECKOUT PRIOR TO SPACE VEHICLE ELECTRICAL MATE

1. RECEIVING INSPECTION
2. MATE COMMAND MODULE/SERVICE MODULE
3. SPACECRAFT SYSTEMS TESTS
4. ALTITUDE CHAMBER TESTS
5. INSTALLATION FLIGHT NOZZLE, ORDNANCE
6. MOVE TO VAB
7. ERECTION
8. COMPATIBILITY TESTS WITH GROUND SUPPORT EQUIPMENT
9. INTEGRATED TESTS WITH LAUNCH VEHICLE SIMULATOR

FIGURE B-4

Figure B-5 lists major tests performed during space vehicle check-out. Here the spacecraft has been moved from the industrial area to the vehicle assembly building and has been erected. Now all our testing is a composite, first stage, up to spacecraft, for total testing. And again we are making systems tests.

For example, for No. 3, the "plugs-in test" we run through the entire countdown and go into what we call "plus time." We do this by simulation. The vehicle remains on the launcher, but we continue to T-zero, then go through a "plus time" powered flight phase, a simulation of the entire mission. This is all done electronically without ever, of course, having fuels aboard. The flight crew would be on board for that particular run. The "plugs-out test," No. 4, is similar, but involves disconnecting the swing arms for a complete electrical disconnect test. After successful plugs-in and plugs-out tests, certain tests concerning ground support equipment are made, and the space vehicle is prepared for a "simulated flight test." This is the last test to be accomplished within the building, and demonstrates that the flight hardware is ready to be moved to the launch pad.

Upon successful conclusion of simulated flight, the space vehicle is moved to the pad. At the pad, we run through a further series of tests. Initially, the time spent at the pad prior to launch will be about 6 weeks. After an initial learning curve, we expect to reduce this time to less than a month.

The one thing that we do at the pad that cannot be done elsewhere is the countdown demonstration test, where we fuel the vehicle and run through a total test. This is in truth a dress rehearsal. Our countdown demonstration test is run before the flight readiness test during AS-501 to check out the fuel system as early as possible. During subsequent missions, we will run our countdown test after the flight readiness test and then reconfigure and go into the final countdown.

SPACE VEHICLE CHECKOUTVAB

1. SPACE VEHICLE ELECTRICAL MATE AND EDS TEST
2. INTERFACE COMMAND TEST WITH HOUSTON FLIGHT CONTROL
3. PLUGS-IN TEST
4. PLUGS-OUT TEST
5. SWING ARM OVERALL TEST
6. SIMULATED FLIGHT
7. MOVE TO PAD

PAD

1. COMPATIBILITY TESTS WITH GROUND SUPPORT SYSTEM
2. LAUNCH VEHICLE LOADING SIMULATIONS
3. SPACECRAFT SYSTEMS TEST
4. CUT-OFF AND MALFUNCTION TEST
5. COUNTDOWN DEMONSTRATION TEST
6. FLIGHT READINESS TEST
7. RECONFIGURE, PREP FOR COUNTDOWN
8. COUNTDOWN

FIGURE B-5

Figure B-6 shows our "task force" for carrying out launch operations during the final countdown. You will not see this on our organization chart, because these elements are drawn from the total NASA organization and not only from our Center.

We have a Mission Director who is assigned out of NASA Headquarters and who will operate part-time here before the actual launch, when he will be in Houston. The Launch Director at KSC will work through the Launch Operations Manager and the Space Vehicle Test Supervisor.

The Space Vehicle Test Supervisor coordinates the activities of the Launch Vehicle Test Conductor and the Spacecraft Test Conductor

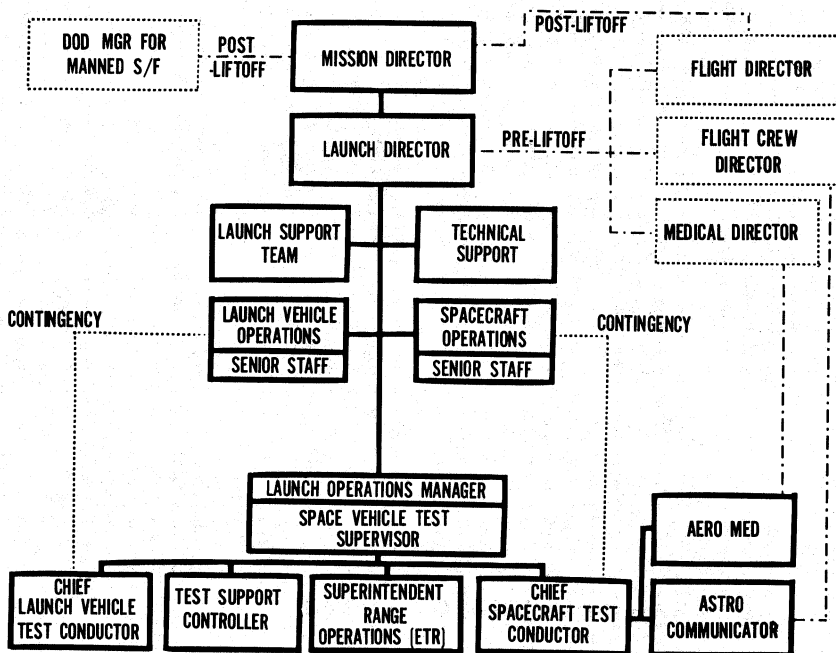


FIGURE B-6

as well as the necessary support elements such as the Eastern Test Range and our own technical support personnel which the Center furnishes.

Now we tie in spacecraft activities with the Aeromed and the Astro-Communicator in our Launch Control Center.

The test conductors will carry out commands from the test supervisor and carry them out through a contractor structure. They interface, for example, with the Boeing test team. In addition, the test conductor will have a systems engineer for each major system supporting him for the test. This is where the Government team and the contractor counterparts work together for the conduct of the operation on a task force basis. The real time command will flow through this line to the launch vehicle or spacecraft. Although there is an agreed-to countdown, a contingency line is also available if the countdown does not proceed as planned and rehearsed. There is a Launch Vehicle Operations Staff as well as a Spacecraft Staff. These staffs consist of the senior people; for example, Dr. Gruene, Director, Launch Vehicle Operations, or John Williams, Director, Spacecraft Operations. They have a contingency line direct to their test conductor if they have to resolve a specific technical problem. In addition, they will have with them representatives from MSFC for the launch vehicle and representatives from MSC for the spacecraft. One of the contingencies may be a question concerning a necessary waiver. For example, if a measurement listed as "highly desirable" in the mission rules fails, or if a tolerance approaches a red line—not necessarily passes it—there

has to be consultation with the appropriate development center in order for us to get a waiver to proceed.

Shown also in figure B-6 is the task force consisting of the Flight Director, the Medical Director, and the Flight Crew Director. Decisions needed involving status of the crew or the world net would flow from the Flight Director sitting in the Mission Control Center at MSC. This then gives an overlay of how a task force made up of Government and contractor people carries out the execution of this very large endeavor where real time communications are most important.

Next, we will look at some of the facilities used to launch our Saturn V vehicles. Figure B-7 is a cutaway of the Vehicle Assembly Building, while figure B-8 is a cross section showing the erection of stages. Yesterday we erected the S-11 stage. This afternoon we should have completed erection of the third stage. Next week we will put up the spacecraft. This is all leading to the final flight configuration for the AS-501 launch this summer.

Figure B-9 shows the bay where we are now working. Bay No. 1 is fully equipped and ready. Bay No. 2 will be ready shortly. We plan to erect AS-502, the second Saturn V flight vehicle, in late March or early April. Bay No. 3 is presently on contract.

Figures B-10 and B-11 illustrate 6 major steps in our launch operations flow at the Vehicle Assembly Building. Step 1 shows a stage

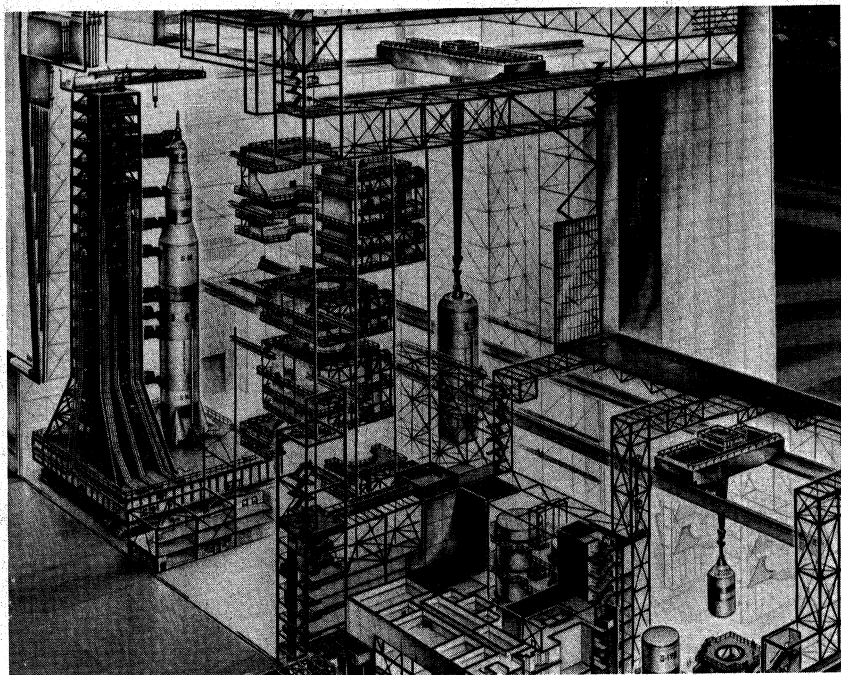


FIGURE B-7.—Artist's concept of Vehicle Assembly Building (cutaway).

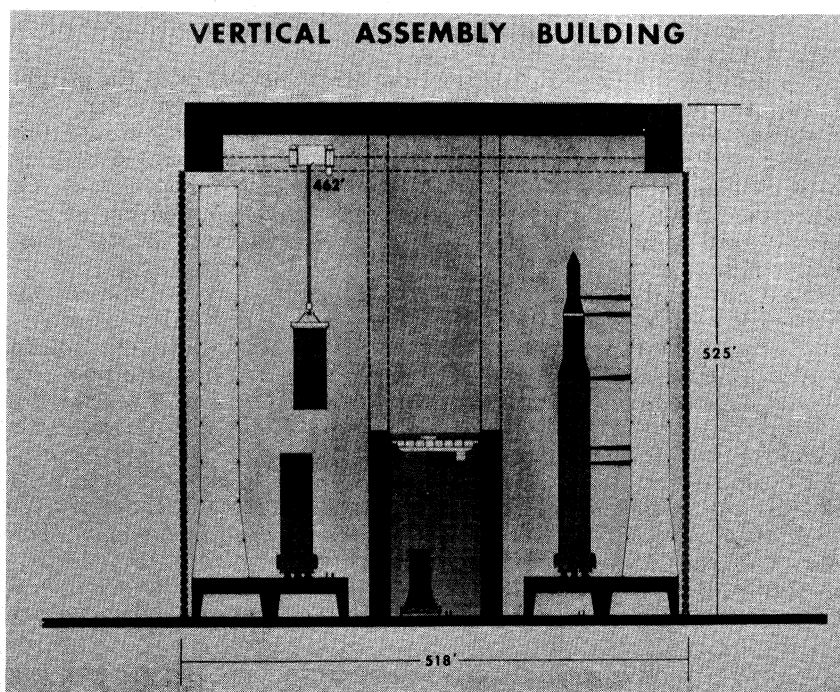


FIGURE B-8

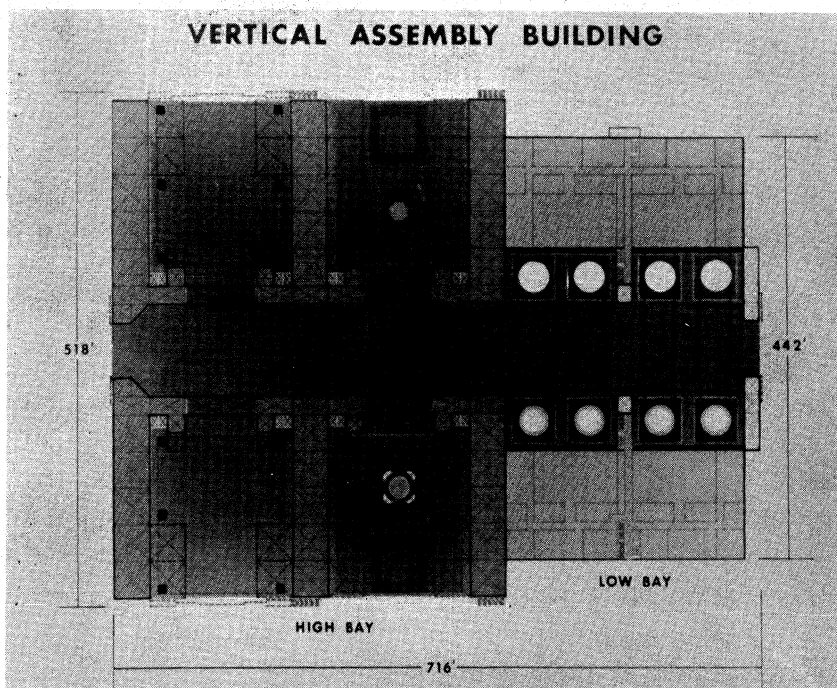


FIGURE B-9

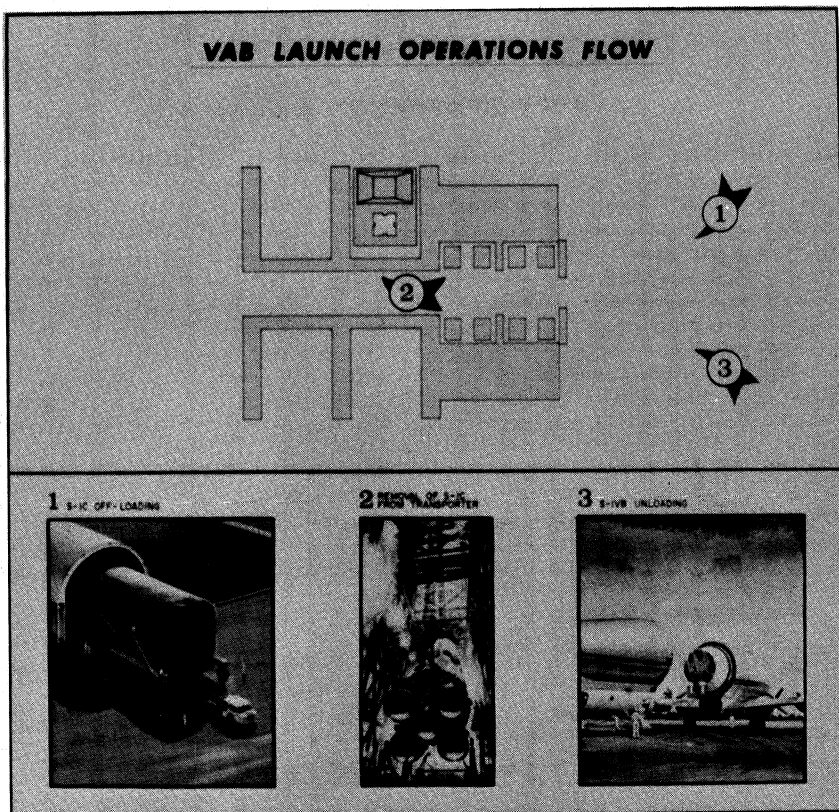


FIGURE B-10

arriving and going into the center aisle. Step 2 shows a stage arriving and going into the center aisle to be erected onto the launcher by a large crane. Our third stage (step 3), our instrument unit, and spacecraft can be flown in. The first and second stages must come by water. Step 4 shows operations on the second stage taking place here in the low bay before erection. Step 5 shows erection of the spacecraft itself, while step 6 illustrates the checked-out vehicle being transferred to the pad.

Figure B-12 shows the S-IC stage from below. This is the stage made by Boeing. The F-1 engines are visible in the photograph.

Figure B-13 shows the stage after erection sitting on four hold-down arms. The five engines are 10 feet below the deck of the launcher and the stage is being made ready for further cabling that has to be connected before proceeding with stage checkout.

Much of our time has to be taken up with physical assembly. The S-II has to be mated to its inner-stage units (fig. B-14) and then be bolted together on a table before erection. Normally, our work on the S-II stage would be about 7 to 10 days. In this specific case, we had some modifications to do prior to erection; however, the work was completed and the stage erected yesterday.

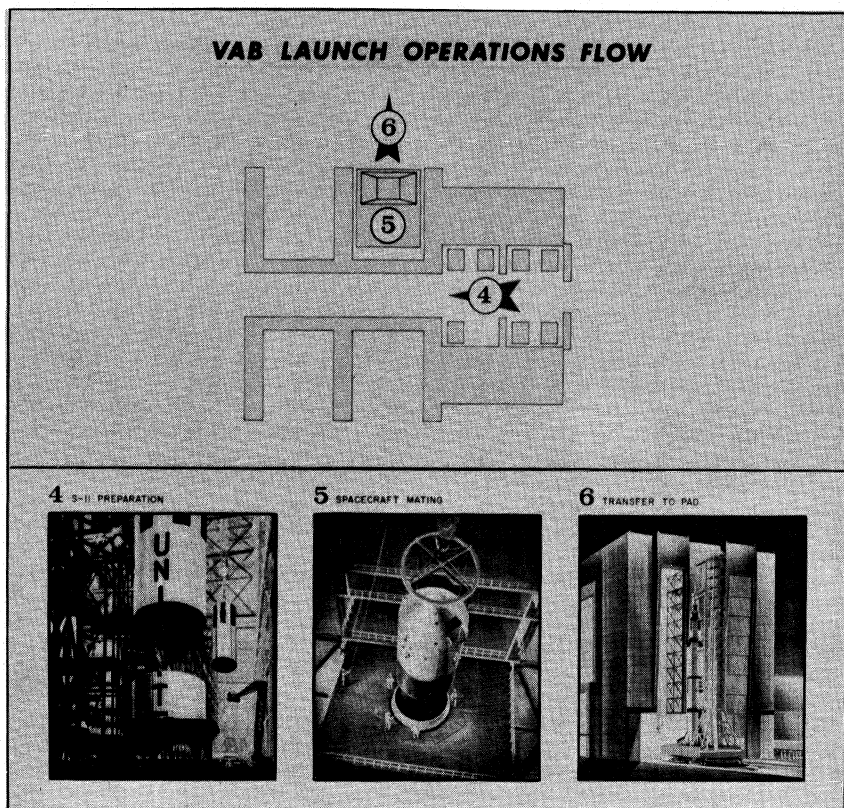


FIGURE B-11

Figure B-15 shows the third stage (S-IVB) in the center aisle of the low bay. We have moved it out of the checkout cell, and are preparing it for erection.

In figure B-16, the S-IVB has been erected on the S-II, and the instrument unit is being lowered into place. At this point in time, the launch vehicle is ready to begin checkout. We now have the three stages and the instrument unit erected on the launcher.

Concurrent with launch vehicle erection, spacecraft operations are proceeding in our operations and checkout building as described earlier. Systems tests are performed in the altitude chamber with the astronauts. There are usually two runs, with the prime crew and the backup crew running the spacecraft through its paces.

Figure B-17 shows the combined command and service module in front of an altitude chamber. You will note that the engine thrust nozzle is in place although we cannot handle it in the chamber because of the chamber size. When nozzle installation is completed, the command and service module is then mated to the spacecraft LM adapter (fig. B-18).

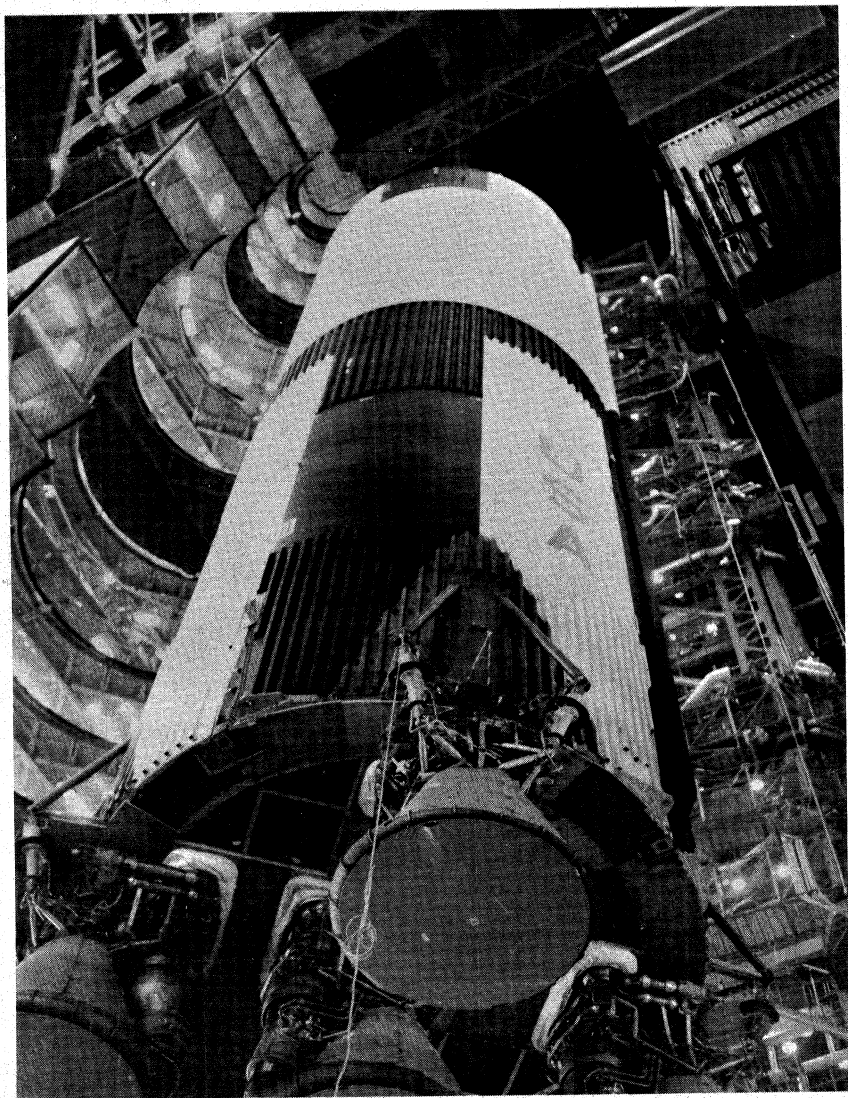


FIGURE B-12.—Erection of Saturn IC-501 in the Vehicle Assembly Building.

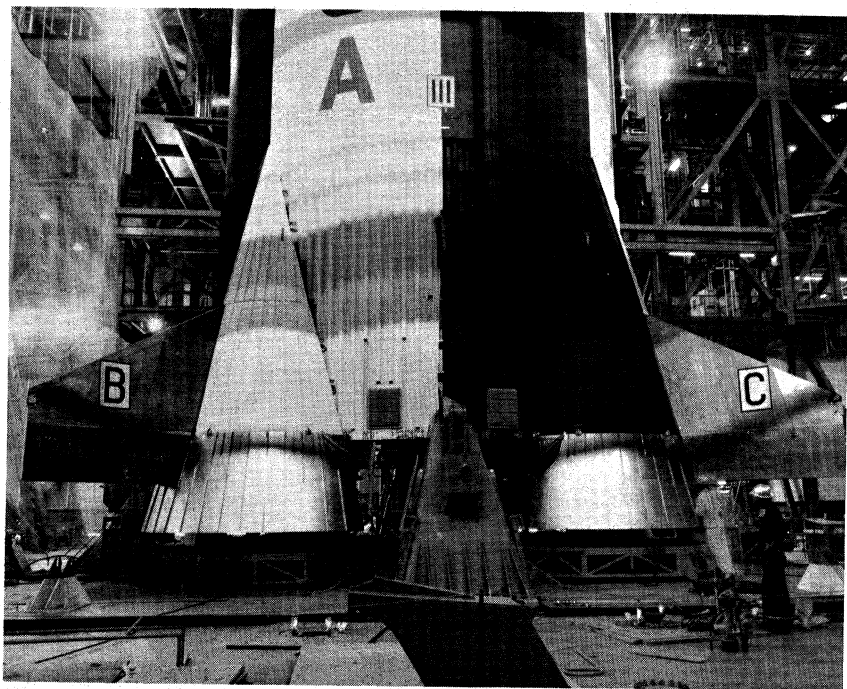


FIGURE B-13.—Stage S-IC sitting on holddown Arms.

Figure B-19 shows the lunar module being assembled within a part of the spacecraft LM adapter. Now, although this will fly on AS-501, it is not a complete lunar module. It is called an LM test article. AS-501 and AS-502 will have test articles wherein we will be able to measure dynamic data. There will be no fuel aboard and no life support system on the LM test article. Figure B-20 shows the complete spacecraft being erected in the high bay.

Figure B-21 is the launch control center for the launch vehicle. The contractors are each working at certain rows of equipment. The row of racks in the foreground is for the command and management elements of both spacecraft and launch vehicle.

The detailed checkout of the spacecraft that started when it arrived in the operations and checkout building is carried out with a system we call the ACE system, automatic checkout equipment system (fig. B-22). Overall control of spacecraft checkout is maintained by the ACE system located 6 to 7 miles from the vehicle assembly building. As described earlier for the launch vehicle, connection to the spacecraft is accomplished by digital-data techniques.

Once our checkout is complete within the building, we are ready to move to the launch pad. We accomplish this with what we call the Crawler-Transporter.

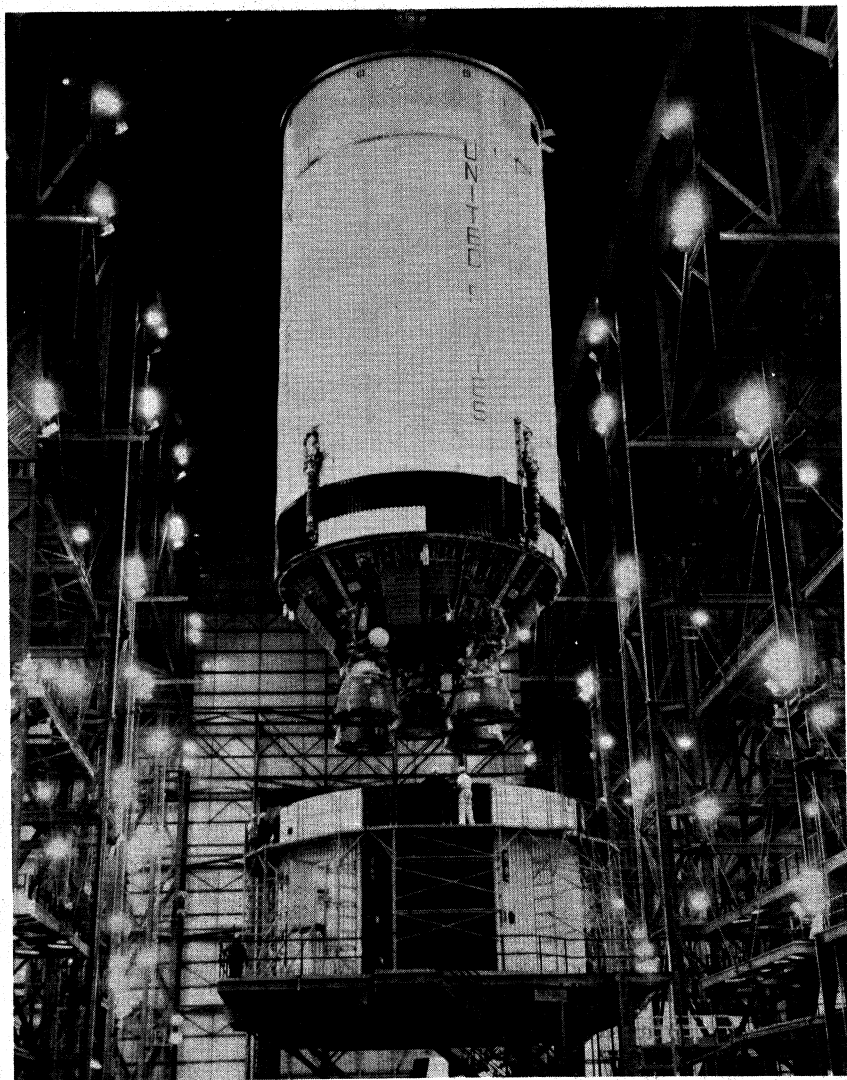


FIGURE B-14.—Erection and mating of S-II stage to innerstage and placement in cell.

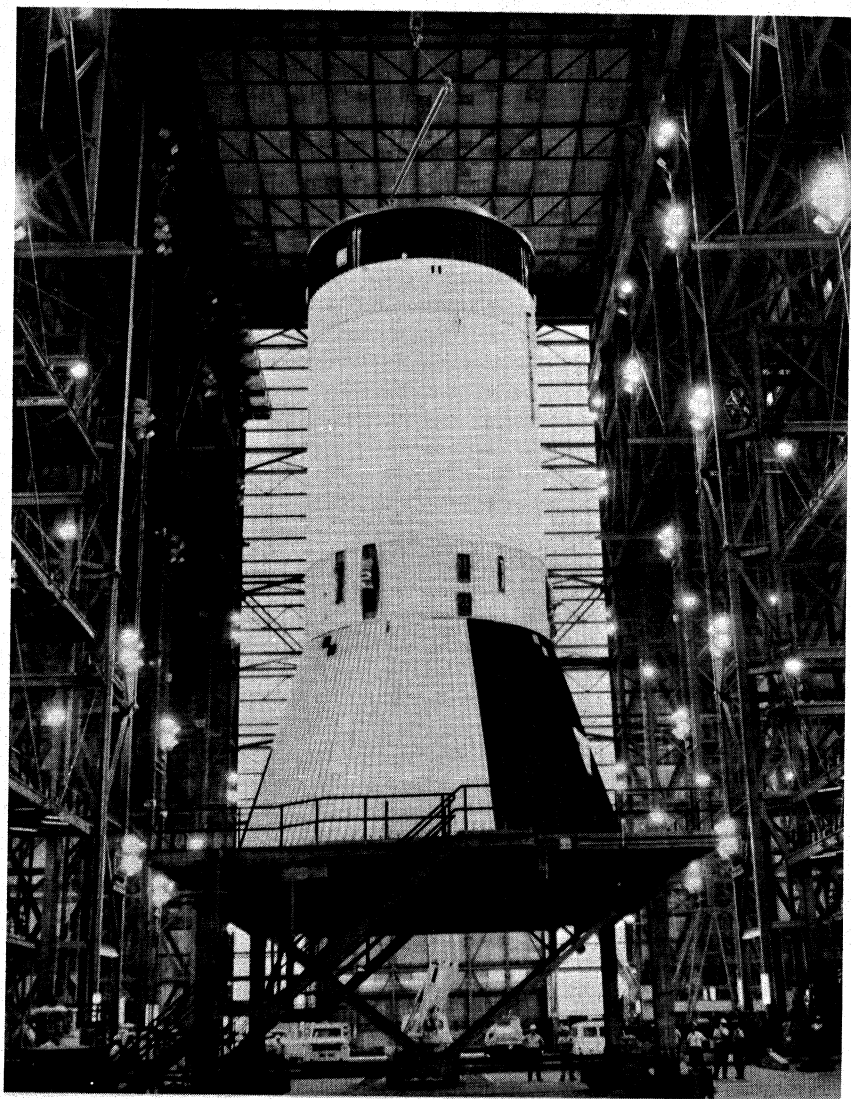


FIGURE B-15.—Erect Saturn IVB in center aisle of vehicle assembly building low bay.

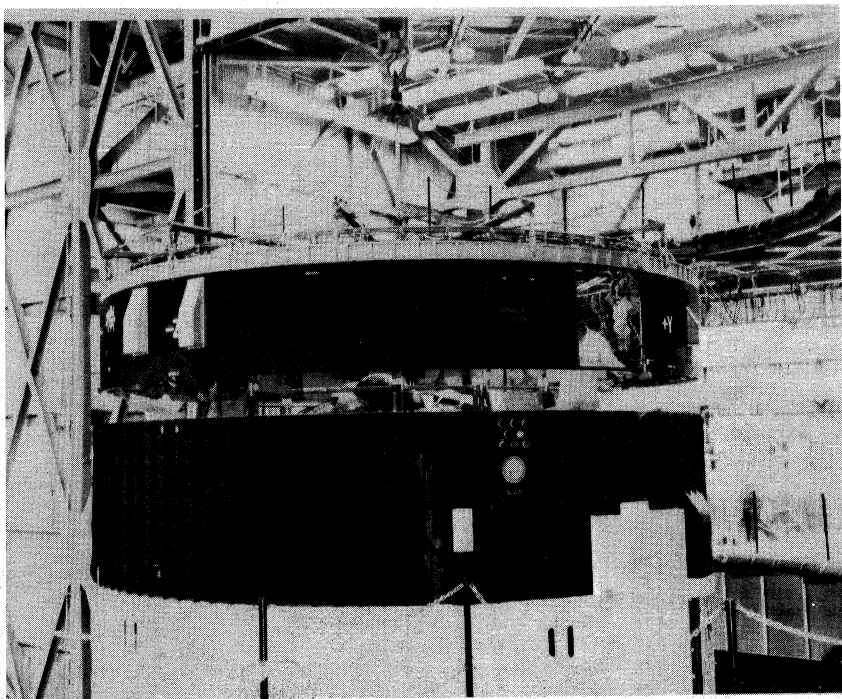


FIGURE B-16.—Mating of instrument unit and S-IV-B stage.

Figure B-23 shows the Crawler-Transporter leaving the building. Shown also is the back of the launcher. The crawler is operated by Bendix, who is one of the support contractors here.

Figure B-24 is a photograph of AS-500-F coming out of the building. The day was May 25, 1966, exactly 5 years after President Kennedy announced the goal of getting to the Moon. It shows the accomplishments that can be made and have been made in just 5 years. Figure B-25 shows the vehicle coming up to the pad, while figure B-26 shows the vehicle in place on the pad.

The mobile service structure, which is now being tested, was brought to the pad initially in July for test purposes and set down on the remaining pedestals. All the large equipment shown on either side of the launcher has to be mated. The mobile service structure allows us outside access about the spacecraft and into the launch vehicle where necessary. It will be removed from the pad some 7 hours before launch. The astronauts will be loaded over the top arm of the launcher into the white room in the command module after all fuels are aboard. As you know, however, the first launch, AS-501, will not be manned. We will then proceed with the countdown.

That, sir, is a brief résumé of our operations.

Mr. WINN. I have one question. You were pointing out that after they get to the pad, then you pointed to several structures and said then they have to be mated. I don't quite follow you on that.

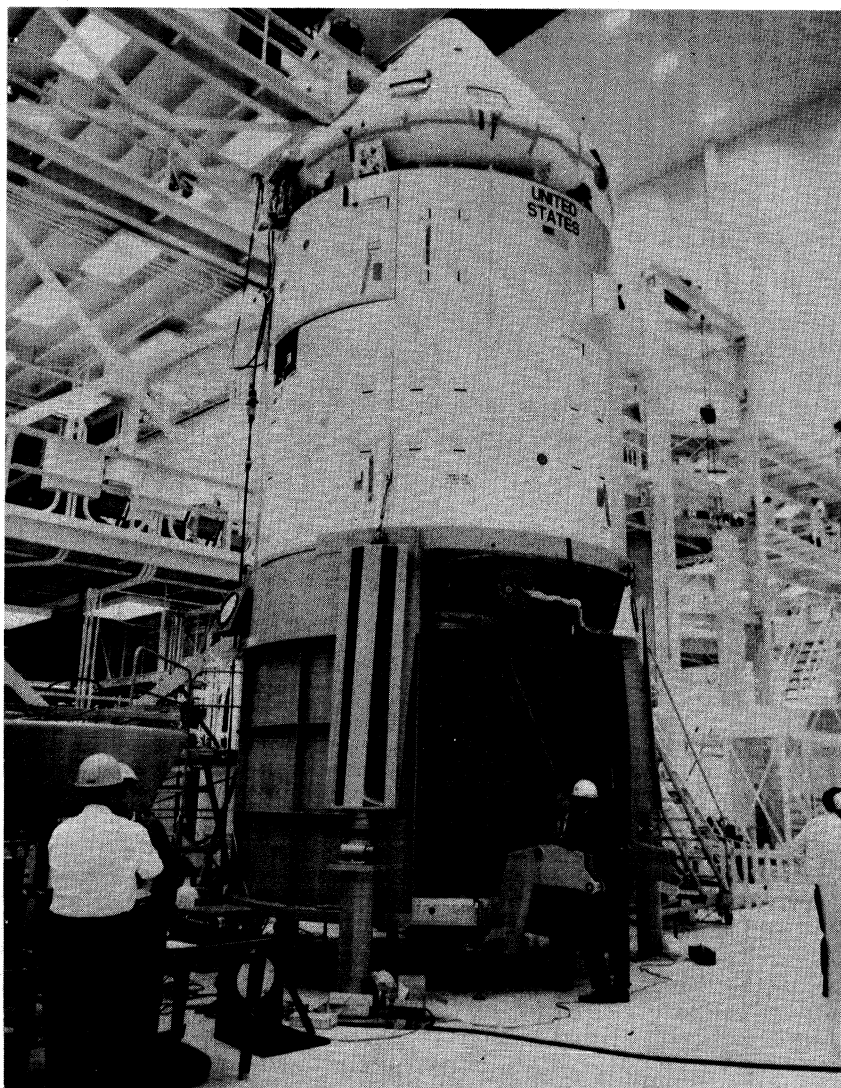


FIGURE B-17.—Combined command and service module.

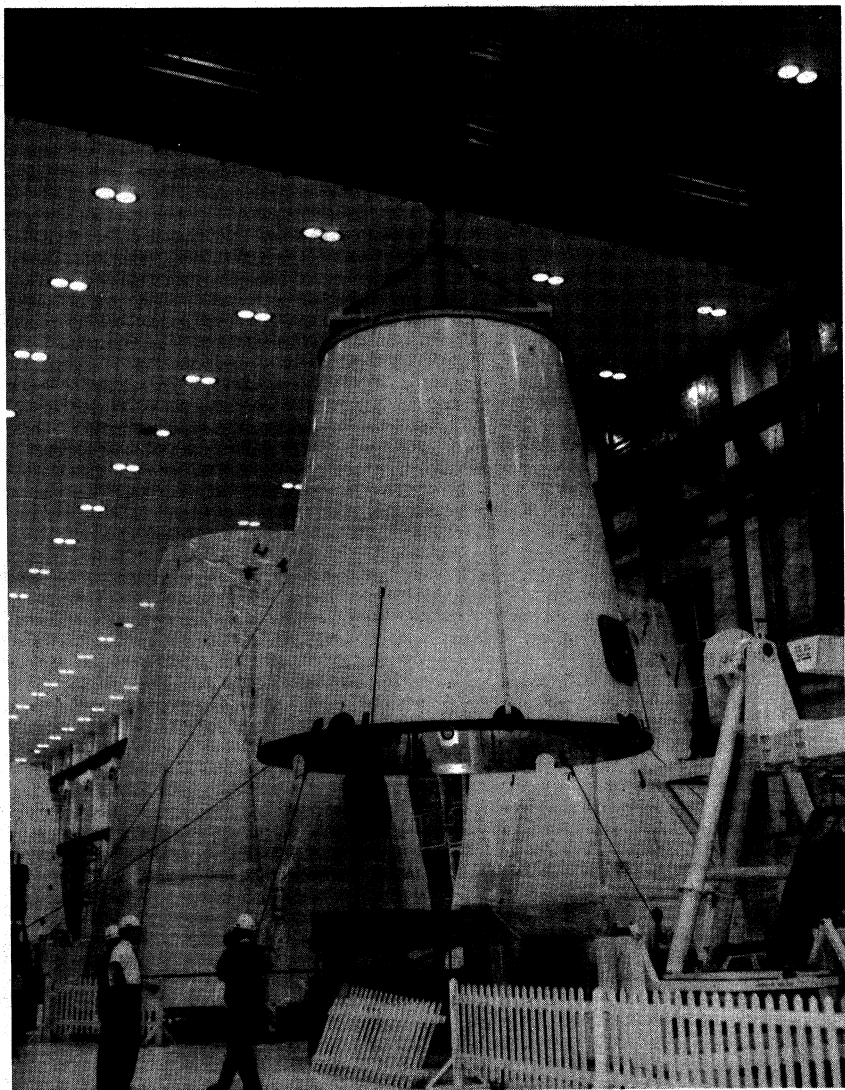


FIGURE B-18.—Lunar module adapter.

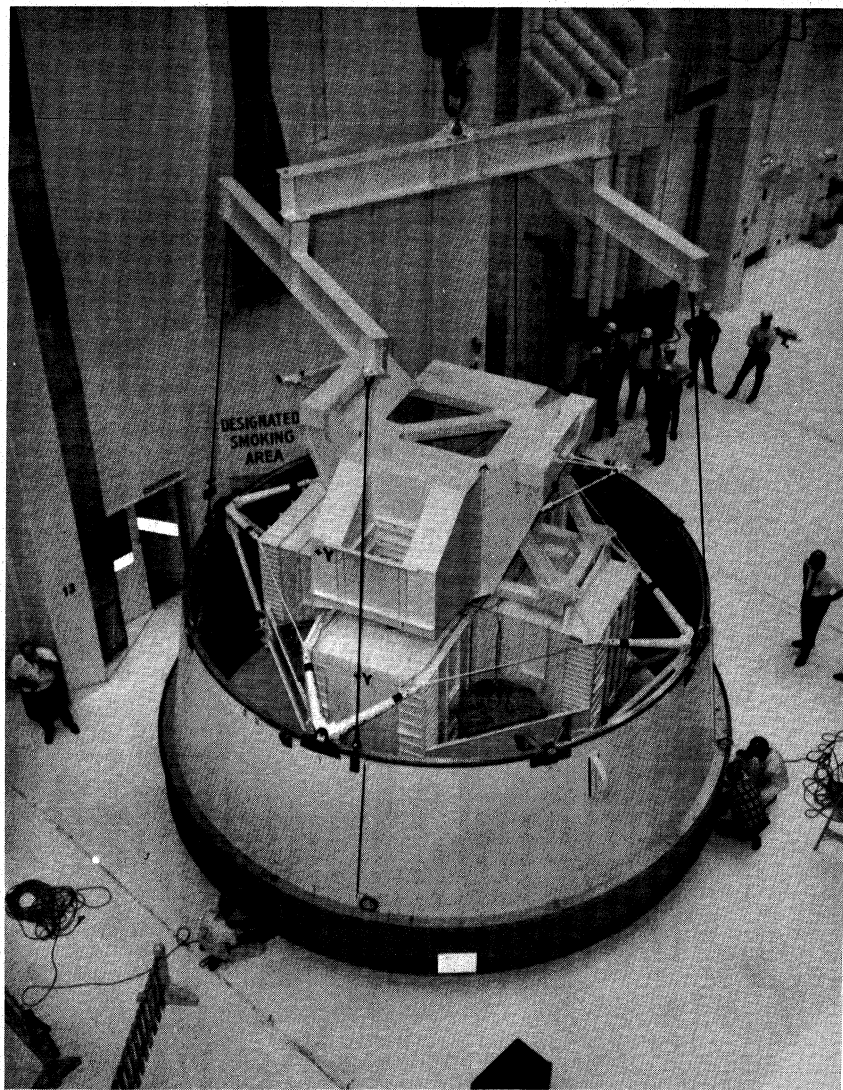


FIGURE B-19.—Assembly of lunar module within part of lunar module adapter.

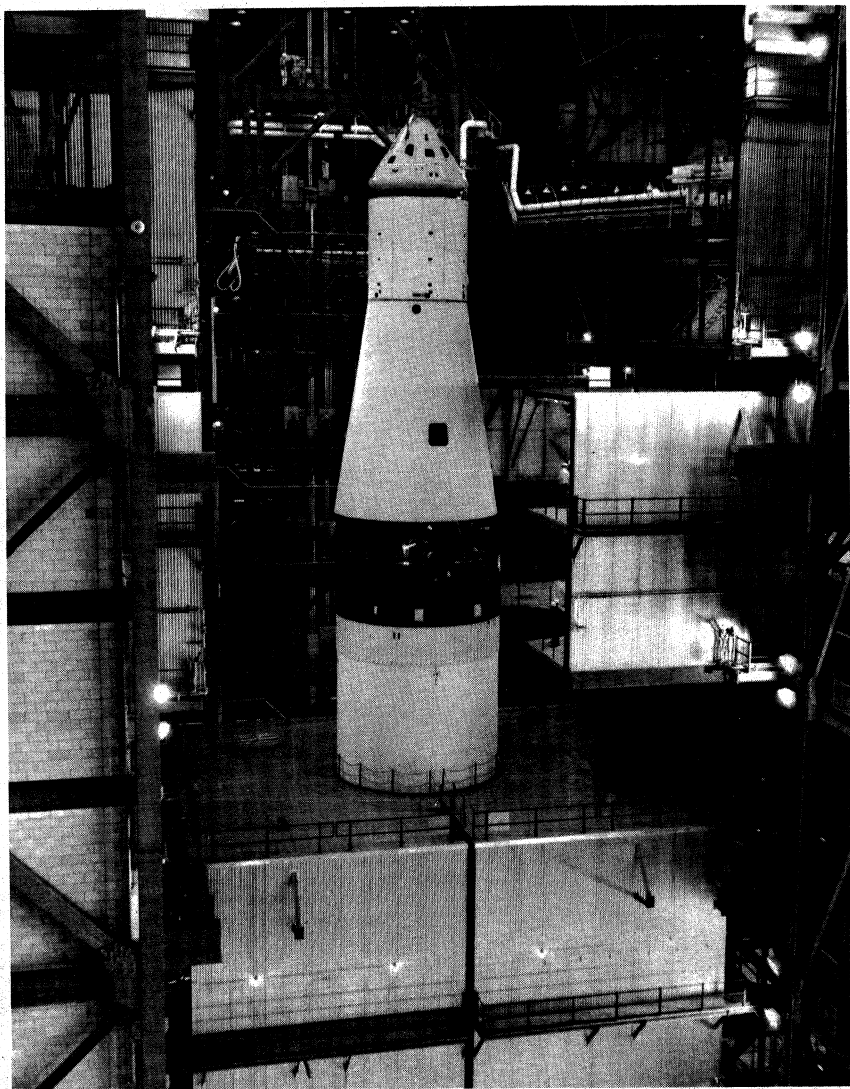


FIGURE B-20.—Erection and mating of Apollo spacecraft and command module to Saturn 501.

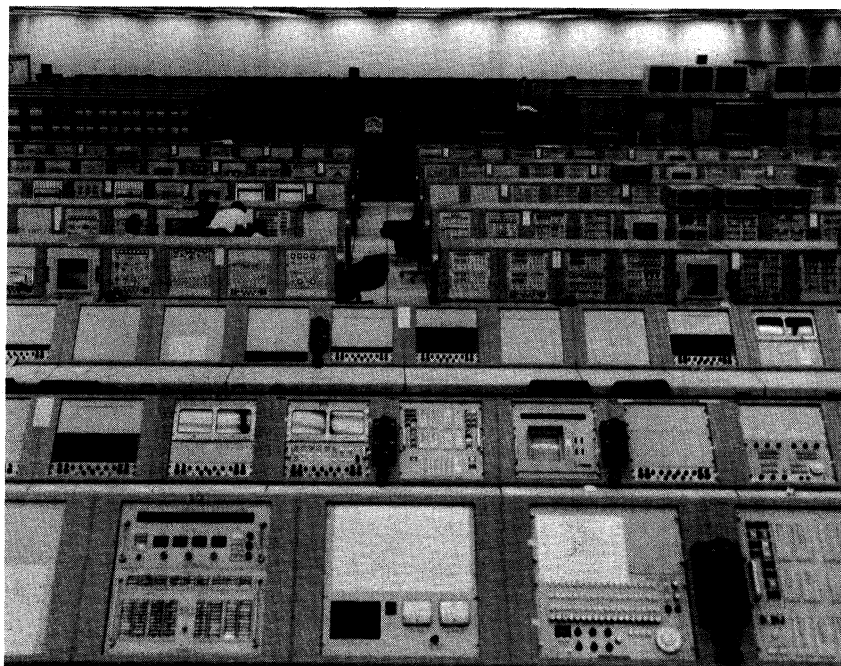


FIGURE B-21.—Launch control center.

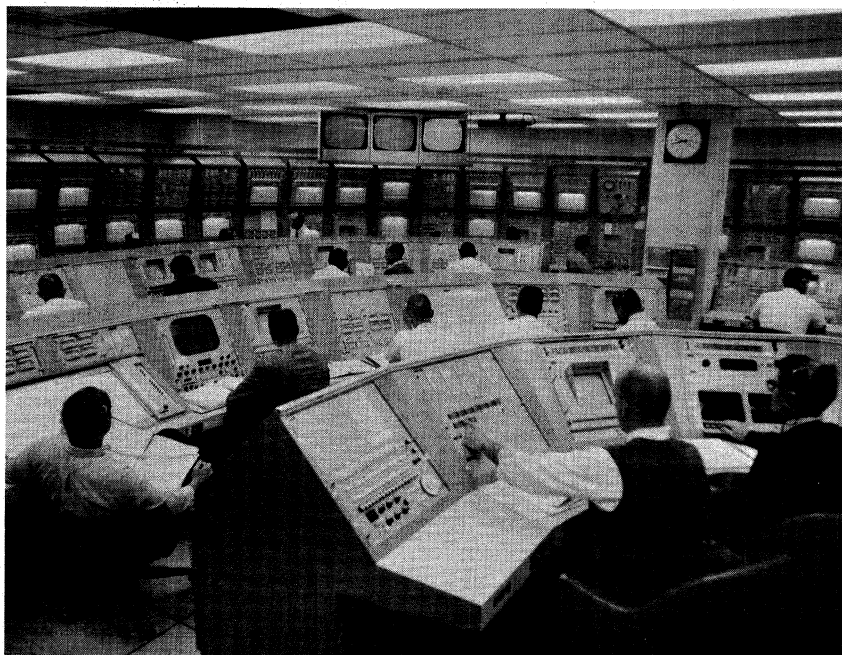


FIGURE B-22.—Automatic checkout equipment system.

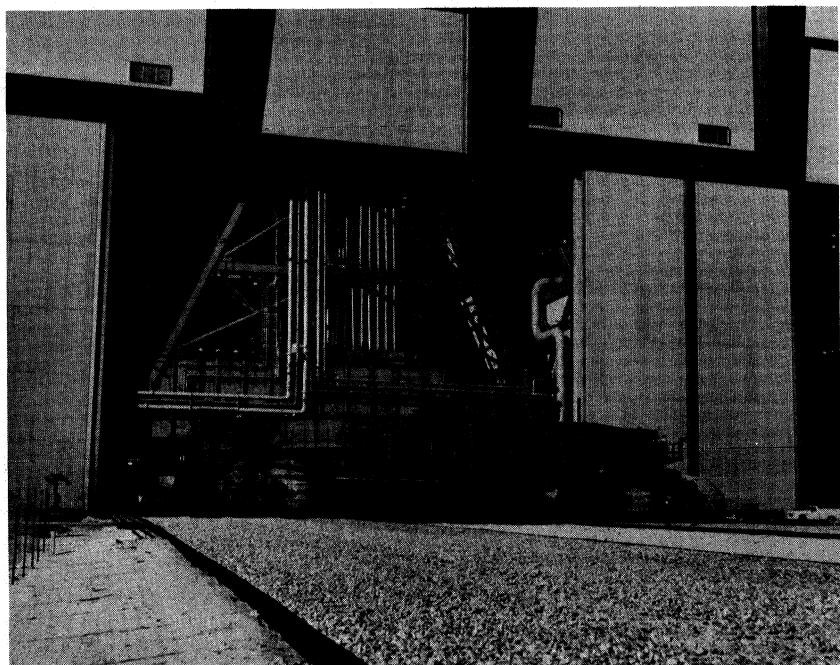


FIGURE B-23.—Crawler leaving vehicle assembly building.

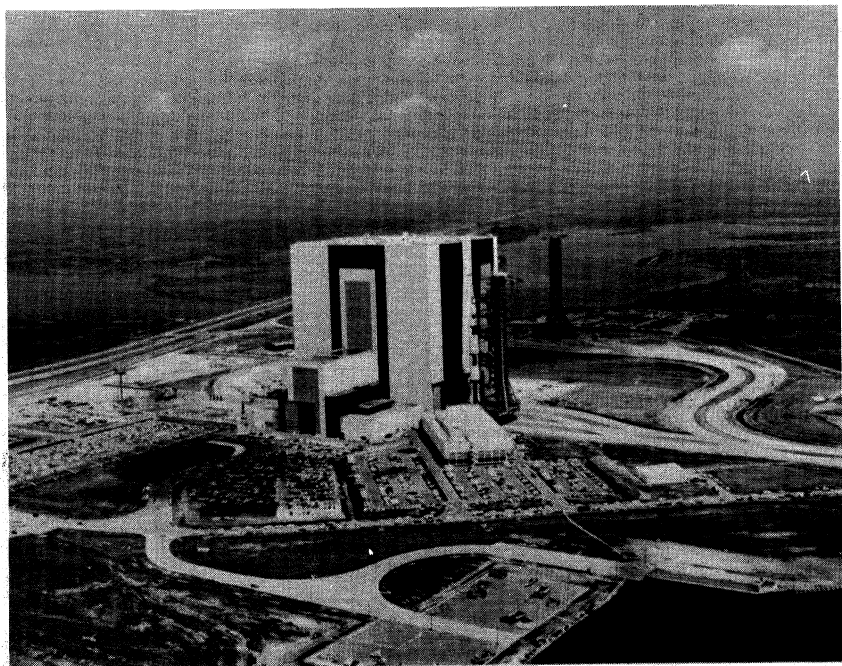


FIGURE B-24.—Photograph of AS-500-7 leaving vehicle assembly building.

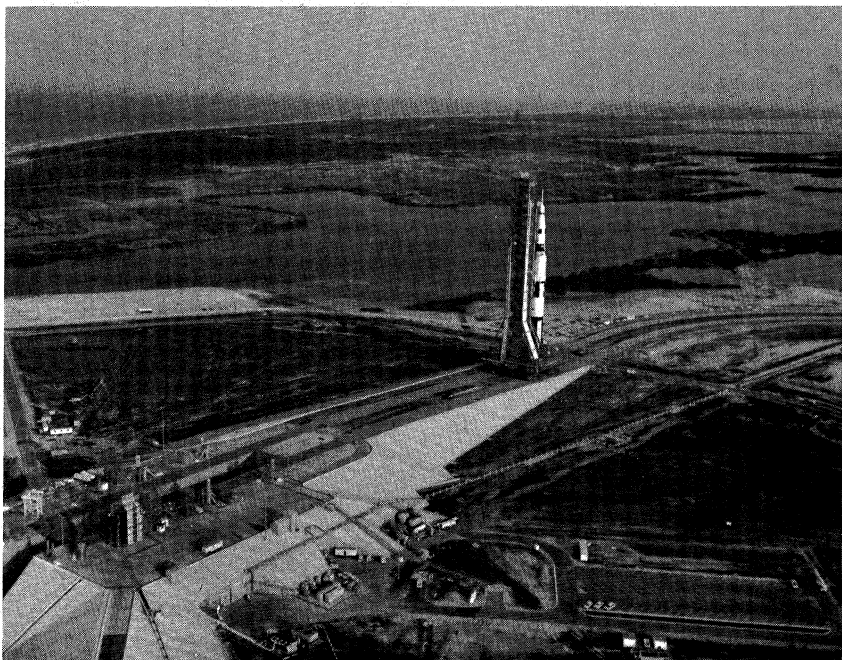


FIGURE B-25.—Vehicle approaching launch complex 39A.

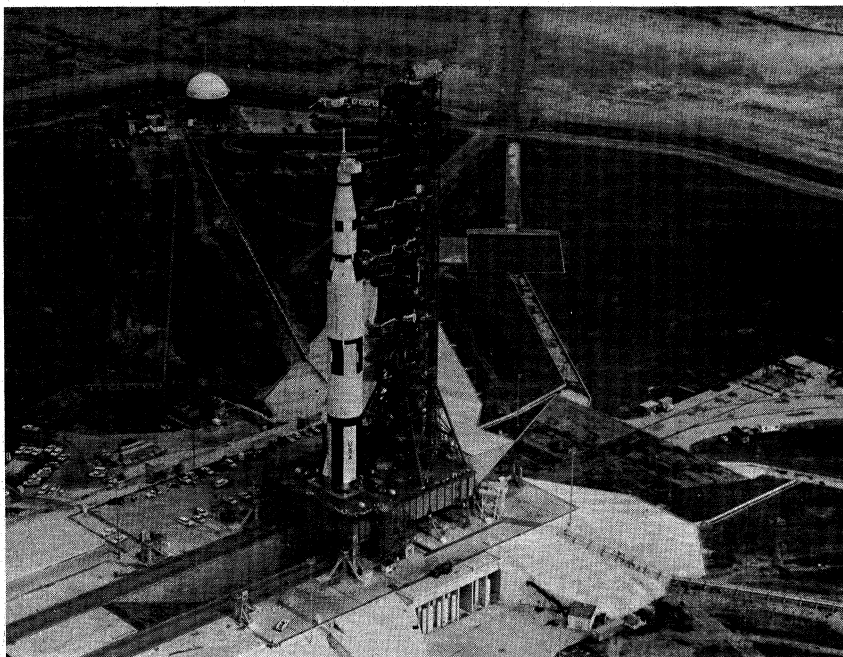


FIGURE B-26.—Vehicle in place on launch complex 39A.

Mr. PETRONE. When you get to the pad, you have, in effect, severed the electrical connections when you left the building.

Mr. WINN. Oh, I see.

Mr. PETRONE. Then you have the launcher which has now lost the electronic connections to the test equipment.

Mr. WINN. Yes.

Mr. PETRONE. When you get to the pad, you now restore those connections, and since we are using this digital data technique, it is quite simple to reinstall these connections to get your configuration. The main thing you have not done is break the connection between the vehicle and the launcher, because there are many as compared to the relatively few connections between the launcher and the ground.

Mr. WINN. I see. Thank you.

Chairman TEAGUE. Thank you, Rocco.

Dr. DEBUS. I will now ask Mr. Siepert to talk about management.

Representative WAGGONNER. That is the best overall presentation of the process from start to finish that we have ever had.

Dr. DEBUS. Mr. Siepert.

Mr. SIEPERT. I will discuss with you certain points concerning our basic management; that is, how we are organized, what our growth in staffing has been in recent years, and certain characteristics and concepts of the Government/contractor team. I will close with a progress report on some current procurements that are underway for the recompetition of certain of our major support service contracts.

This, figure C-1, is a condensed version of the basic functions which Dr. Debus showed on an earlier chart. A second chart, figure C-2, of the Center shows our primary organizational structure and also shows an allocation of the manpower to these several blocks. Under each box you will notice figures on the left showing the civil service resources; on the right are the contractor resources which directly serve in that function.

Our first function is, of course, to prepare, checkout, and launch NASA space vehicles. That is our only reason for being here. The operating component which does that is the launch operations directorate, the one that Mr. Petrone heads. You will notice it is divided functionally among launch vehicle, spacecraft, and unmanned launch operations. You will have a chance to see something of all three of these operations this afternoon.

A second function is to assure that the designer back in the development center retains responsibility at all times for the precise configuration of the flight hardware in the final flight. This is achieved by the launch operations group working with the development center to figure out what the engineering changes need to be. However, all changes are coordinated between centers and if it is Apollo flight hardware, are approved and cleared by the manager of the Apollo program office, in each Center which is affected.

The third function is to develop new launching concepts and implement them. This is a responsibility which emerges from the collective experience of the launch operations group, the technical support people, and the design engineering organization. Mr. G. Merritt Preston has just taken charge of design engineering. Once the concepts have been cleared, the Design Engineering Directorate has re-

KENNEDY SPACE CENTER'S BASIC FUNCTIONS

1. PREPARE, CHECKOUT, AND LAUNCH NASA SPACE VEHICLES.
2. ASSURE CONFIGURATION CONTROL OF FLIGHT HARDWARE BY DEVELOPMENT CENTERS.
3. DEVELOP NEW LAUNCHING CONCEPTS; DESIGN AND INSTALL LAUNCH FACILITIES, INCLUDING GSE.
4. OPERATE LAUNCH COMPLEXES AND VARIOUS TECHNICAL SERVICES IN IMMEDIATE SUPPORT OF LAUNCH TEAM.
5. FURNISH BASE INSTALLATION AND ADMINISTRATIVE SUPPORT FOR ALL NASA OPERATIONS.

FIGURE C-1

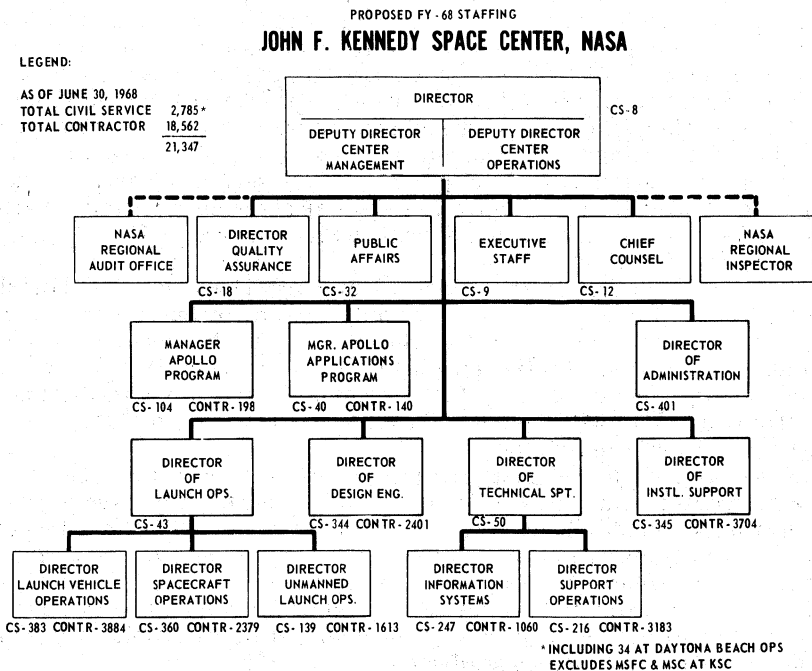


FIGURE C-2

sponsibility for designing and installing the actual launch facilities, including any related GSE or ground supporting equipment.

Once facilities are built, KSC has a fourth function, the responsibility for operating the launch complexes and the various technical services in immediate support of the launch team.

To recapitulate at this point, the concept of the present KSC structure is to locate within one operating Directorate (the Director of Launch Operations) all functions which are unique to our being an installation that launches hardware into space. In other words, these are functions which occur only because we are in the launching business, but these, moreover, are functions which need to be performed directly by the launch team itself. Basically, the Launch Operations Directorate is concerned with the flight hardware and with that GSE in intimate support of the flight hardware.

The rest of the total ground environment is operated by the Technical Support Directorate, the function that Mr. Ray Clark heads.

The fifth and last major function is furnishing installation support and administrative services. By installation support we mean functions which have to be carried out on a 24-hour-a-day basis, whether we launch or not. Obviously, there is a great accentuation of such functions during an actual countdown or critical test, but these are the things that have to be done to keep in operation a very large and complex installation representing a capital investment of close to \$1 billion. These base installation services are managed by the Directorate of Installation Support, Mr. Keith O'Keefe.

Administrative services cover the functions that the Government itself must perform in areas of procurement, personnel, management analysis, and resources management. This is done by the Director of Administration, Mr. George Van Staden. Note that certain of these organizational boxes, and particularly this box, have no contractors working with them, the reason being that they are performing a function which cannot be delegated in any fashion outside the Government's own hands.

Over the last 5 years we have recently gone through a period of rapid growth. The civil service component of governmental people stands at 2,785 in our budget projections for fiscal year 1968. This is the same figure as last year. I should note that the figure is somewhat larger than the one shown in Dr. Debus' earlier chart. He showed 2,720. The difference represents temporary positions not included in his figures.

You will notice that our team is made up of several important components (fig. C-3). I would like to comment on each of these as we pass. First, the ULO stage contractors are those who work with unmanned launch operations. You will notice that this group has been constant at about 1,500 over the last 4 or 5 years.

On the other hand, we had until recently a group here for the Gemini program. Until that program was completed during the current year, there were about 500 Gemini stage contractor personnel.

Construction workers were a very significant part of our total work force 2 years ago. They are winding up their work as our facilities on Merritt Island are completed. By the end of 1968 we expect there may be as few as 600 people in this category. That contrasts with 5,900 here in 1965 when complex 39 was at its greatest peak of activity, that is, when it was under construction.

The area called Support Operations on figure C-3 represents 9,800 contractor personnel who provide mission support for operating our total installation but are not concerned with the checkout of the flight

KSC PERSONNEL GROWTH

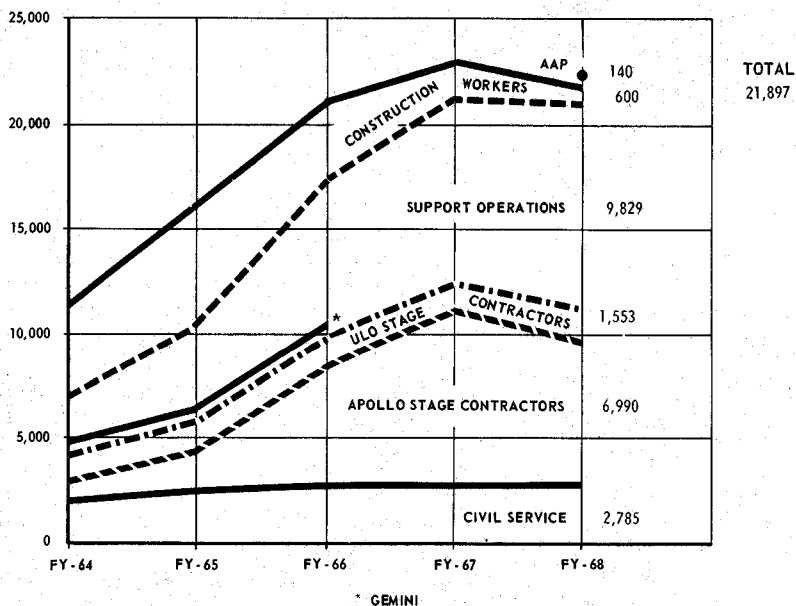


FIGURE C-3

hardware itself. Flight hardware is handled entirely by the unmanned launch operation stage contractors or the Apollo stage contractors. You will notice that the peak in total KSC personnel is reached in the 6 months immediately ahead of us. In the budget year ahead of us we do expect a slight tapering off in the numbers of people that are actually needed to prepare the Apollo flight hardware.

On the other hand, support operations will have a slight increase, rounding out the organization at about 9,800 people. This slight increase will occur because of the fact that the full array of facilities for complex 39 will come into operation only when pad B becomes operational.

I have also prepared as a matter of information figure C-4, which lists the various companies supporting these operations: the vehicle contractors, the space contractors on Apollo, the array of contractors for the Unmanned Program, and the support contractors who provide total support for this whole operation. All are located here in Florida with the exception of Unitec, which is a small supporting contractor out on the Western Test Range. It supports the unmanned launch operations conducted from that launch site.

It is apparent from looking at this growth that the Kennedy Space Center in the past 5 years has made major moves to build up a Government-industry team rather than develop a Government-operated organization in its entirety. This is in accordance with a basic NASA policy for accomplishing the space program. Excluding the construction workers, the ratio in 1964 was about two civil service people to

every three contractors. It is now at a ratio of 1 to 7, and will probably remain there through 1968. So it follows that the way Kennedy Space Center and the contractors work together becomes a very important element in whether we are successful in achieving our goals.

I would like to show a chart which will attempt to summarize four of the main concepts in our contractor relationships (fig. C-5). The first concept is that each stage and each support contractor is held responsible for performance of a specific mission. His contract definitely prescribes a scope, or scopes, of activity for which he, as an industrial organization, is expected to produce a satisfactory result. The question of whether this performance is satisfactory, of course,

KSC STAGE & SUPPORT CONTRACTORS END OF FY 68

APOLLO PROGRAM					
VEHICLE STAGE CONTRACTOR		MANPOWER	UNMANNED	MANPOWER	MANPOWER
CHRYSLER	685	LMSD - AGENA	299	AAP	140
DOUGLAS	532	GDC - AGENA	205		
BOEING	2,322	BURROUGHS - AGENA	23	SUPPORTING OPERATIONS	
NORTH AMERICAN	540	GE - AGENA	45		
IBM	747	WECO - DELTA	54	*LTV	740
		AEROJET - DELTA	7	*TWA	2,939
SPACECRAFT CONTRACTOR		ROCKETDYNE - DELTA	3	UNITEX	30
		DOUGLAS - DELTA	343	BENDIX	2,609
		GDC - CENTAUR	240	*RCA	574
		HONEYWELL - CENTAUR	3	*FEC	1,060
NORTH AMERICAN	924	WECO - DELTA / AGENA	60	GE	1,270
GRUMMAN	1,000	ROCKETDYNE - DELTA / AGENA	14	*DOW / BECHTEL	607
MIT	10	TRW - SUSTAINING ENG.	18		
AC ELECTRONICS	45	UNM - SUSTAINING ENG.	28	TOTAL	9,829
KOLLSMAN	6	JPL - SURVEYOR	33		
RAYTHEON	13	HUGHES - SURVEYOR	33	GRAND TOTAL	18,562
LIN	204	BOEING - LUNAR ORBITER	60		
INTERNATIONAL LATEX	6	GE - BIOSATELLITE	85		
HAMILTON STANDARD					
TOTAL	7,040	TOTAL	1,553	*SUBJECT TO RECOMPETITION IN FY 67	

FIGURE C-4

KSC-CONTRACTOR RELATIONSHIPS

1. EACH STAGE AND SUPPORT CONTRACTOR HELD RESPONSIBLE FOR PERFORMANCE OF A SPECIFIED MISSION.
2. GOVERNMENT RESPONSIBLE FOR INTEGRATING THE TOTAL MISSION, INCLUDING MONITORING, AND REDIRECTING THE CONTRACTOR'S EFFORTS WHERE APPROPRIATE.
3. KSC EVALUATES CONTRACTOR PERFORMANCE AGAINST INCENTIVE OR AWARD FEE TARGETS.
4. KSC'S OFFICIAL INTERFACES WITH THE CONTRACTOR ARE KEPT TO THE MINIMUM AND CLEARLY SPECIFIED BY DELEGATIONS FROM THE KSC CONTRACTING OFFICER.

FIGURE C-5

depends upon how well the contractor responds to specific requirements that have been laid upon him by the Kennedy Space Center organization.

The second point is that the Government remains responsible, and must be accountable, for integrating the total mission, pulling together the efforts of a variety of contractors. This includes monitoring and redirecting the contractors' efforts wherever appropriate.

Third, these present contractors are operating with KSC on the basis of an award fee return. Their profit from the operation is dependent upon satisfactory performance which is measured and evaluated by the Kennedy Space Center people against certain incentive targets or award fee targets.

You have heard in your discussions with other NASA Centers, or you soon will hear, about their progress in installing incentives in their flight hardware contracts. Our Center took the lead in developing methods of handling award fee concepts for service support contractors. We do this by a series of periodic evaluations. At the present time the awards are made quarterly. They are preceded by monthly feedbacks between KSC civil service monitors and the contractors so that the contractor knows every month how he is standing in terms of doing things that are laid out as priority items. Narratives and numeric scores are pulled together on a quarterly basis and formulated into a report which the line operators must defend before a senior awards board appointed by Dr. Debus. The board makes recommendations to the Center director, who then determines the fee.

In the case of the stage contracts, we do not have much experience yet with the KSC stage contract supplements that have been negotiated covering the actual launch services work of the stage contractors down here. With the exception of the Chrysler Saturn I-B contract, all of the Saturn I-B and V contracts have now been renegotiated with specific incentives built into them. Milestones have been established for scheduled accomplishments which they expected to do within certain cost, time, and quality targets. We judge their performance against these. On a semiannual basis the stage contractor will be given an award fee based on how well he has accomplished the milestones. Again, the Center director will be the final authority on the extent of that fee.

We are asked the question, of course, whether all this emphasis on incentives is worthwhile in terms of getting the job done better.

As of today, our overall assessment is that this has been a successful and useful management device. As our organizations were learning how to integrate the needs of contractors, it has been particularly helpful in getting them to do their best work in our environment rather than retaining methods used back in their factory plant. The incentive awards process requires, to be successful, a tremendous amount of communications between us and the contractors. That in itself, is time consuming. But I think, on balance, we very much needed that kind of communication in the first instance in learning how to work together. This has been a useful exercise, but we do feel that in the future, now that we have learned how to work together, we should be able to accomplish these awards with less overall time tied up in the

paperwork in making these evaluations than was necessary during the initial period. At least, we are trying to simplify that process.

Now, the fourth and last concept on this chart states that the Kennedy Space Center deliberately keeps the number of interfaces with the contractors down to a minimum, and, to assure this, we have specified exactly what are the delegations of authority for each individual who interfaces with the contractor.

There are four main types of interface, or working chains for management action (figure C-6). Each is covered by formal written delegations which emanate from the top procurement officer.

He is the contracting official and the formal representative of the Government in committing the Government to any activity undertaken by the contractor. He, therefore, is responsible for issuing all formal directions and all scope changes. Putting additional money on the contract, assigning additional work requirements, or directing the preparation of additional reports—all these are the responsibility of the top contracting officer.

However, these are highly technical contracts, and an understanding of what is actually required for accomplishment must come from the key line officials—the technical engineers. For each contract we designate a contract technical manager who is the senior line official in the actual operations. He develops and approves technical plans. He issues operational instructions to the contractor on his own initiative, providing they are within the scope of the contract and provided he keeps the contracting officer advised. He also has the major technical responsibility for evaluating the overall technical performance of the

PRINCIPAL KSC INTERFACES WITH THE CONTRACTOR

<u>TITLE</u>	<u>DUTIES</u>
CONTRACTING OFFICER (TOP PROCUREMENT AUTHORITY)	ISSUES ALL FORMAL DIRECTIONS AND SCOPE CHANGES
CONTRACT TECHNICAL MANAGER (KEY LINE OFFICIAL)	DEVELOPS/APPROVES TECHNICAL PLANS ISSUES OPERATIONAL INSTRUCTIONS WITHIN SCOPE EVALUATES OVERALL PERFORMANCE
TECHNICAL REPRESENTATIVES (SENIOR TECHNICAL SPECIALISTS)	FOR A MAJOR FUNCTIONAL AREA: IDENTIFIES SPECIFIC WORK REQUIREMENTS ISSUES WORK REQUESTS WITHIN SCOPE MONITORS END RESULTS
CONTRACT MANAGEMENT ASSISTANCE OFFICER (STAFF AIDE IN EACH OPERATING DIRECTORATE)	COORDINATES CONTRACT RESOURCES CONSOLIDATES AND PREPARES AWARD FEE PERFORMANCE REPORTS REPRESENTS DIRECTORATE IN CONTRACT NEGOTIATIONS (ISSUES NO DIRECTIVES TO CONTRACTOR)

FIGURE C-6

contract, while the contracting officer evaluates the business management compliance of the contract.

However, the contract technical manager cannot do the job unassisted. Several technical representatives are designated basically one for each major functional area within the contract. The "tech rep" is responsible for identifying specific requirements, issuing work requests, provided they are within the contract scope, and monitoring the end result.

We have recently introduced one other participant—a contract management assistance officer. He is a staff aid to the operating directorate. He coordinates resource problems, consolidates the preparation of performance evaluations for the award fee process, and represents the directorate contract negotiations. Note, however, he does not have authority to issue any instructions or obligatory actions upon the contractor. Those go through the contracting officer.

The chart does not show all the people who talk to the contractors. It is apparent that, in the kind of technical activity we are in, an operating director—for example, the head of launch operations, Mr. Petrone, or the Apollo program manager, Mr. Shinkle—must have the opportunity for direct communication with the senior industrial leadership on these contracts. They do discuss policies and program requirements directly with the key company managers, but I want to emphasize that anything that is placed upon the contractor's mission goes through the formal contracting officer channels that are shown here.

My last chart deals with the recompetition of major support service contracts (fig. C-7). We have listed the present KSC contracts over

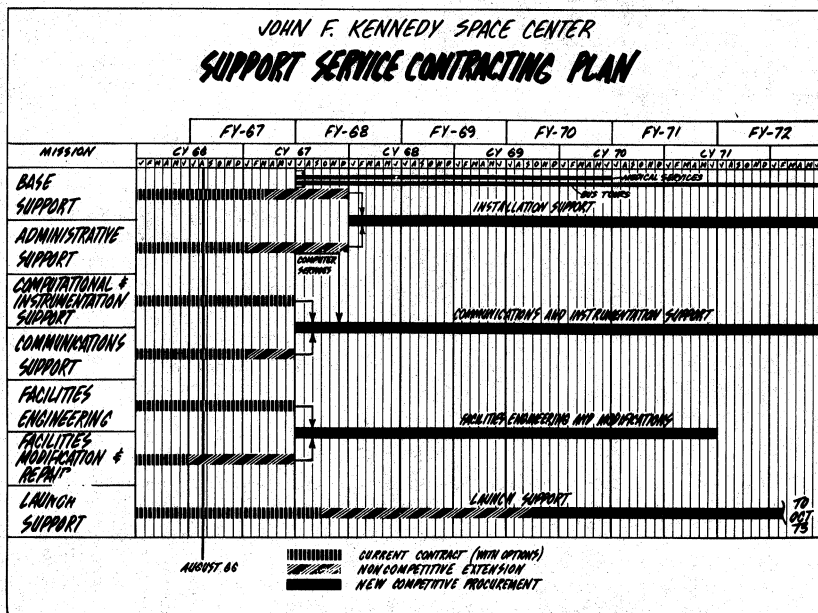


FIGURE C-7

here in the left column and have charted the expiration of the current contracts. In some cases, certain contracts are being extended beyond the original time in order to synchronize them with other contracts. In solid bars is shown the proposed period for the new contracts which will be awarded.

As a matter of history, when this Center put together its contractor structure for the first time, the NASA Headquarters authorized original contracts—the ones shown on the left here—for periods not in excess of 3 years. There was intense competition for this business at the time. As a result, KSC obtained extremely favorable arrangements, offered by the successful contractors, on their organizational structure, their overhead costs, minimum staffing, high quality performance, and a very reasonable competitive fee scale.

In anticipation of that kind of experience, NASA made crystal clear at the start to all proposers, including those who later won these awards, that they would definitely be recompeted at the expiration of the original contract. Now, our challenge here has been to build a Government/industry team which accepts that policy and goes ahead to develop new procurements and lays plans for a possible succession of any or all of these present contractors with a minimum of handicap to our going operations.

That has not been easy, but we believe we have gone a long way to minimize the difficulties.

Let me illustrate how we have proceeded. The Kennedy Space Center is particularly concerned with a situation where it might have to change contractors right in the midst of our most critical launch phase of the Apollo/Saturn program. We could not afford to have the launch support contractor, who works in the most intimate association with the launch assembly team, be changed to a newcomer right at the time we have finally shaken down our operational launch procedures. As a result, NASA has authorized us to extend this contract for 2 years. It will go out for recompetition in fiscal year 1970.

In the other cases, though, the original contracts were all expiring at least a year earlier than the one for launch support services. KSC made a decision that it would be better to put these contracts under recompetition now rather than later. As a result, these have been extended only far enough to time-phase certain of the contracts with others which, under present guidelines from NASA, are being coordinated or put together in a larger package—that is, with fewer contracts.

There are three sets of two contracts each which are being combined in a recompetition into larger packages.

These combinations will permit us to have the contractor management deal with only one major element of the KSC organization. It complicates the organization structure of a contractor if he must work for a variety of contract technical managers throughout the Government's organization. The communications and instrumentation support contract, for instance, will now be handled by one directorate, the technical support office. Base operations and administrative support, which today are TWA contracts and the Ling-Temco-Vought contracts respectively, are to be combined within one installation con-

tract. It will be administered by only a single KSC element, the installation support people.

One activity which is now in the LTV contract has been transferred and combined in our information systems directorate under the technical support operations of Mr. R. Clark. This function is automatic data processing (ADP) which, for efficiency, has been consolidated with scientific computation.

Facilities engineering, which is a design support function, and facilities modifications or repair, which is a quick-response-repair-on-the-pad type of function, are being combined. This requires extending the Bechtel contract out to June 1967, when the Dow contract on facilities engineering also expires. Putting this together in a single package will give a single manageable package. It will be administered by our design engineering directorate under Mr. Preston. This package has been on the market since last December. Proposals arrived in the middle of February—seven proposals—and are under evaluation right now. The other recompetitions are in preparation and proposal requests will be ready to go out in time to meet the award dates shown on the chart.

Note that two new lines have been added on the top of the chart showing the KSC support service contracting plan (fig. C-7).

Although it is NASA policy to consolidate service contracts wherever practicable, decisions have been made that two parts of the present TWA scope will be put into separate contracts. One is medical services, or occupational health, where NASA on the basis of its experience with industrial medicine programs in a variety of NASA field centers has determined they can attract the highest grade of competition in that area by confining the proposal just to the medical program. Accordingly, a specialized contract will be awarded as a separate procurement.

We have also pulled out the public tours program from this group. During the initial year of the tours, Trans-World Airlines has been handling this activity as an added part of its base operations contract. That activity will be a separate competition because we have now enough experience with public tours to believe that they can be handled on a concessionaire contract and not on a cost reimbursement contract.

Thank you, Mr. Chairman. Does the committee have any questions?

Mr. WAGGONER. You were talking about not wanting to be caught short in some critical period in the area of launch support. Say that NASA has authorized you to extend on a noncompetitive basis the services for the present contractor up until the last part of calendar year 1969, or well into fiscal year 1970; how do you stand as a result of the possible Apollo schedule revision? Is it likely that you are going to have to go back to NASA again and ask for authority to continue in a noncompetitive way with the present contractor and his personnel?

Mr. STEPERT. I have no judgment whether that will be necessary later. You are quite right that this question must be faced, but sometime after we know what the revised launch schedule is. However, we accepted these extensions for planning purposes and definitely expect to go ahead with them unless a later launch schedule makes that obviously an unwise thing. We do not now have any judgment on that.

Mr. WAGGONNER. Won't the next 60 to 90 days be critical there in making these decisions about revising your plans?

Mr. SIEPERT. Well, I don't know whether the next 60 to 90 days will give us the answer to this question, but we have time to make that kind of a decision. To give you an idea of a leadtime, we will need 8 or 9 months to implement the kind of decision to which you refer. I am putting in the necessary leadtime to do all the work of getting out proposals, evaluating them, and awarding the contract.

Mr. WAGGONNER. In consolidating your operations—for example, combining instrumentation support and communication support—and abandoning the idea of noncompetitive extension of contracts and going to competitive awards from this point on, by what are you going to be guided in awarding these contracts, other than dollars and cents? Is this going to be just a perfunctory operation on the part of NASA, or are you going to become so enamored with those here that it would be useless for somebody else to bid?

Mr. SIEPERT. I think that is a central question.

Mr. WAGGONNER. You know your judgments are going to be based on what the people in the field think about them. Are the people in the field saying, "We are not going to be able to get rid of the people now like you"?

Mr. SIEPERT. I don't think that will be the judgment of all the people. Some of our people will feel very strongly, through experience, that some of the present contractors are, in a sense, irreplaceable.

On the other hand, what has happened in the last 3 years is a tremendous sophistication by a number of contractors in doing the work of supporting aerospace operations. Initially, when we went on competition 3 years ago, we had some preconceived ideas of how many companies could actually bring to bear the sort of specialized experience we are after. We were greatly surprised. Certain of the contractors who won the award were ones we had never envisioned were in the field. Yet they put together the kind of technical and business proposal that was clearly superior to that of the companies who presumably were the established competition. From this earlier experience, we can't make a prejudgment that the existing contractors will have superior proposals to those who enter the competition from the outside.

Mr. WAGGONNER. You are going to consider something other than money?

Mr. SIEPERT. We must.

Mr. WAGGONNER. You say that in consolidating the support service contractors in different areas, you want no more than one interface between the Kennedy Space Center personnel and these contractors where you consolidate the different areas—Communications and Instrumentations, for example. Are you going to allow these present contractors, who supposedly have ability in only one area, to consolidate and, in effect, stay on the job? Is this perhaps big enough to be representative in the consolidated area?

Mr. SIEPERT. All of our procurement proposals in this field will leave to the discretion of the proposers whether they propose as a prime without any subs, whether they come in with a joint venture, or whether they come in as a prime with certain subcontractors under

them. All we require is that their proposal demonstrate that KSC will not be dealing, if it is a joint venture, with two different companies. We have to deal with a single responsible agent to get this job done. The answer to your question is, Yes, we are quite prepared to accept joint ventures.

Mr. PRESTON. To answer the point you have made regarding two contractors, where two contractors have their work combined into one new contract, we will have to change one of them at least.

Mr. WAGGONNER. What did the record show in the way of unsatisfactory performance by any contractor of any size? Who did you start with that you dropped because he couldn't cut the mustard?

Mr. SIEPERT. We have not dropped any contractor because he couldn't cut the mustard. However, we have had growing pains and substantial learning curves.

Mr. WAGGONNER. How do you relate that answer to my first question about becoming enamored with the people you started out with, all staying on the job because their performance was good?

Dr. DEBUS. From the very beginning these were incentive award contracts. Some of these will have almost no fee if their performance is only satisfactory. From the very first procurement process, these contractors were aware that we were asking for top management and top performance, and evaluation is only between satisfactory and excellent. Continued nonsatisfactory performance would have led to termination of the contract. So, we have had better than satisfactory or satisfactory performance. We were quite pleased with this incentive award scheme.

I don't believe that one could say our people have become enamored with these contractors. We are satisfied, but this does not mean that there cannot be better proposals and they will be evaluated by the best objective means.

As to your question about people staying on the job, I believe that whoever would be successful in competing against one of the existing contractors would count on taking over quite a number of people living here who would be phased to a new contractor.

Mr. WAGGONNER. I think that period of transition is the key to it. It seems impossible to me, in spite of the argument I advanced or the question I raised, that you can take an integral contractor and move him and his people out and move new people in.

Mr. SIEPERT. We have, in most of these cases, made specifications to all the proposers that, if a new contractor should win the award, he needs to plan on a 60-day startup time while the other contractor management is involved in a 60-day tapering-off time. We have an overlap to that extent.

Our procurement proposals make clear that we expect anyone proposing on this business to take into maximum account the utilization of local talent that is already here.

We don't mean to say that there will not be transition problems, but we think they are quite manageable.

Mr. WAGGONNER. You commented that you were quite successful and fortunate with the contractors and the quality of the personnel that they supplied here at the Center for you to do business with, and I think that is fine. But all the charts and everything that you had

to say to this point, show we have been fairly level in the administrative cost—not administrative cost, but in personnel numbers. If I read correctly the charts you have shown, there has been a disproportionate increase in administrative cost as related to the number of personnel—both contractors and civilian—that you have had, and I think this is reflected on some of your earlier graphs. Now, you come along and propose in the area of support service contracting that you are consolidating on a competitive basis in some of the areas with an idea that, when you consolidate some of the support services, you should have to deal with no more than one man and just have one NASA man to interface with. How is this going to affect your administrative costs? Measurably? Or insignificantly?

The trend points to administrative costs even though you said you now have a ratio of 1 to 7, whereas you once had 2 to 3. I think your administrative cost figure is \$99 million here this year as compared 2 years ago to \$83 million. How do you account for that?

Mr. SIEPERT. I should have defined our terminology better. The "Administrative operations" appropriation is used to pay all the civil service people. That pays for the total technical competence of the Government, not its administrative competence alone. The AO funds pay for that too, but we need to keep in mind that over 40 percent of our total manpower consists of highly trained engineers. They are not doing administrative work. They are the heart of the technical operation that integrates the contractors' missions.

Mr. WAGGONER. Classified as administrative personnel?

Mr. SIEPERT. They are classified as AST, that is, aerospace technologists—space engineers. Now, on the contractors side we described a large group called support operations. The great bulk of those people are not doing administrative work. They are performing direct technical or operational functions that are needed in order for us to carry out our launch activity here.

Mr. WAGGONER. I know that the trend affects the operation cost, but what part is overtime playing for administrative personnel in those administrative costs?

Mr. SIEPERT. Overtime is a special problem. Once KSC gets the impact of a schedule change down here, the question is whether or not we can get the flight hardware assembled, checked out, and launched in the agreed time. Overtime money is tight in the present budget, but its availability can make the difference.

Mr. WAGGONER. On the basis of what was said, it was planned to shorten from 6 weeks to about a month that time at the pad to be ready for launch. Now, have you been able to shorten that?

Mr. PETRONE. We expect to be learning. It would be our first launch off pad A. As you go into subsequent operations, you should—and we expect them to—proceed smoother and faster. That would not be reduced by overtime operations.

Mr. SIEPERT. In Launch Operations, for example, what is your overtime at the present time?

Mr. PETRONE. Of course, it varies. You might say it varies week by week. We average 10 or 11 percent.

Mr. SIEPERT. It has been higher than that, hasn't it?

Mr. PETRONE. We have been up to 20 percent.

Mr. SIEPERT. If I could move over to an administrative area, the Office of Administration, what is your overtime in the present terms of administration?

Mr. VAN STADEN. I would say something on the order of 3 to 4 percent on an overall.

Mr. SIEPERT. And within installation support?

Mr. PARKER. Two percent.

Mr. SIEPERT. The procurement overtime load runs a little higher because of the current urgency in preparing the service contract competitions.

Mr. WAGGONER. The increases are not in the administrative area, but in the operational performance areas.

You had two graphs prior to this which had to do with the incentive contract and evaluation of incentive contracts. Somehow, for the first time, I got the faint impression that there was a new ingredient in this incentive formula that I wasn't aware of before. That is, every contractor is judged, and his overall award is based upon evaluations or a compiling of what all the Centers have to say about what that man's performance was, is that right?

Mr. SIEPERT. I am sorry that I left that false impression. I think I can clear it up.

The evaluations that are made here by this Center are based upon an evaluation of the work entirely by Kennedy Space Center people and not by inputs from other centers.

Mr. WAGGONER. On that part of the contract which is actually done here?

Mr. SIEPERT. Yes. For instance, Marshall has contracts with Chrysler, Douglas, IBM, North American, and Boeing for their development of Saturn stages; Marshall incentivizes each contract. There is a negotiated formula under which Boeing's fee is determined by how well it does its job for Huntsville. We have separate supplemental contracts for their launch services down here. The technical performance of everything they do down here is judged in accordance with the criteria set up here by the KSC launch operations people and not by Huntsville.

Mr. WAGGONER. I have one other question about overtime and being able to do things better in reducing this period from 6 weeks to 4 weeks out at the pad. You said you hoped that you could reduce significantly the number of personnel and the time and cost involved in evaluating these incentive contracts. Could you tell me now how many people are actually involved at Kennedy Space Center in evaluating the contracts on the incentive basis?

Mr. SIEPERT. No, I can't, but I would be glad to compile that (compilation attached). Let me illustrate an example. We had on one contract as many as 24 different people who were making narrative and numerical score evaluations of the work of a contractor. I should note here that these numbers will include not only the immediate senior managers for the contracts but also the other officials who devote only part of their time to such evaluations. And, of course, there are many other technical systems specialists in our civil service ranks who provide factual information to these senior managers as a part of their normal operating functions.

Number of people involved in award fee evaluation exclusive of board

TWA -----	41	Douglas -----	11
LTV -----	21	IBM -----	13
Bendix -----	14	NAA -----	10
RCA -----	9	Boeing -----	16
FEC -----	20		
Chrysler -----	17	Total -----	172

Mr. WAGGONNER. A single contractor?

Mr. SIEPERT. Practically all of these were technical representatives—Kennedy Space Center top specialists—in each of these subfunctions. We now feel the number can be abbreviated, because the people above that level are sufficiently close to the functions of a contractor to provide evaluations of equal or superior objectivity. This means evaluations from as few as, let's say, six or seven rather than the two dozen.

Now, the two dozen technical representatives are still monitoring the contractor and are still giving information up the line in terms of how the contractor is doing, but they are not engaged in the formal written evaluation process.

Mr. WAGGONNER. The only thing you are saying is, you have gotten better at that game?

Mr. SIEPERT. Yes, we have learned, and I think the contractor has very much appreciated our efforts to focus the evaluation higher in our organization rather than lower.

The CHAIRMAN. Why not two or one contract instead of four?

Mr. SIEPERT. That's a hard question. There is no magic number in saying "four" versus "five." For the benefit of some of the members of the committee who have not visited here before, we ought to answer this historically.

At the time this Center was getting underway in 1963, we made a study of how many supporting service contracts there should be on our Merritt Island installation. We studied four possible ways to get our job done. One was to have no support contractors of our own, but just go to the Air Force Eastern Test Range and utilize their prime contractor, Pan American. The second one was for us to have our own separate contract with Pan American. The third was to do it all with civil service. And the fourth was to do it with a series of specialized contractors. I am going back 4 years. Our people first reached the conclusion that they wanted to work with a wide variety of specialized contractors. I recall that the desired number initially was as many as 12 or 15. We actually obtained approval to work with six. It turned out to be seven, as you see here. The negotiations with NASA Headquarters really rested on the question of whether the Center, if it had fewer contracts, would be able to handle the monitoring and direction of the total effort with less overall increase in the civil service. The burden of evidence was that we could economize if we dealt with fewer contractors, but we could not answer then that seven would be better than six or eight. The basic management question there is whether or not you have to cross organizational lines within the Center in order to deal effectively with a contractor.

My personal appraisal, Mr. Teague, would be that if we had only two contractors at the Kennedy Space Center, we would have more organizational problems than if we had three or four.

The CHAIRMAN. Is your philosophy different from that of Huntsville and Houston? They had 26 supporting contractors—one for each laboratory.

Mr. SIEPERT. If they had 26 at MSFC, they had more than one for each laboratory.

The CHAIRMAN. They have 26 now.

Mr. SIEPERT. I don't know their current situation. However, their main operational structure for the kind of work they are doing is the laboratory. They were obliged to get out of the situation where two or three companies were serving the same laboratory, so they competed for one contract in each major laboratory area.

The CHAIRMAN. What would be the cost to offer a proposal for this competition?

Mr. SIEPERT. May I refer that to Mr. Lohse, our new procurement officer?

Mr. LOHSE. From \$50,000 to \$80,000.

The CHAIRMAN. This Commission would be interested in seeing your costs of operations go down as a result of this, but I bet it will go up.

Dr. DEBUS. If you reduce the comparison to a unit of workload, I don't believe so. The workload is supposed to go up, and it will go up until it reaches a level. The total cost will go up, but the cost per unit worked and the cost of overhead should stay the same or go down.

Mr. SIEPERT. If, in your offer to bet, you excluded the inflationary costs, which we cannot control, this would be an interesting thing for us to track and later report to the committee.

Mr. CLARK. We are trying to relieve the competition pressure for people now on existing contracts, whoever they might be—for instance, the communications and the instrumentation contracts. They really use about the same types of skill. We found, for example, present contractors were competing for the same man. We wanted to pool the same types of skill under a single contractor.

Mr. SIEPERT. This offers better utilization of every man.

The CHAIRMAN. You have had a real good operation.

Mr. WAGGONER. How could you remove competition for people without removing, to some extent, the competition of the man who oversees those people—the contractor? Does it follow that a little of that spills over?

Mr. CLARK. It could very well.

Mr. WAGGONER. You have to make the contractor secure to remove the competition of the people, and in making him secure you are ignoring competition to a certain extent.

Mr. GURNEY. When did you make your basic decision to go from seven groups to four groups?

Mr. SIEPERT. Let's see. The basic decision was made before the end of the last fiscal year.

Mr. LOHSE. It started in December of 1965.

Mr. SIEPERT. We were asked to study the problems beginning in December 1965, and our proposal for implementation was completed during the summer. The proposal has been changed, timewise, only by the decision here to extend these two contracts, TWA and LTV, by another 6 months.

This occurred for two reasons: We, at Kennedy, were worried about our ability to mount three concurrent major source evaluations at the

same time. Now, when I say "source evaluations," what I mean is we cannot do an objective job of really looking at these proposals—and some of the proposals are more than 1 foot thick—without pulling out of the line many of our very best people to do this kind of evaluation. This often becomes a continuous, full-time, closed-door assignment. It is almost like convening a grand jury.

Under such circumstances, they are real limitations as to how many source evaluations you can handle well. We were worried about doing this in the same time scale.

The other factor we were concerned with is that this is a very large contract in terms of the amount of money involved. The level of Fiscal Year 1968 administrative operations funds directly affects this contract. It was our feeling that we would be better off if the scope of that contract during this period were negotiated with a better knowledge of what might be the actual funding level in the budget. We have gained some time to remove that uncertainty.

Mr. GURNEY. Did the idea of reducing this from seven to four come from you or from Washington?

Mr. SIEPERT. It came from Washington.

Mr. GURNEY. You made no suggestion or proposal that the mode of operation be changed?

Mr. SIEPERT. This is not exactly what we proposed, but, given the guidelines that we were asked to consider, this is the Kennedy Space Center proposal. In other words, our Center assumes total responsibility for the particular combination of contractors.

Mr. GURNEY. You did not initiate the idea of changing the mode of operation?

Mr. SIEPERT. To fewer contractors; no, sir.

Mr. GURNEY. What were the reasons given when you were instructed to do this study?

Mr. SIEPERT. As resources for the total space program had become more and more stabilized, and the cost requirements have, in fact, been increasing, NASA has been under a great self-initiated pressure to make its dollars go further. Headquarters analysis of service support contracts was that field centers can get overall economies and a more economical response from a contractor if the packages are in larger chunks.

Mr. GURNEY. How long have you had experience with the seven contractors?

Mr. SIEPERT. Three years.

Mr. GURNEY. How many did you have before that?

Mr. SIEPERT. Well, we didn't have these contracts, Mr. Gurney, because we weren't operating a facility of our own. You see, we were entirely at the Cape as tenants of the Air Force, and, therefore, the people doing this kind of work for us were contractors of the Air Force. So, I can't answer your question.

Mr. GURNEY. The seven-plan is really your plan, initiated when you started operating your own Space Center?

Mr. SIEPERT. Yes, sir; but it is again the result of agreements reached after guidelines and negotiations were signed off by NASA in Washington.

Mr. GURNEY. One other question touched on before. I asked how long you had been operating under the seven plan to find out whether you have a little concern about the morale problem of your personnel as well as whether your personnel are going to shop around for other jobs when they know these contracts are up for bid?

Obviously, some are not going to be retained by the new man, and, as far as they are concerned, maybe none of them will be. There has been such experience down here.

Mr. SIEPERT. I am sure there is some unrest on this point among the local employees. Our own studies of this, however, show that there is very little movement in and out of the community when contracts change hands.

For example, contractors on the stage site, as you know, leave the Cape when the Air Force contracts have been finished. Yet the personnel do not, by and large, leave the area, because they are, due to their experience, readily hired by the new contractor.

Mr. GURNEY. Those have been a little different. When those people came onboard, they knew the contract was going to end at a certain time. This is somewhat different.

Dr. DEBUS. They were renewable options each year up to a maximum of 3 years.

Mr. SIEPERT. Most of these contracts have a period of time which is renewable 1 year at a time in order to preserve the Government's ability to terminate for convenience or unsatisfactory performance.

Mr. WAGGONER. You said that you had 3 years of experience in the support contractor area of dealing in seven areas. Isn't it a fact that the 3 years of experience had its start at the time of the separation of Marshall and Kennedy?

Dr. DEBUS. These started with the activation of the new area. In the old area at Cape Kennedy we were still relying on the Air Force—the Eastern Test Range, specifically. Our support was by Air Force contractors—Pan American and its subcontractor, RCA. When we started to activate this area, we needed a similar type support, and we assessed this in two ways.

As you may recall, the mission contractors at the Eastern Test Range were really Air Force personnel and contractors to the Systems Division. The Eastern Test Range was operating with Pan American and RCA, and this support is still given to us at Cape Kennedy.

However, we did not conclude that it would be in the best interest of the Government for the civilian space agency, the landlord of the new Merritt Island facilities, to make the Air Force its executive agent by extending the Air Force contract into this area.

Another possibility was to do it all by adding large numbers of civil service personnel. All factors considered, the most practicable way was to develop a NASA team of civil servants and mission contractors. It seemed likely that some of the best specialization in the country lay with industrial contractors—color photography, for example. We want to bring to bear the best knowledge in color photography and keep it up to date as this technology increases and improves. Costs may go down and new processes may develop, so we want to have a contractor who is right at the pulse of this technology and can bring it to bear in our area. The same is true in other support areas.

We wanted industrial capability from the company to help support and manage this area. We feel now that the specialization of four or five is adequate to bring this concept to bear.

Mr. GURNEY. One other point now. The initiation of the study of this change of operation, as you say, came from NASA Headquarters in Washington. Then you made a study, and you came up with this idea. The reason for the change of operation, as I understand, was for economy.

Just exactly what economies do you propose to get out of this change in operation? What fewer men are you going to use on your side? How do you think the contractor operations will be improved, either in fewer men or basic cost economies?

Mr. SIEPERT. We do not predict fewer men on either side of this interface in fiscal year 1968. We do not think it is practical to expect a net decrease, because the workload imposed on both the civil service and the contractors during this period of time is greatly in excess of what we estimated in our early planning. This job has a complexity for which we, frankly, did not fully plan, that is, the kind of manpower requirements involved.

In terms of greater efficiency for the men that we have, we look forward confidently to being able to show even better utilization. However, the NASA Headquarters position with respect to the consolidation should not be oversimplified to rest on this point alone. The committee may wish to have in its report the actual statement by headquarters as to why it approved the consolidation support plan.

The Manned Space Flight Office was requested by NASA general management to come up with an overall set of guidelines to implement service support contracts. Their final proposal, which was approved by Dr. Seamans on April 1, 1966, had the following paragraph on the question of consolidation:

The policy of consolidation into a few large service support contracts is based on several basic management principles. In general, it reduces the total of contractor management personnel required for administration, reduces interface problems, allows cross training and cross utilization in some instances, and causes less administrative effort to NASA. These advantages are obtained principally if the tasks are grouped into similar types of work, since wide and diverse tasks under one contract tend to dilute the gains achieved by consolidation. However, the management simplicity warrants consideration of consolidation in any case.

Mr. GURNEY. Actually, your manpower projection, at least for the Center, doesn't reflect that there is going to be any change in numbers, does it? I mean, you have leveled off last year and assigned the method. This is exactly the level you plan to continue for some time, is it not?

Mr. SIEPERT. That is correct. The statement here with respect to less manpower was with respect to administrative manpower to manage the contracts and report the costs and the like for both Government and industry.

There is no discussion here that you would be able to save, really, the end product technical manpower necessary to do the job. In our case, that's where the workload is increasing steadily.

Mr. GURNEY. I don't know whether the plan is good or not. It may be a better operation administratively, but certainly it doesn't seem to indicate economy here as the principal object as was stated in the beginning.

Mr. SIEPERT. We do not have an a priori case of being able to prove economy in the absence of having a new contractor on board—

Dr. DEBUS (interposing). There's a hidden economy, Mr. Gurney. Inasmuch as those people who are now engaged—technically highly qualified technicians—can free some of their time to be applied to the technical systems, management and operation, and can be freed from the administrative and paperwork procedures, we gain manpower. It will not show in numbers, but it will show in the technical talent we can apply totally to our basic management, and this is very badly and sorely needed.

Mr. GURNEY. I understand that. That was my concept of efficiency. That's all.

The CHAIRMAN. Al, you people have been working these studies for years. You know just exactly which company does a good job, and you can probably take a pencil right now and list the degrees of efficiency of the existing contracts.

Suppose one of these companies that is less efficient spends \$100,000 in writing up their proposal, and the efficient one spends \$50,000—we are told over and over, more and more, that the companies have all the good men writing proposals and the second-rate men doing the work. How are you going to decide this when you get down to the stack of stuff I have seen about this high (indicating)? Who is going to go through 500 or 600 pages of detailed statistics and whatnot?

Mr. SIEPERT. A Source Evaluation Board of Kennedy Space Center people which will also include—

The CHAIRMAN (interposing). And you know these companies. How are you going to decide?

Mr. SIEPERT. We do not know which one is better in a competition for the same piece of business. We know how good that contractor was on a particular contract that he had. Let's take one as a case in point. You have RCA doing communications, and you have Federal Electric doing instrumentation. Federal Electric also has extensive communication capabilities. They are in that line of business. However, KSC has not had any actual experience with FEC in that area. The question of which of these contractors, if they should choose to compete against each other, would have the best proposal would be based on the Source Evaluation Board's appraisal of the content within that proposal. This would be supplemented by, and checked against, any information that we could obtain on how this contractor had done similar work for other governmental customers. We are not dependent only upon personal information concerning a contractor's work with KSC or with NASA.

So, the Source Evaluation Board can and should approach its task without a preconceived notion that the proposal is unimportant compared to the known experience of the company with KSC business. The proposal is very critical in the competition. And that is why American industry puts its good people on it, just as you say.

Mr. GURNEY. What about this concept? Have you thought of this? I mean, ordinarily when the person is doing a particular job, like one of those seven, and is competent, he learns how to do this job better as time goes on, and becomes more efficient. That's the human way things work. However, instead of putting it out for competitive bid every

3 years, or instead of this new arrangement of consolidating seven to four, had you ever thought of using your incentive fee arrangement for you and the contractor to work out another deal, another extension that would save you money or get you better efficiency based on the prior experience that you and the contractor had in this job?

Mr. SIEPERT. We have considered this. We are implementing the idea that you raised in a little different fashion. These new contracts with the incentive fee arrangement in them will place considerably greater emphasis on the contractor's actual ability to measure up and to meet preagreed cost targets.

In other words, this will be a significant factor in his profit return.

Mr. GURNEY. Well, the point I make there, Al, is, would it not be possibly better to use that arrangement than this great mass of paperwork, the rearrangements, and all the rest of the redtape to put this new plan into action?

Dr. DEBUS. Are you asking whether it should be largely noncompetitive procurement?

Mr. GURNEY. What I am saying is this: We all believe—all of us on this committee—that once you have gone through a competition such as you have here, and you have a pretty good, fairly well organized, and streamlined operation, as you have said—seven as opposed to four—it isn't, obviously, a tremendous amount of change here; I simply say that your incentive fee business with the persons on the job, and doing it now, might be a substitute to preserve the competitive arrangement so that you can get the best bargain and also the best efficiency.

Mr. WAGGONER. If you follow that attitude all the way through the cycle, from the time it begins at NASA until somebody pays off the last subcontractor down the line, ultimately you won't have a new man doing the business. There won't be anybody for him to supply. He will be foreclosed. There won't be any way for a man to establish a new business and break that hiring circle.

Mr. SIEPERT. I think NASA is merely, in this situation, Mr. Gurney, being consistent with its original commitment to American industry. In effect, it said: We are endorsing competition for NASA procurements as a basic policy matter, and we are going to recompute not only because we believe that's in the overall Government interest, but also because we want this to be a basic incentive for the one who wins the contract the first time. Then he knows he must be trying all the time to improve his performance posture.

We have instances where we have been impressed that our support contractors, rather than move ahead and spend money authorized in the contract, have come up with ways where it didn't need to be done. The contractor has chosen not to staff up to that peak yet, although, contractually speaking, he had authority as a mission contractor to move. You do not expect that kind of response from a contractor who believes he is locked in and assured noncompetitive extensions for his services.

Mr. GURNEY. I can understand that.

Dr. DEBUS. A learning curve element, I think, is retained, because we negotiate every year. Any experience we make over that year

can be brought to bear within the total time the contract is completed. We do that every year when the time comes to renegotiate.

Mr. WINN. Mr. Chairman.

The CHAIRMAN. Yes, Mr. Winn.

Mr. WINN. May I ask a question for my own information? Changing the subject a little bit, are these contractors still paying—at least, I have always been of the opinion that they have been paying premium wages for their type of labor—premium, meaning much higher than in most other places in the country. Am I wrong in that?

Mr. SIEPERT. I do not believe that is the correct perception of the support contractors we have been discussing. You may be referring to two other kinds of situations. One in particular got publicity several years ago. That was the wages earned by construction workers of the building trades who were engaged in modifying and building launch pads; things like unusual portal-to-portal pay and premium wages for hazardous work and the like. This was looked into quite carefully by Senator McClellan's committee. That type of craft labor is not involved in these supporting service contracts.

Another possibility to which you may be referring is that a number of the aerospace manufacturers, when they brought their flight hardware down here to be tested and flown, came with the idea that they were actually not going to be a permanent part of the Cape community. They paid a sort of isolated-duty-station premium that is sometimes called swamp pay. Some still do. In all of our contracts with those stage contractors we are attempting to get such pay eliminated, because we now know the people who come here do stay and make their homes.

Mr. Lohse, are there any that still have that? Which ones?

Mr. LOHSE. Boeing and Douglas still have it.

Mr. SIEPERT. None of our support contracts.

Mr. WINN. Is this so-called swamp pay union pressure on these men?

Mr. LOHSE. It is pay to both groups. It is about 50 cents an hour in the union categories, and some of the stage contractors are nonunion, and it's about ninety to a hundred dollars a month in the managerial levels. It's a joint problem which NASA has with DOD and this is currently being explored at the headquarters level.

Mr. WINN. How can we get rid of it?

Mr. LOHSE. DOD and NASA are trying to bring pressure down on the corporate managements involved. This is no longer an isolated area. In some instances, they brought enough pressure to correct it. Lockheed, on the other hand, just incorporated a \$0.40 to \$0.50 per hour increase in their basic rate structure and labeled it a "test base" rate. They did drop swamp pay for salaried employees. There is no easy solution to it.

Mr. WINN. It would seem to me that after 3 or 4 years of operation some of those costs could be renegotiated or just plain thrown out, and that this thing should have leveled off as the rest of your charts show.

We keep talking about economies, and I think this committee wants to start seeing in this operation and Government operations, too, some type of economy.

Mr. LOHSE. It is locked into the union agreements, some of which have 2 or 3 years to run—long-term labor contracts.

Mr. SIEPERT. The best guarantee of working on this situation, really, is the competitive world. This was not true in an earlier period of time. There were once only a few contractors that really knew this aerospace business, and now there is hardly a single piece of business about which you can say any one company really has a technical pre-eminence in the field. The idea of being able to make a sole source justification, in lieu of competitive justification in areas like this, would just be a very difficult thing to establish.

Mr. WINN. Going back to Mr. Gurney's question, basically, the competitive system is possibly how you can arrive at some economies in the program. Do you have any other ideas on where you can arrive at some economies?

Mr. SIEPERT. Yes; we believe so. I would rather not amplify my answer beyond that. The competitive situation, plus the necessity to negotiate with these companies each year as they go along, makes for a clean-cut, preagreed work program; we have to agree on what is the minimum amount of staffing required to do the jobs as we lay them out. We believe that our new contractors will seek to become and remain efficient in an environment of competition.

Mr. WINN. I think you are right to a certain extent, except when you automatically extend the contract like you did in one, two, three, or four cases, if I am reading your chart right. You don't renegotiate by extension, do you?

Mr. SIEPERT. There was a specific negotiation as to what the levels would be for this period of extension. Our only reason for doing that, sir, was to get one contract synchronized with another.

Mr. WINN. I understood that; but I didn't realize you renegotiated.

Mr. SIEPERT. Each period of operation has a specific cost determination.

Mr. SHINKLE. Gentlemen, I would like to begin my portion of the hearings by taking a closer look at the KSC organization chart (figure D-1) and defining the relationship between my office, that of the Apollo program manager, and the KSC line organizations, which were previously discussed.

Generally speaking, this office provides appropriate assignments, guidelines, and resources, so that those charged with the execution of specific aspects of the overall Apollo program move effectively to get the total job done. Specifically, my office translates general and specific program requirements and schedules received from the OMSF Program Director and the other MSF centers into discrete packages, which we forward to line organizations for preparation of detailed plans to meet such requirements.

After we receive, validate, and coordinate such plans of execution as prepared and priced by the line executive, my office then analyzes these plans against total program needs and available resources, taking appropriate action to assure that these are kept in balance. Upon approval and funding, such plans become a directive for execution by the line organization.

In carrying out our mission, we have the inherent responsibility of establishing all program schedules and are specifically concerned with

JOHN F. KENNEDY SPACE CENTER, NASA

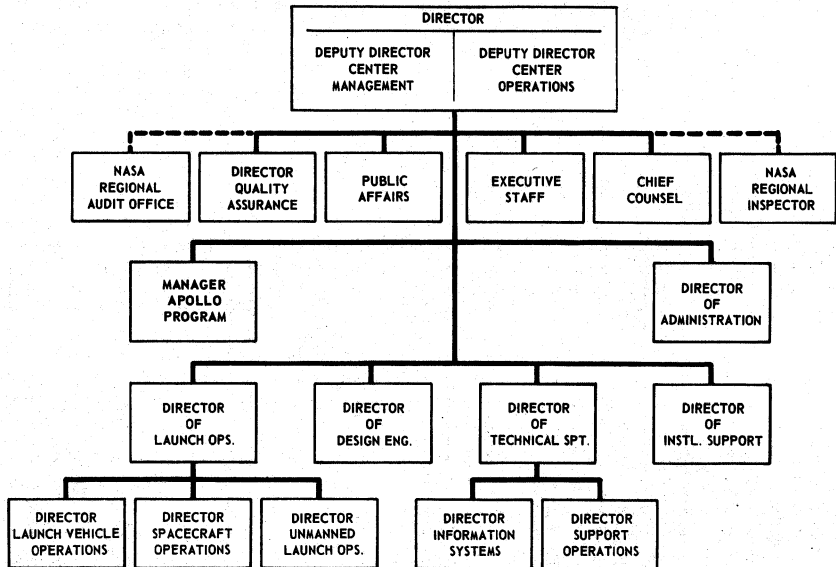


FIGURE D-1.—Kennedy Space Center organization chart.

the effect of problems arising from late delivery, installation work-around times, and other schedule or cost impacts.

Everything within the Apollo program which is executed at the time of launch has its focal point here at KSC (fig. D-2). All the various stages, modules, materials, and hardware from other cognizant NASA Centers converge here. We then use a series of contractors to assemble and checkout this hardware and perform the launch operations at the proper time. Our objective is to perform a quality service; that is, a launch at the proper time within the cost allocated in accomplishing the program.

Activities at KSC call for a service to be performed, as opposed to a physical product being delivered. Hence, we cannot easily draw upon the experiences of other centers in developing and implementing incentives and controls.

The problem is compounded when you consider the number of contractors that interface with each other and are interdependent in meeting schedules (fig. D-3). The contractor's ability to meet their schedules within cost is not solely within each contractor's own capability. Varying delivery and launch dates, unpredictable modification requirements, and limited statistical history useful to predict Saturn V launch operation requirements add to this problem.

In this chart (fig. D-4) we have identified in brief terms the functions of each contractor. Some of these stage contracts are launch operations supplements to MSFC contracts, while others are the responsibility of KSC. In the Boeing and Chrysler contracts we have added functions where it was to the Government's advantage to do so. We do not have quite the same responsibilities delegated to us from

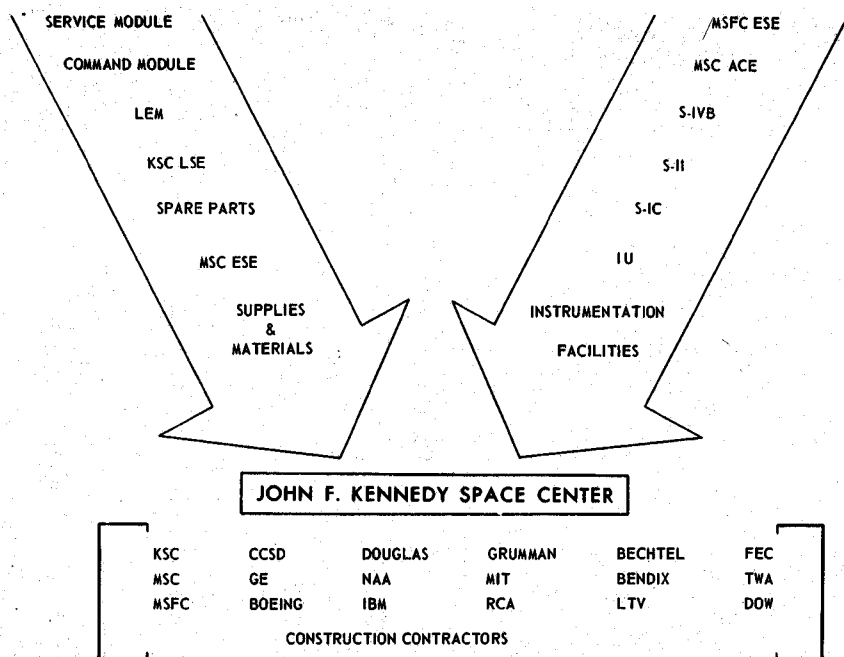


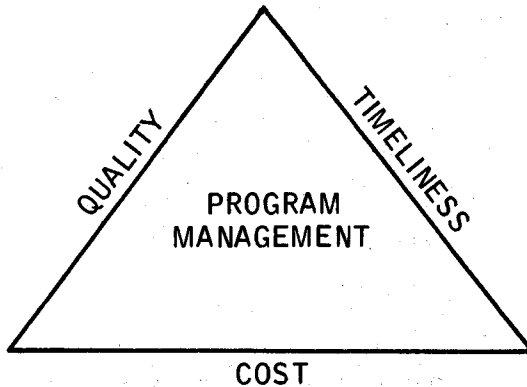
FIGURE D-2.—Apollo impact at KSC.

MSC for the spacecraft contracts such as Grumman and NAA. Instead of having official contractual responsibility, we have secondary delegation for technical direction. The support contractors are the sole responsibility of KSC. The Apollo R. & D. manpower posture chart (fig. D-5) represents statistically the contractor and civil service personnel allocated to the Apollo program for fiscal year 1967. The contractors are identified according to their respective effort, such as spacecraft, uprated Saturn I, Saturn V, and launch support. You will notice that only 10 percent of the total manpower allocation is civil service personnel. These personnel act as the prime contractor here at KSC to coordinate the activities of this entire group of contractors. The Apollo R. & D. program represents approximately 67 percent of the total manpower at KSC. Unmanned launch operations accounts for approximately 7.5 percent and administrative operations for the remaining 25.5 percent.

Allow me to point out that the AO budget pays for all these civil service personnel plus their overtime, transportation, telephone calls, and the operation of those contractors who perform printing and reproduction services and the base housekeeping services.

Our stage contractor manpower level (fig. D-6) is shown for fiscal years 1967, 1968, and 1969. This chart shows personnel working on the uprated Saturn I, Saturn V, and spacecraft programs, respectively. We are fully operational on the uprated Saturn I program and are moving well into the Saturn V program. Notice that the uprated

KSC's CONTRACTOR PROBLEMS IN MEETING GOALS



FLUCTUATING MANPOWER REQUIREMENTS RESULTING FROM INTERFACES WITH OTHER CONTRACTORS

VARYING LAUNCH SCHEDULES AND AS A RESULT, VARYING MILESTONE DATES

UNPREDICTABLE MODIFICATION REQUIREMENTS

LIMITED STATISTICAL HISTORY

FIGURE D-3

Saturn I program terminates in fiscal year 1969. The Saturn V and spacecraft contractor manpower curves are parallel, peaking about middle fiscal year 1968 and then decreasing.

The support contractor manpower chart (fig. D-7) represents the cumulative total of all our R. & D. support contractor personnel of FEC, Dow, RCA, Bechtel, and GE. Consistent with the recompetition as discussed by Mr. Siepert, Dow-Bechtel and FEC-RCA are represented by the facilities support contractor and the communications/instrumentation support contractor, respectively, in fiscal year 1968 and fiscal year 1969. You will notice that our support requirements increase until middle fiscal year 1969 because we are entering an operational phase which increases until that time.

This funding summary chart (fig. D-8) is a rather dramatic illustration of the transitional phase occurring at KSC. It illustrates C of F and corresponding R. & D. costs from fiscal year 1963 through fiscal year 1968.

KSC APOLLO CONTRACTORS & FUNCTION

STAGE

BOEING	PREPARE, CHECKOUT AND LAUNCH THE S-IC STAGE; OPERATE, MAINTAIN AND PROVIDE DESIGN SUPPORT FOR COMMON MECHANICAL GSE; INTEGRATE LAUNCH VEHICLE INPUTS FOR LAUNCH AND MISSION RULES DOCUMENTS AND INTEGRATED TEST PROCEDURES; PERFORM OTHER RELATED LAUNCH SERVICES
CHRYSLER	PREPARE, CHECKOUT AND LAUNCH THE S-IB STAGE; OPERATE, MAINTAIN AND PROVIDE DESIGN SUPPORT FOR COMMON MECHANICAL GSE; INTEGRATE LAUNCH VEHICLE INPUTS FOR LAUNCH AND MISSION RULES DOCUMENTS AND INTEGRATE TEST PROCEDURES; PERFORM OTHER RELATED LAUNCH SERVICES
DOUGLAS	PREPARE, CHECKOUT AND LAUNCH THE S-IV STAGE AND PERFORM OTHER RELATED LAUNCH SERVICES
IBM	PREPARE, CHECKOUT AND LAUNCH THE I.U. STAGE; OPERATE AND MAINTAIN COMMON SATURN V LAUNCH VEHICLE ELECTRICAL GSE; PERFORM OTHER RELATED LAUNCH SERVICES
NAA (S-II)	PREPARE, CHECKOUT AND LAUNCH THE S-II STAGE AND PERFORM OTHER RELATED LAUNCH SERVICES
NAA (S/C)	PREPARE, CHECKOUT AND LAUNCH THE APOLLO CSM. PROVIDE INTEGRATED PLANNING FOR GSE SITE ACTIVATION IN SPACECRAFT INDUSTRIAL AREA AND THE LAUNCH COMPLEXES. OPERATE AND MAINTAIN SPACECRAFT GSE. PROVIDE INPUTS FOR LAUNCH AND MISSION RULES DOCUMENTS AND INTEGRATED TEST PROCEDURES.
GRUMMAN	PREPARE, CHECKOUT AND LAUNCH THE APOLLO LUNAR MODULE (LM). PROVIDE PLANNING FOR GSE SITE ACTIVATION IN THE SPACECRAFT INDUSTRIAL AREA AND THE LAUNCH COMPLEXES. PROVIDE, OPERATE AND MAINTAIN SPACECRAFT GSE. PROVIDE INPUTS FOR LAUNCH AND MISSION RULES DOCUMENTS AND INTEGRATED TEST PROCEDURES.

FIGURE D-4

KSC APOLLO CONTRACTORS & FUNCTION (CONT.)

SUPPORT

BENDIX	MAINTAIN AND OPERATE MAJOR FACILITIES ON COMPLEXES AND IN INDUSTRIAL AREA
BECHTEL	SPECIAL MAINTENANCE AND MODIFICATIONS
DOW	FACILITIES ENGINEERING SUPPORT SERVICES
GE	GENERAL ENGINEERING AND FABRICATION SUPPORT
FEC	OPERATE, MAINTAIN, INSTALL AND REPAIR INSTRUMENTATION EQUIPMENT
RCA	PLAN, OPERATE, AND MAINTENANCE OF COMMUNICATIONS

FIGURE D-4A

KSC APOLLO R&D MANPOWER POSTURE FY-67

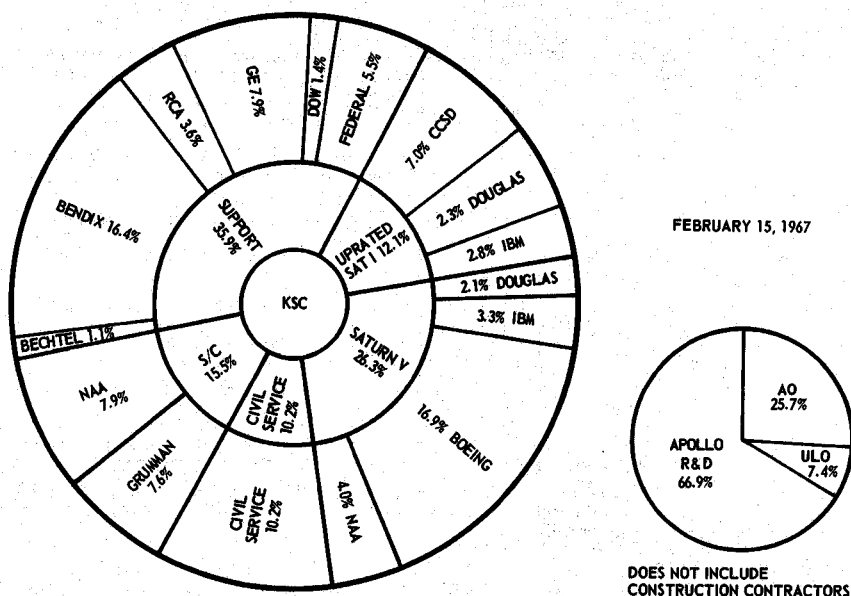


FIGURE D-5

You can see that starting in 1963 we were spending large sums of money to bring our facilities such as launch complex 39, which you shall see, into being. As construction of facilities nears completion or is completed, our operational costs increase as indicated by the growth in the R. & D. budget from \$10 million to a fiscal year 1968 request of \$228.5 million. I would like to point out that, although the costs in fiscal years 1966, 1967, and 1968 are quite small in the C of F, in actual fact we had about \$100 million not under contract at the end of fiscal year 1966.

This chart (fig. D-9) represents a breakdown of the R. & D. funding, the R. & D. portion of the summary chart. We have taken the liberty of correlating it with the major segments of our program such as the Saturn I phaseout into the uprated Saturn I project, Saturn V, launch support operations, launch instrumentation, and spacecraft operations. Spacecraft operations was a field operation transferred to us from the Houston organization in 1963. The fiscal year 1968 funds are a request on the part of KSC from NASA Headquarters and represent a growth in the R. & D. budget because we are moving into the operational facets. For exactly the reason our C of F budget has come down from its peak of \$332 million, the R. & D. budget has gone up as we phase out site activation.

In order to give you an idea of how much money will actually be spent here, I have added two other things. I have added MSFC costs because they budget for a certain part of the work done in these areas by their contractors here, so that, although the money is spent here, it

KSC APOLLO
STAGE AND SPACECRAFT
CONTRACTOR MANPOWER POP 67-1

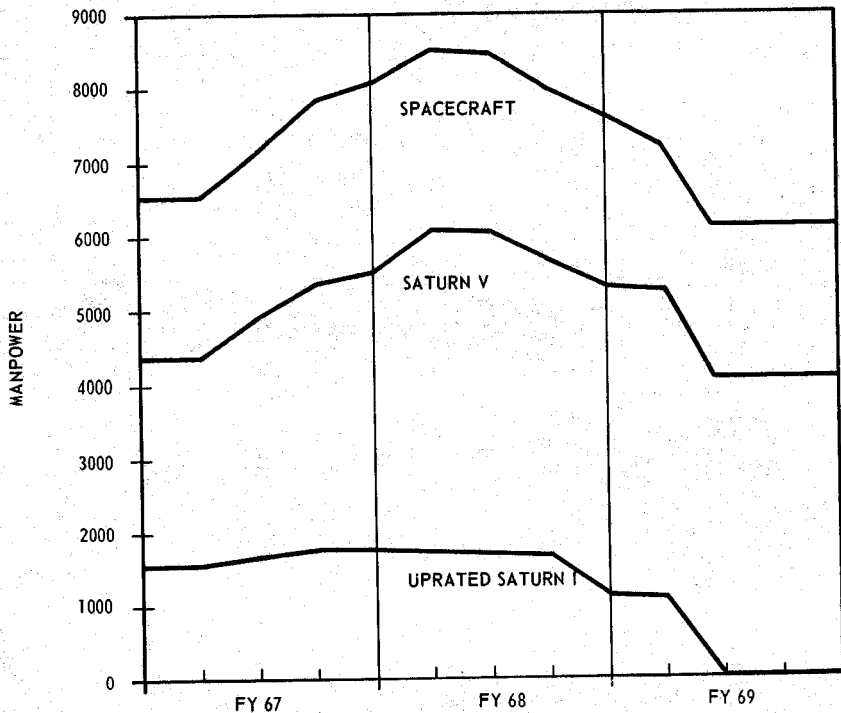


FIGURE D-6

doesn't appear in our budget. The same is true with the MSFC total. This is an estimate, and it was shown on some of the charts used by Dr. Debus earlier.

Continuing our discussion of KSC budgets, this Apollo C of F funding summary (fig. D-10) highlights how we have spent and intend to spend our money in the C of F area. The main thing it shows is the dramatic falloff of the money allocated to us after the fiscal year 1965 and prior year funding of \$830 million.

This chart (fig. D-11) is the detail of the largest single construction that we have here, launch complex 39. You will see that this afternoon. Starting in fiscal year 1963 we had money allotted to us as illustrated on this chart. At that time we projected a cost run-out on LC-39 at less than \$500 million. We are going to meet that goal. As you can see, the planned obligations run out to approximately \$490 million. The obligation curve shows the various component items during the construction period.

The chart (fig. D-12) illustrates the C. of F. procured plant value of KSC planned through fiscal year 1970. You can see it increases to approximately \$890 million. This is an indication of the scope of

KSC-APOLLO SUPPORT CONTRACTOR MANPOWER (R & D)

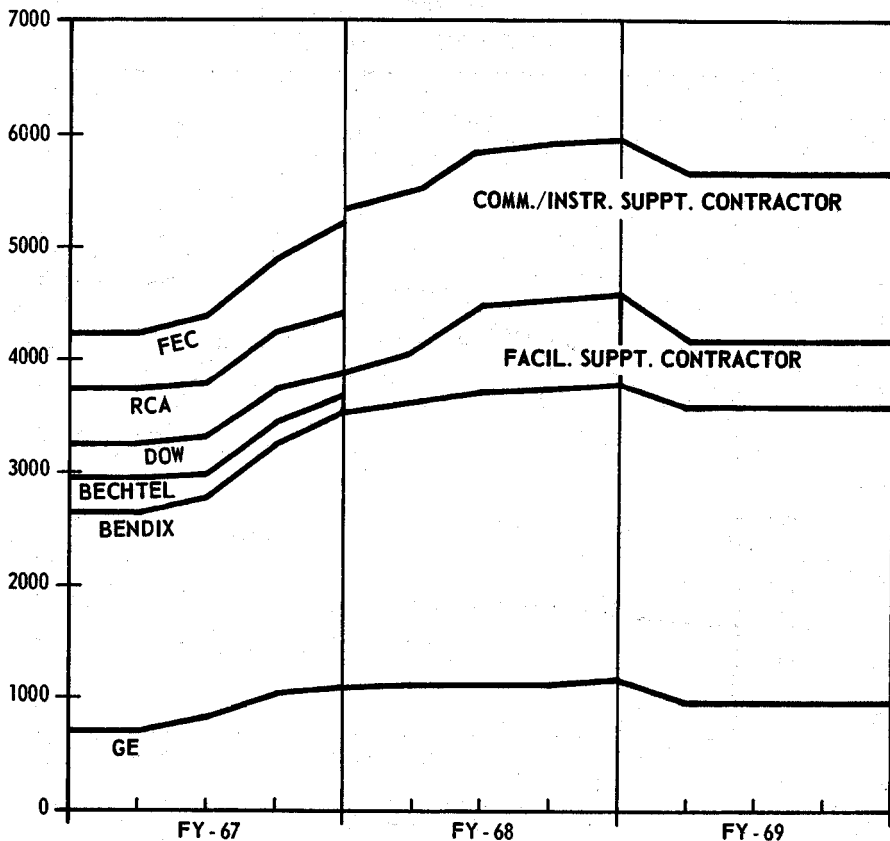


FIGURE D-7

work that KSC must manage. This plan, which has been under activation and is almost complete today, will continue to require considerable effort for day-to-day operations and maintenance.

To pictorially illustrate some of the major items contributing to our plan value, I would like to show you some before and after photographs of our facilities.

These photographs represent the KSC industrial area as it appeared in 1963 (fig. D-13) and as it appears today (fig. D-14). As a reference point this is the KSC Headquarters building.

Figure D-15 is a photograph of the vehicle assembly building in 1963 and figure D-16 as it is today. You will be visiting this facility later today.

And finally here (fig. D-17) is launch complex 39, pad A, as it appeared in its early construction stages in 1964. Figure D-18 is an aerial view of the same launch pad with the 500 F vehicle in place. I believe you saw that milestone, Mr. Chairman.

APOLLO R & D AND C OF F FUNDING SUMMARY

FY 63 THRU FY 68

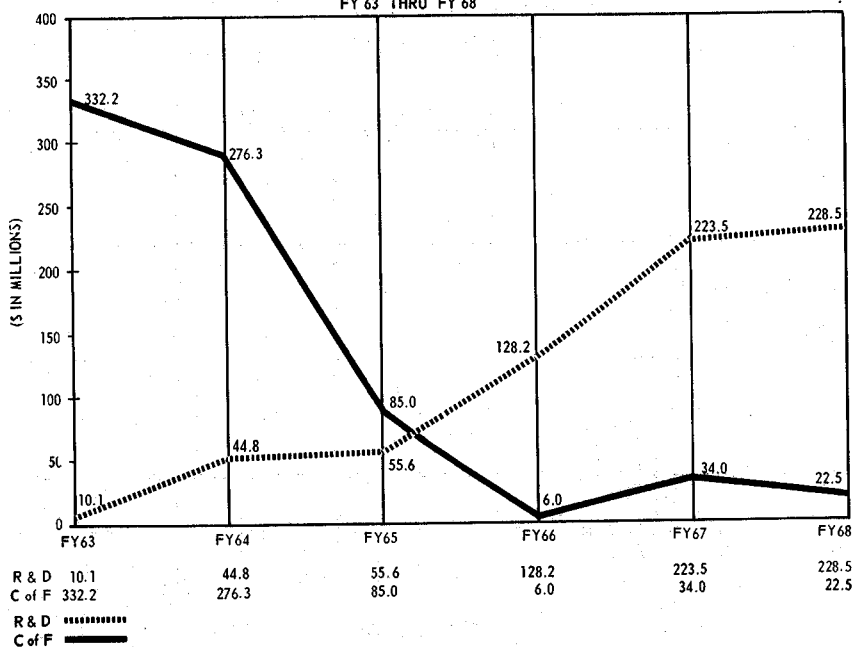


FIGURE D-8

KSC APOLLO RESEARCH & DEVELOPMENT PROJECT

FUNDING SUMMARY

(DOLLARS IN MILLIONS)

KSC

	FY-65 & PRIOR	FY-66	FY-67	FY-68
SATURN I	13.2	—	—	—
UPRATED SATURN I	13.5	25.8	36.8	26.3
SATURN V	21.8	28.4	83.8	88.8
LSO/LAUNCH INST.	64.3	65.6	92.6	100.7
SUP. DEVELOPMENT	1.9	1.1	1.3	2.5
S/C OPNS	—	7.3	9.0	10.2
KSC TOTAL	114.7	128.2	223.5	228.5

MSFC

	FY-65 & PRIOR	FY-66	FY-67	FY-68
SATURN I	14.0	—	—	—
UPRATED SATURN I	1.0	2.0	21.7	21.2
SATURN V	1.4	4.3	40.3	48.5
MSFC TOTAL	16.4	6.3	62.0	69.7

MSC

	FY-65 & PRIOR	FY-66	FY-67	FY-68
MSC TOTAL	18.4	22.5	49.6	44.3
TOTAL ALL CENTERS	149.5	157.0	335.1	342.5

FIGURE D-9

1968 NASA AUTHORIZATION

KSC APOLLO C OF F
FUNDING SUMMARY
(DOLLARS IN MILLIONS)

	FY-65 & PRIOR	FY-66	FY-67	FY-68
LC-39	443.756	-0-	29,500	16,660
LC-34/37	97.859	-0-	-0-	5,725
OTHER	288.547	6.030	4.521	.210
TOTAL	830.162	6.030	34.021	22.595

FIGURE D-10

LAUNCH COMPLEX 39 COST RUNOUT

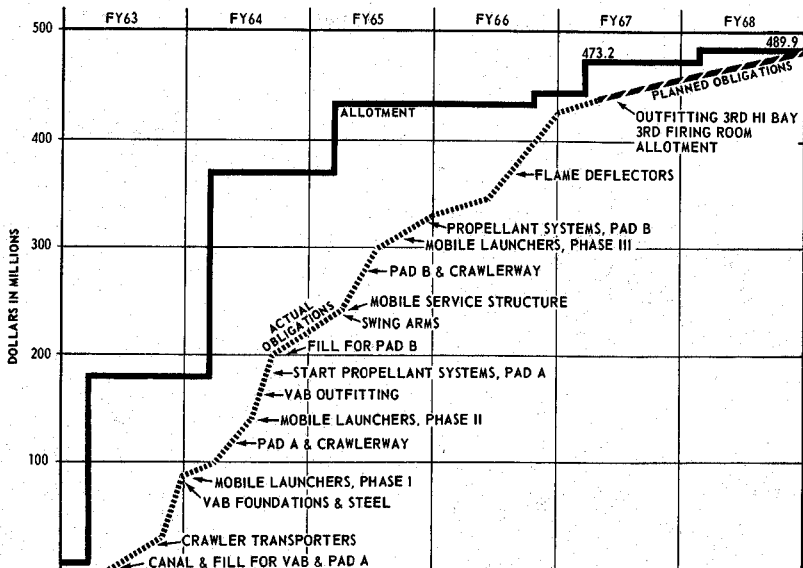


FIGURE D-11

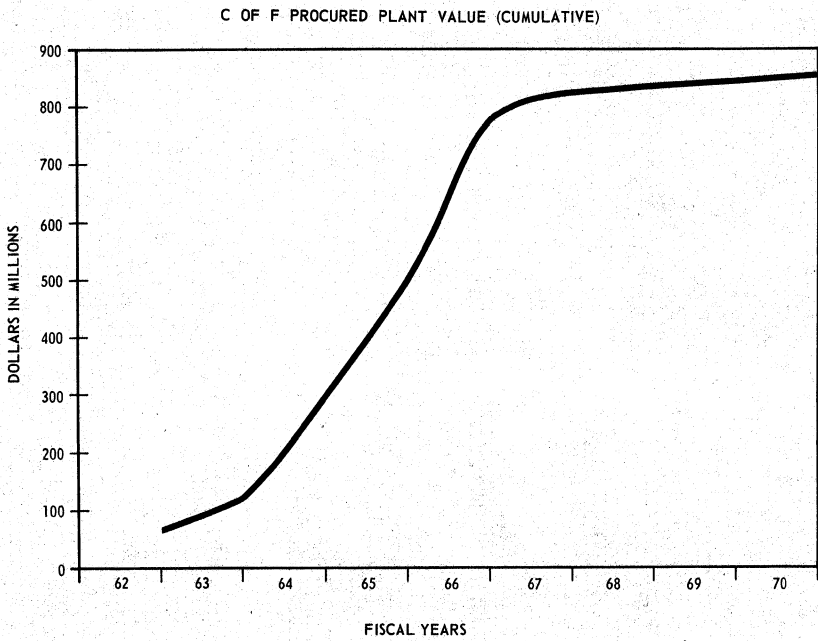


FIGURE 12-D



FIGURE D-13.—KSC industrial area in 1963.

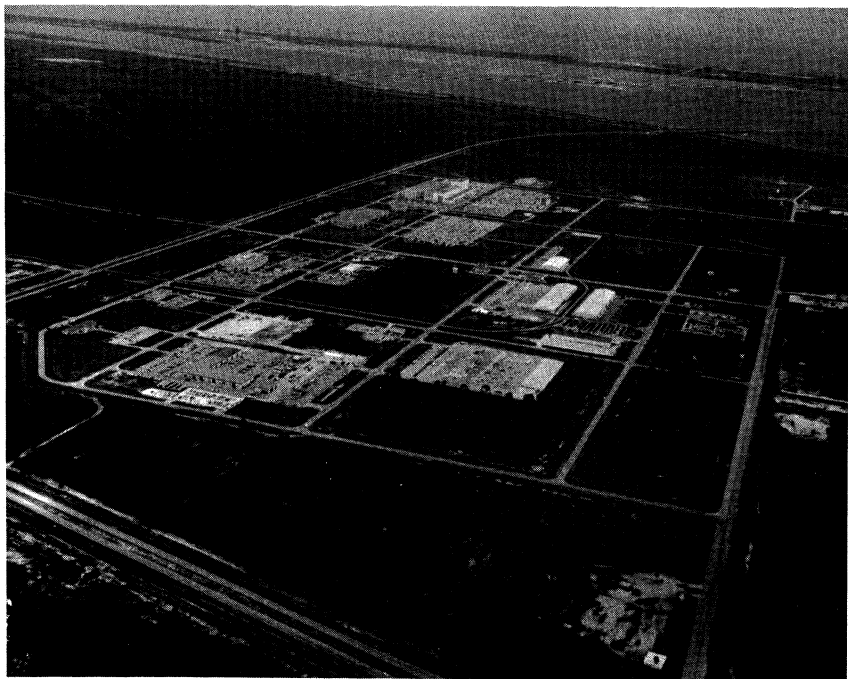


FIGURE D-14.—KSC industrial area in 1967.



FIGURE D-15.—Vehicle assembly building in 1963.

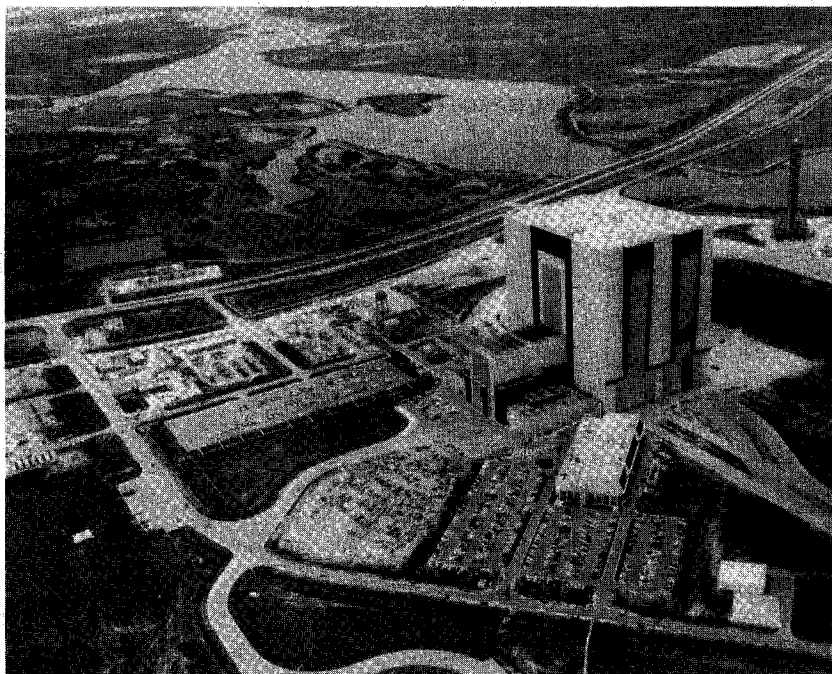


FIGURE D-16.—Vehicle assembly building in 1967.

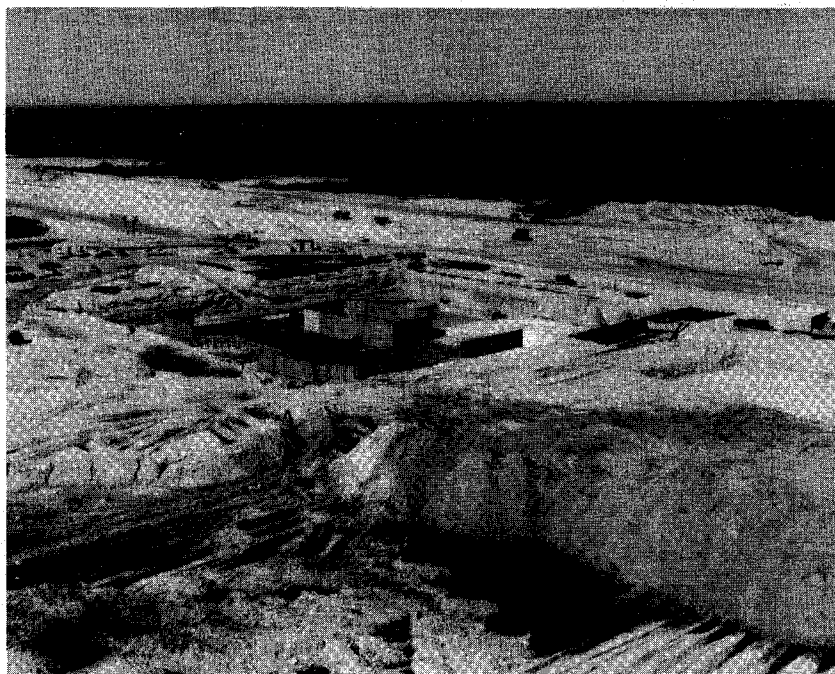


FIGURE D-17.—Launch complex 39, pad A in 1964.



FIGURE D-18.—Launch complex 39D with vehicle 500 F in place.

Over the past year, we have had some troubles, and here is an event which I thought would be of interest to you. Figure D-19 is the liquid oxygen storage tank at pad A. This drawing (fig. D-20) will be used to illustrate the operations of this facility and the problem that occurred. The lox tank is a large tank, as you can see. The outlet pipe is located as shown in the figure. It has an outlet out to the pads, through the T joint and by the redundant lines.

These two pumps, each capable of 10,000 gallons flow per minute, serve the two outlet lines. From the T the line goes in this direction through a manual valve, through an automatic valve, which could be actuated remotely, then through the pump and up to the pad.

At the time the accident occurred, this particular line (fig. D-21) was being used. What happened was that suddenly this pipe broke as shown. An analysis showed the following series of events to have occurred: (1) The manual valve was opened and then the automatic valve started to open by remote control; (2) as the second valve started to open, gas against the face of the valve came through very quickly; (3) suddenly the gas was followed by a wall of liquid oxygen which impinged on the valve element opening against the flow of liquid, and the forces were such that it broke the pipe; and (4) the section at the flexible connection broke, as you can see.

A point that I would like to make is that the operation just described is, in fact, an R. & D. effort. The flow of liquid oxygen through this pipe is 10,000 gallons a minute. Nobody has done that before. We



FIGURE D-19.—Liquid oxygen storage tank at launch complex 39, pad A.

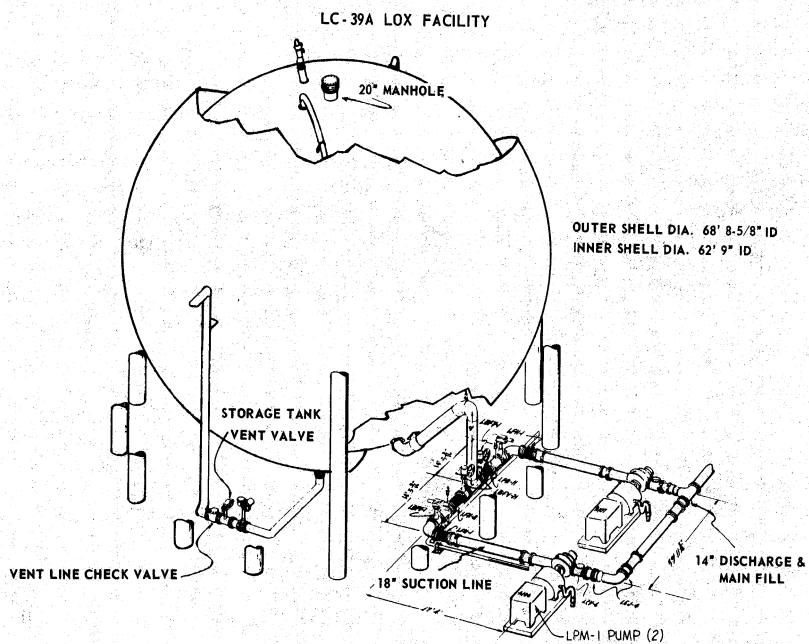


FIGURE D-20

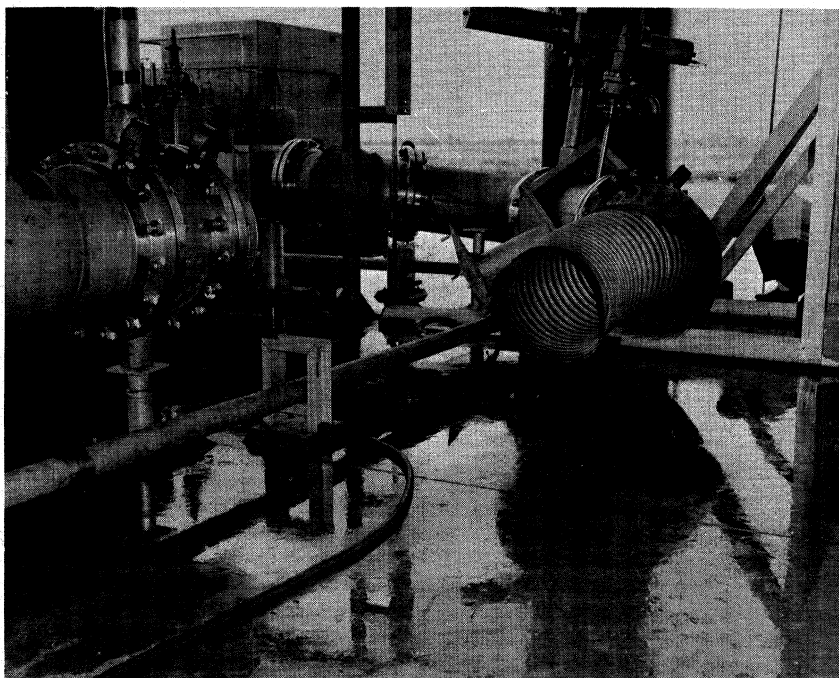


FIGURE D-21.—Liquid oxygen line failure.

are using 18-inch lines. Nobody has transported liquid oxygen at that rate through 18-inch lines before.

This particular break occurred on August 20. In 1 calendar month, September 20, this particular liquid oxygen tank had been refilled, the correction of the deficiencies had been redesigned, and it was back in operation.

Mr. WAGGONER. Was the solution to open the second valve manually?

Mr. SHINKLE. No. A recirculation and precooling system was installed in front of the second valve so that there would always be liquid against the face of the valve rather than gas.

Mr. WAGGONER. Couldn't you have done the same thing by simply opening that second valve manually and allowing enough time to elapse to be sure that liquid was against that valve to prevent the gas from doing what you described?

Mr. SHINKLE. Experiments were conducted on opening the second valve very slowly to allow the built-up gas to escape without creating the severe shock of impinging with the liquid oxygen. These experiments failed, since upon slight opening of the valve the quick release of gas occurred and the shock forces were again experienced. Therefore, we solved the problem by installing the recirculating system, which eliminated the gas build-up at the valve interface.

It became apparent last year that, to meet all our program commitments and milestones, we had to develop management systems which

would provide KSC with insight into the status of activities and the ability to identify problems before they became serious. This chart—figure D-22—is one of these management systems. We are pulling together information from the program control rooms established at LC-39, LC-37, and the spacecraft room, into a central Apollo Program Management Center. These program control rooms were originally designed to do the planning that is necessary for activation. With the transition from activation to operations, these program control rooms are being used for the planning necessary for the operations management of these areas.

At the Apollo Program Management Center, program and center management is provided with up-to-the-minute data on site activation progress, identification of current and potential problems, schedule impacts, and factors upon which to base future planning.

This photograph—figure D-23—shows a segment of the program control room at LC-39. You can see on the display boards examples of the charts and systems under analysis.

Finally, relative to this management system, I would like to show you one of the techniques, PERT, that is used to plan an effort as large as LC-39. Figure D-24 is an example of a PERT trend chart (prepared on a biweekly basis), for pad A, the crawlerway, and the crawler-transporter.

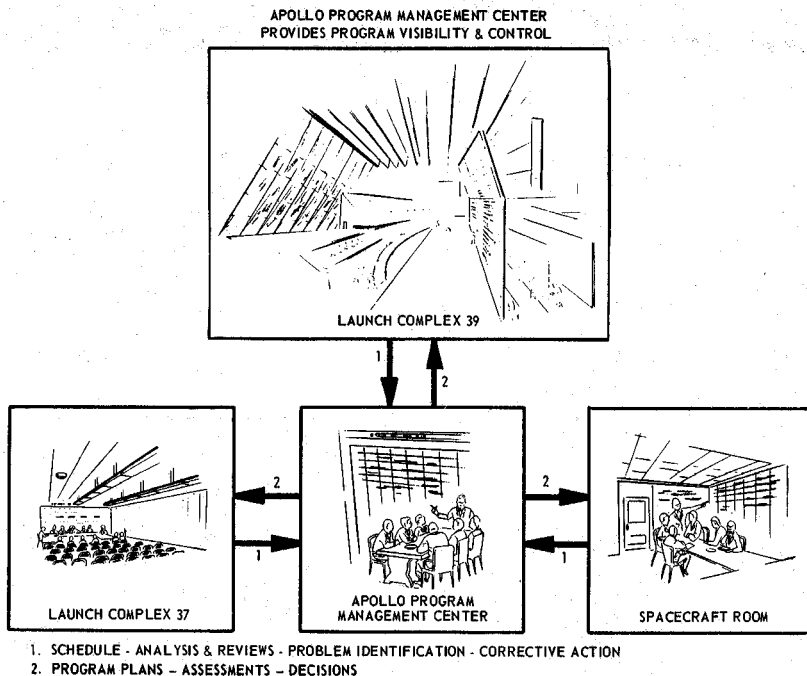


FIGURE D-22

When we started this chart, the availability of these particular facilities was 19 weeks behind schedule. By analyzing the various things that seemed to be out-of-line timewise, working on them as individual items, or planning around them, we brought the availability up to the scheduled time by January.

In April we realized suddenly that a certain requirement for this particular facility was 20 weeks behind schedule. This requirement happened to be the use of the facility in September for the 500 F operation. The General Electric Co. was supposed to furnish a hazard monitoring system; that is, a monitoring system that would tell us if any hydrogen was leaking for a hydrogen operation necessary in August. We got the General Electric Co. to furnish a part of that system which would be useful for this particular operation on time. We therefore brought the facility back to a time when it could be completed and usable on schedule. This is what we refer to as a work-around. The whole hazard monitoring system wasn't going to be furnished, but that part that was necessary for that particular task was ready.

This PERT technique is used quite a bit within the Apollo program to give us the program visibility needed to exert our efforts in proper priority to stay on schedule.

Another management problem is the interrelation of configuration management logistics and data management as reflected in figure D-25. These things are all mutually dependent because, without good data management or configuration management, you don't have good logistics, and vice versa.

There are policy directives from headquarters, but they are general in nature, so we have had to fit these systems to our program requirements.

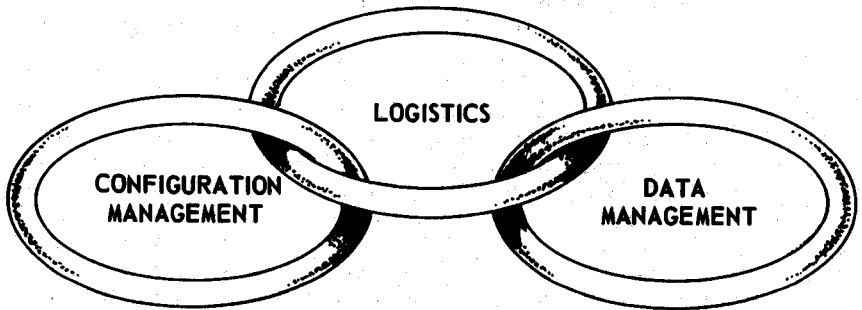
We started local training programs to top and middle management and operational supervisors. We integrated the three systems that are mentioned and have benefited by eliminating duplication and having a method of measuring accomplishments. I have shown here just one chart (fig. D-26) which shows one of these measures of accomplishment.

We have always to consider changes in our hardware that are necessitated by changes in flight hardware. This chart illustrates interface revision notices resulting from such hardware changes. In the past 15 months we have spent approximately \$31.4 million for equipment changes. At the same time we have avoided what would have been an additional \$11 million in cost. We do not know whether such a savings would have been possible without this formal system. However, we know today that because of conscientious utilization of configuration management disciplines our personnel have avoided incurring over \$11 million of officially requested changes.

In summary (fig. D-27), I would like to say that we have met our goals through the past year, and we have met milestones within the program needs.

We have established management systems and controls which I hope are quite effective. We are ready to go into the new phase which I believe was dramatically illustrated by the chart showing the C. of F. and R. & D. planning.

APOLLO MANAGEMENT SYSTEM



- CUSTOM FIT TO KSC
- LOCAL TRAINING PROGRAM
- INTEGRATION OF SYSTEMS
- ELIMINATING DUPLICATION
- MEASURE ACCOMPLISHMENTS

FIGURE D-25

That's all.

Chairman TEAGUE. Questions, please?

Mr. SHINKLE. Now, gentlemen, I would like to turn over to Mr. Hock who will brief you on the Center's Apollo Applications program.

Mr. HOCK. Mr. Chairman, gentlemen, you have just been through a rather detailed report on the Apollo program (fig. E-1). I want to give you a broad view of the activities that we foresee for the future of Kennedy Space Center. Some of you were at Marshall Space Flight Center some time back and got a rather detailed view of the Apollo Applications program. For the sake of those who did not, I am going to hurry through a description of the mission shown graphically in the next slide (fig. E-2). The spacecraft is launched with an uprated Saturn I carrying an Apollo command and service module and a camera system into a low earth orbit where it will perform a photography mission for about 5 days.

Chairman TEAGUE. Kurt, we have already seen this. We saw it at Huntsville, we saw it at Douglas, and North American.

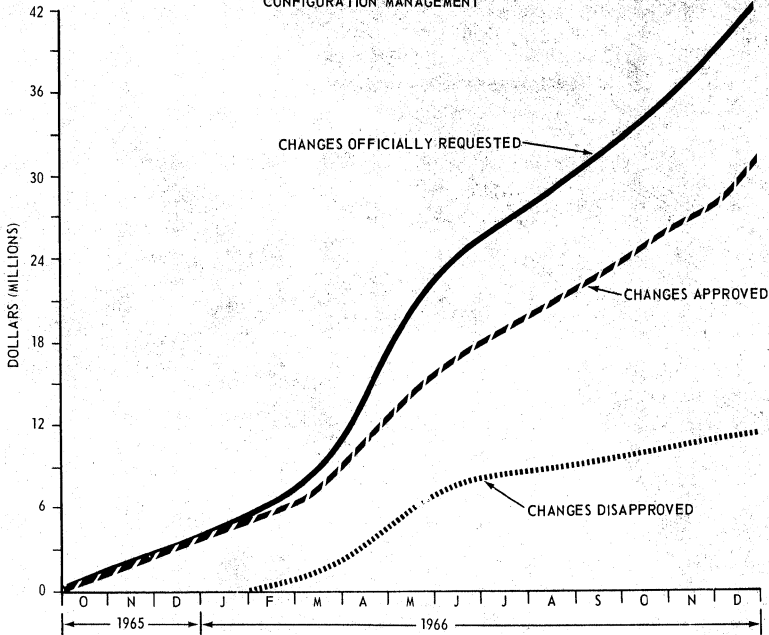
JOHN F. KENNEDY SPACE CENTER
CONFIGURATION MANAGEMENT

FIGURE D-26

SUMMARY

- MET OUR MAJOR GOALS
- MET MILESTONES WITHIN PROGRAM NEEDS
- ESTABLISHED MANAGEMENT SYSTEMS AND CONTROLS

KSC IS PREPARED FOR ITS SHIFT IN MAJOR EMPHASIS FROM SITE ACTIVATION TO LAUNCH OPERATION AND THE OPERATION AND MAINTENANCE OF ITS LAUNCH SITE.

FIGURE D-27

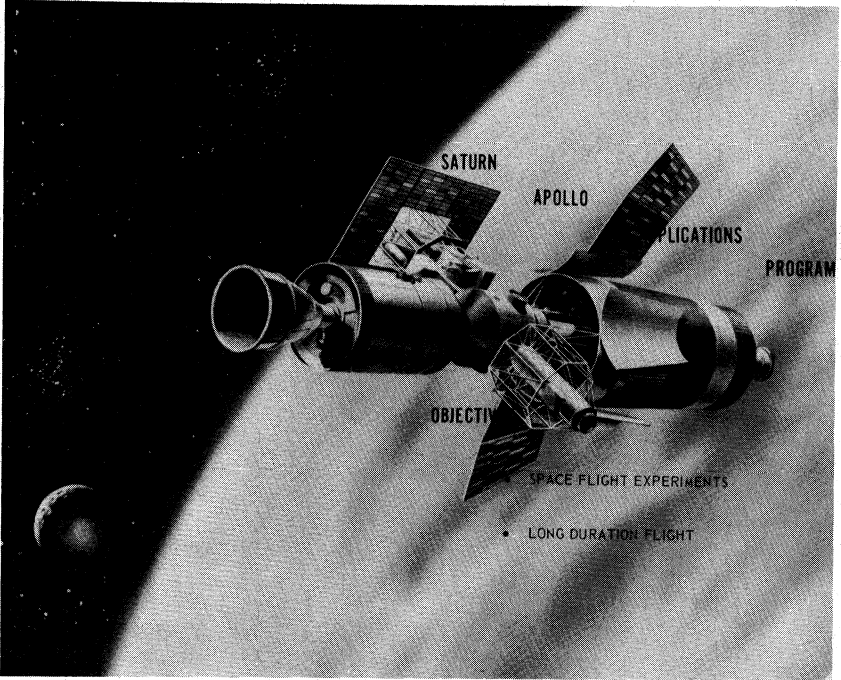


FIGURE E-1

1968 AAP MISSION PROFILE

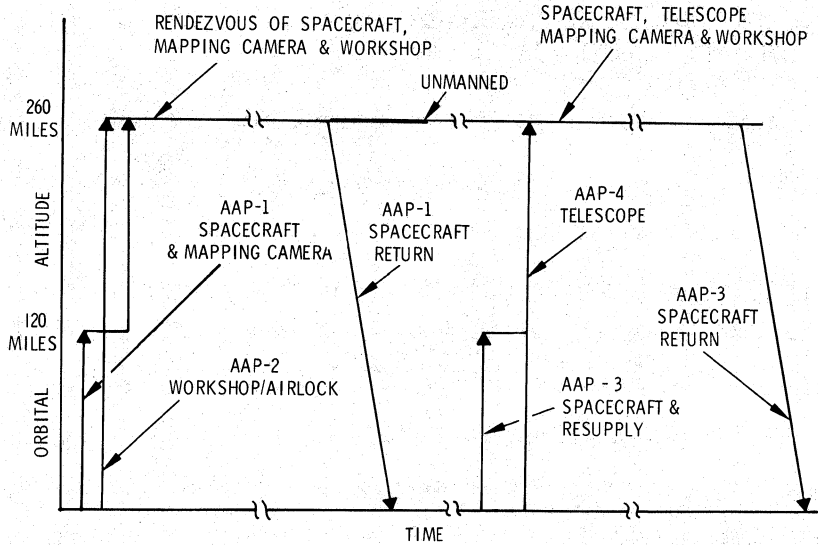


FIGURE E-2

Mr. Hock. We will rush through, then. Slide No. 6 (fig. E-3), please, on the screen.

Our role in this program is to accept the Apollo hardware, just as it has been described today by Messrs. Petrone and Shinkle. We will perform modifications and checkouts of that hardware in the existing Apollo facilities.

We will perform modifications of Apollo hardware to the AAP configuration in existing facilities such as the operation and checkout building in the VAB, where the S-IVB stage will be converted to the workshop configuration.

The next slide (fig. E-4) indicates the new activity that we foresee at the Center for the AAP peculiar hardware. The airlock module that you have heard about, and the Apollo telescope mount will undergo integration with the launch vehicle and checkout facilities.

We expect to perform checkout and modification of the AAP hardware in the existing facilities such as these you see here in the foreground and the operation and checkout building shown in the background (fig. E-5). That will require, of course, that we perform some careful scheduling to insure we don't interfere with the ongoing Saturn V Apollo program.

The next (fig. E-6) is an artist's picture of the airlock module being transferred from the operation and checkout building to the vehicle assembly building for integration with the launch vehicle.

Looking even further into the future and following the program that Dr. von Braun talked to you about at Huntsville, we are planning for the launch of lunar exploration vehicles and Voyager in the 1973

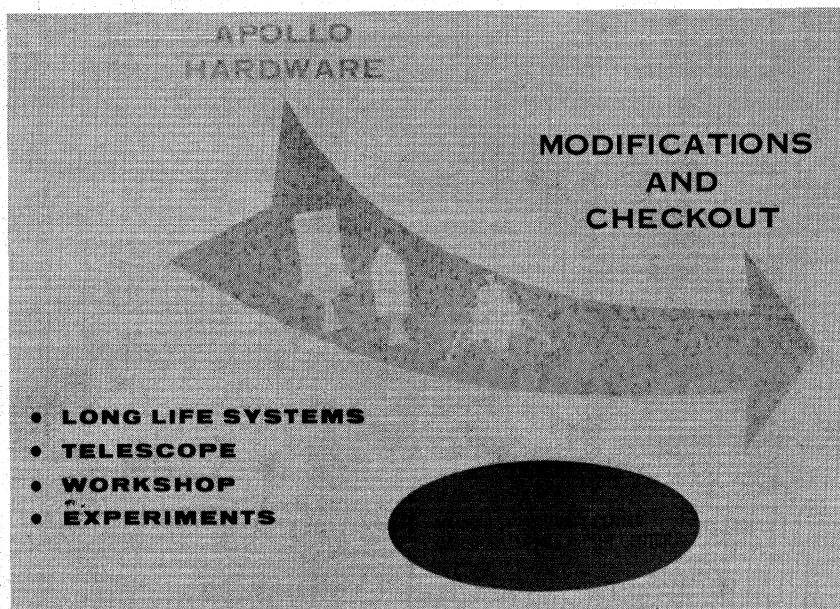


FIGURE E-3

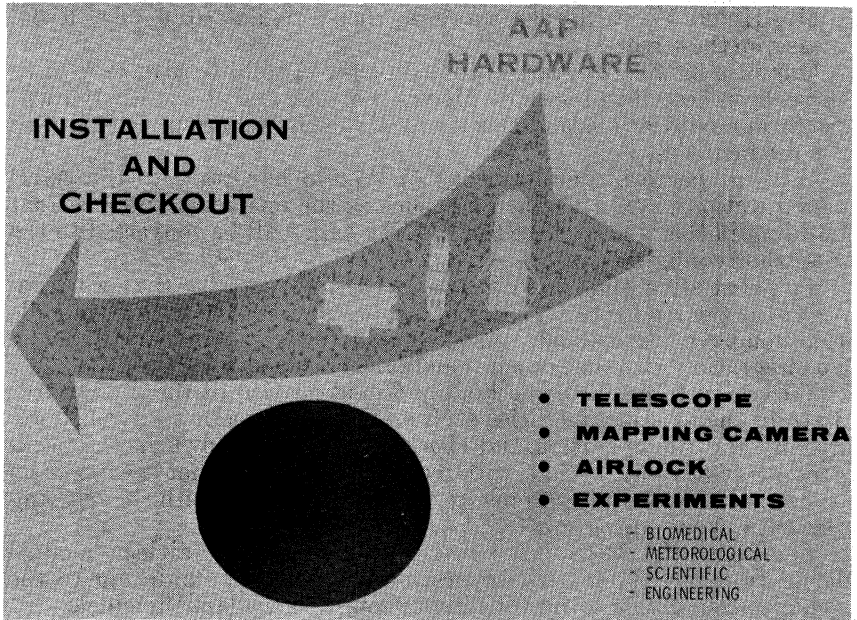


FIGURE E-4

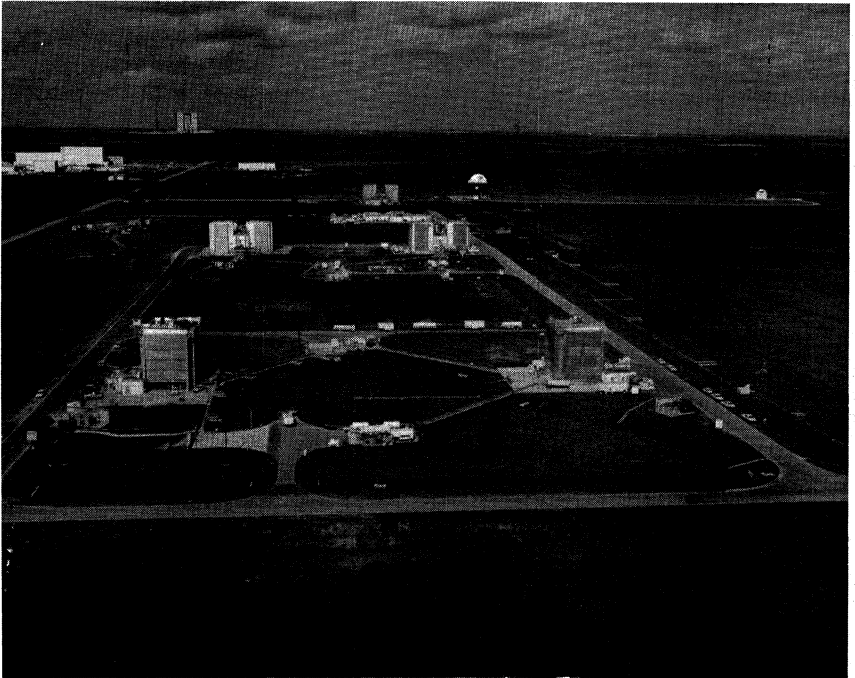


FIGURE E-5



FIGURE E-6

time period. Both of these are launched with Saturn V launch vehicles, and our principal problems are concerned with handling of new spacecraft which are considerably different from those we are now geared for. Space stations may also be flown during this time period. We also are considering planetary missions using uprated Saturn V launch vehicles in the 1975 time period. Finally, nuclear rocket vehicles can be launched from the existing site with only limited facility modifications.

Very quickly, sir, that's it.

Dr. DEBUS. Gentlemen, the message that we want to bring out is twofold. One is that the new organization of the Kennedy Space Center was made for a multiprogram application. We are establishing our Apollo Applications program organization and will establish a Voyager program office, if and when the program should be approved, such that the new elements can be integrated into the total organization in the most effective way that we can conceive.

The second message is this—with the facilities we have I think we can accommodate the new hardware by early design inputs into the configurations as they emerge; that with minor—hopefully, minor changes we can make the maximum use of existing facilities.

Perhaps, Mr. Chairman, if you would like, we could look at General Miller's presentation and have lunch, and at lunch, we could talk about the Visitor Information Center.

I would like to introduce General Miller, who is in charge of our resources management office.

Mr. MILLER. Mr. Chairman, members of the committee, the speakers who came before me have explained in some detail the programs and funding levels proposed for the "Research and development" appropriation and the "Construction of facilities" appropriation. My purpose is to speak to the third KSC appropriation, the "Administrative operations" appropriation and the principal activities it supports.

This chart (fig. F-1) is now in your hands, gentlemen. It was the last chart used by Dr. Debus. It outlines briefly the dollar value of the NASA effort managed here. The top line shows the total of the research and development appropriation applied at KSC. The next summary line relates to the construction of facilities appropriation to which General Shinkle has already spoken. The bottom summary line is labeled administrative operations. This appropriation request totals \$99.6 million for fiscal year 1968, or about 20 percent of the total dollar value represented on this chart.

Since civil service manpower is one of the main programs financed by this appropriation, I would like to speak to it first. This is similar to Mr. Siepert's chart (fig. F-2). It shows the proposed distribution of civil service manpower by organization in fiscal year 1968. Our fiscal year 1967-68 program indicates 2,785 permanent and temporary spaces. They will be distributed as shown. The big authorizations are to the operating organizations, as shown by the blocks on the bottom line of the chart. You will note that the director of launch operations, in total, has 925 spaces, about one-third of the KSC total. The director of technical support and the director of design engineering together have another third of the total resources. The spaces as-

JOHN F. KENNEDY SPACE CENTER

	ACTUAL FY 1966	AUTHORIZED FY 1967	PROPOSED FY 1968
RESEARCH AND DEVELOPMENT	<u>214,736</u>	<u>381,309</u>	<u>391,171</u>
OFFICE OF MANNED SPACE FLIGHT	<u>169,258</u>	<u>337,307</u>	<u>347,739</u>
JOHN F. KENNEDY SPACE CENTER	128,859	224,050	232,200
GEORGE C. MARSHALL SPACE FLT CTR	6,261	61,982	69,659
MANNED SPACECRAFT CENTER	34,138 (EST)	51,275 (EST)	45,880 (EST)
OFFICE OF SPACE SCIENCE & APPLICATIONS	<u>45,263</u>	<u>44,002</u>	<u>43,332</u>
JOHN F. KENNEDY SPACE CENTER	4,647	3,987	3,332
OTHER CENTERS	40,616 (EST)	40,015 (EST)	40,000 (EST)
OFFICE OF ADVANCED RESEARCH & TECHNOLOGY	<u>215</u>	<u>-0-</u>	<u>100</u>
JOHN F. KENNEDY SPACE CENTER	193	-0-	100
OTHER CENTERS	22	-0-	-0-
CONSTRUCTION OF FACILITIES	<u>6,917</u>	<u>35,758</u>	<u>24,885</u>
OFFICE OF MANNED SPACE FLIGHT	6,030	34,021	22,595
OFFICE OF SPACE SCIENCE & APPLICATIONS	887	1,737	2,290
ADMINISTRATIVE OPERATIONS	<u>81,952</u>	<u>92,658</u>	<u>99,575</u>

FIGURE F-1

signed to the director of installation support and the director of administration comprise about one-fourth of the total, and the remainder is distributed in the small organizations at the top.

The Apollo Program Manager has 104, and Apollo Applications will have 40. Our total spaces include 65 temporary spaces, of which two-thirds are in the cooperative program and one-third is in the Youth Opportunity campaign.

This chart (fig. F-3) shows how our civil service manpower is distributed by product. It is a graphic portrayal of the personnel tabulation shown in the 1968 budget book.

The top block, the cross hatched one, as you can read the legend, increases slightly in fiscal year 1968 due to increased manpower in the Apollo Applications program.

The white block in the center represents the strength assigned to the Apollo program.

There is no applicable change between 1967 and 1968.

The bottom block shows manpower alined to support operations. The proportion between 1967 and 1968 is also unchanged. Nearly half of this support block is identified as research and development support.

The next chart (fig. F-4) shows the present distribution of the civil service work force based on the skills they possess. Please note that since 1964, as civil service manpower has increased, substantially all of the increase has been in the top layer, the professional engineering and scientific categories. In this group we have currently 45 percent of our manpower, and with the engineering technicians in the layer just below, we have 61 percent of the total KSC manpower.

JOHN F. KENNEDY SPACE CENTER, NASA

AS OF JUNE 30, 1968
TOTAL CIVIL SERVICE 2,785

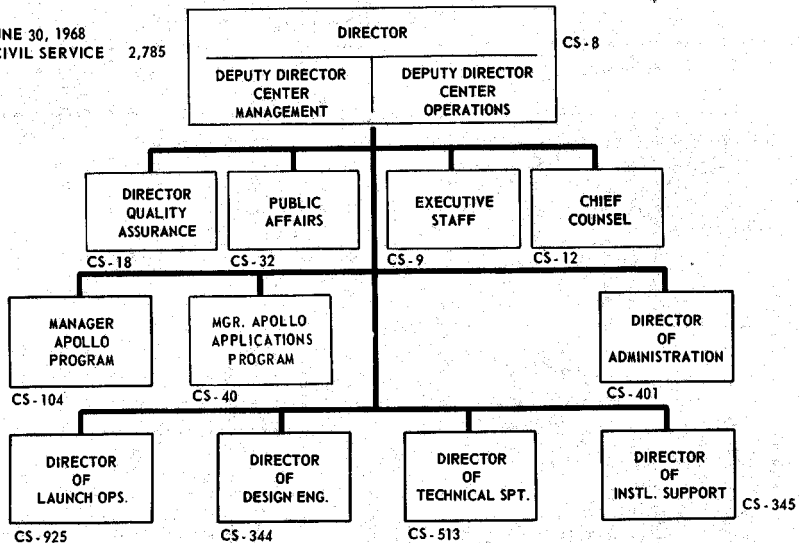


FIGURE F-2

JOHN F. KENNEDY SPACE CENTER PROGRAM DISTRIBUTION OF MANPOWER

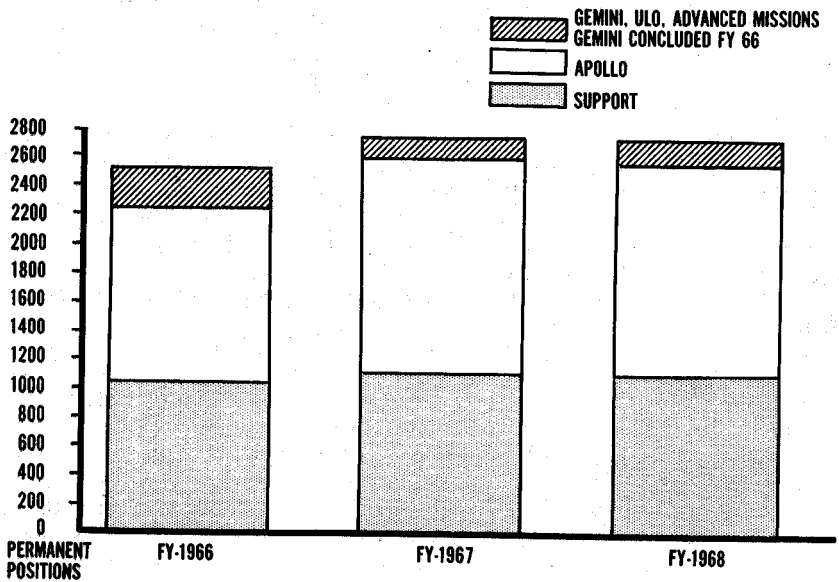


FIGURE F-3

JOHN F. KENNEDY SPACE CENTER CIVIL SERVICE DISTRIBUTION BY CLASS

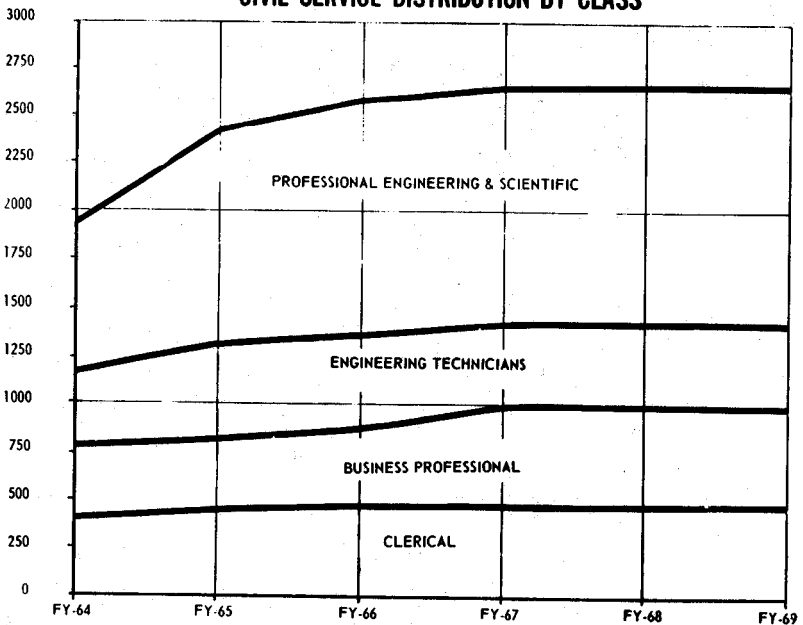


FIGURE F-4

The layer marked business/professional is about 18 percent of our total, and this represents professional types in all disciplines other than engineering and scientific, so that, in total, our professional people amount to 63 percent of the Center authorization.

At this point I want to speak to the KSC manpower management program and discuss the validation of manpower requirements.

Until recently manpower resources were allocated by Dr. Debus personally after each director had presented his requirements. This process generally took several days. This method is excellent in some respects and is particularly useful to a small organization, but large establishments are such that it requires quite a lot of time when detailed inquiries are necessary.

We are faced with the need to develop a better method of validating our manpower requirements because our civil service program has leveled out, and in addition we need to validate the effectiveness of the distribution of the manpower spaces we have made in the new KSC organization.

Considering these factors, the staff recommended, and Dr. Debus approved, a manpower validation program based on making surveys in depth, and we have now moved into that program. A small but competent professional staff has been authorized and has now been hired. The first survey of a major organizational element is just about completed. We are confident this method will improve the effectiveness of KSC manpower management.

This chart (fig. F-5) portrays the cost of our civil service manpower program in millions of dollars. Compensation shown on the top line includes all pay items such as regular pay, overtime pay, holiday pay, shift differential pay, and others.

The items included in the personnel benefits are self-explanatory. The fiscal year 1968 increase in compensation is caused by three factors, an increase in the average man-years of employment from 2,591 in fiscal year 1967 to 2,683 in fiscal year 1968, in-grade step increases as authorized by law, and a pay increase averaging 6 percent for our professional scientific and engineering people.

KENNEDY SPACE CENTER

PERSONNEL COSTS

(IN MILLIONS)

	ACTUAL FY 66	ESTIMATED FY 67	PROPOSED FY 68
PERSONNEL COMPENSATION	\$27.8	\$30.9	\$32.8
PERSONNEL BENEFITS	1.8	2.3	2.4
CONTRIBUTION RETIREMENT FUND			
CONTRIBUTION EMPLOYEE LIFE INSURANCE			
CONTRIBUTION EMPLOYEE HEALTH INSURANCE			
INCENTIVE AWARDS			

FIGURE F-5

In response to an earlier question about overtime, I would say now—I do not have a chart—our overtime program for fiscal year 1968 is the same as 1967. It is a level program for a total of \$2,180,000.

This chart (fig. F-6) speaks to our temporary duty travel program. The program is financed by this appropriation and is important to the accomplishment of KSC responsibilities. This chart shows that our travel program by dollars per fiscal year is unchanged for fiscal year 1968 at \$1.1 million.

To give you an idea of where this travel is accomplished I have added an entry at the bottom called travel destination. You will note that 63 percent of our travel is to other NASA organizations, 19 percent to contractor facilities and 18 percent to others. This is based on a sample of 800 trips taken over the past 2 months. I think it reflects the interdependence of the NASA centers and the NASA contractor effort. It is also an expression of the highly technical nature of our business.

At this point I want to recall a chart—figure F-7—used earlier by Dr. Debus, which shows the principal KSC responsibilities. I direct your attention to statement No. 5, which reads, "Furnish on-site technical and administrative support for all NASA programs.

This support is furnished to our civil service manned functions and the contractors at KSC and the Cape.

The administrative operations appropriation has a major role in meeting this responsibility. It funds the support which is commonly

KENNEDY SPACE CENTER
TEMPORARY DUTY TRAVEL PROGRAM

COST OF TRAVEL

(IN MILLIONS)

	ACTUAL FY 66	ESTIMATED FY 67	PROPOSED FY 68
ANNUAL COST	\$.8	\$1.1	\$1.1

DESTINATION OF TRAVEL

NASA	PERCENTAGE OF TRIPS
MARSHALL SPACE FLIGHT CENTER	
MANNED SPACECRAFT CENTER	63%
WESTERN TEST RANGE	
NASA HEADQUARTERS	
CONTRACTOR FACILITIES	19%
OTHER	18%

FIGURE F-6

PRINCIPAL KSC RESPONSIBILITIES

1. PREPARE, CHECKOUT, AND LAUNCH ASSIGNED NASA SPACE VEHICLES.
2. ASSURE FLIGHT HARDWARE CONFIGURATION CONTROL BY DEVELOPMENT CENTERS.
3. DEVELOP NEW LAUNCHING CONCEPTS AND PROVIDE LAUNCH REQUIREMENTS AFFECTING LAUNCH VEHICLE AND S/C DESIGN.
4. DESIGN, INSTALL, AND OPERATE LAUNCH FACILITIES, INCLUDING GSE.
5. FURNISH ON-SITE TECHNICAL AND ADMINISTRATIVE SUPPORT FOR ALL NASA PROGRAMS.
6. PROVIDE NASA A SINGLE CHANNEL FOR OBTAINING LAUNCH SUPPORT FROM THE EASTERN TEST RANGE.
7. ASSURE GROUND SAFETY COMPLIANCE FOR ALL NASA MISSIONS.

FIGURE F-7

classed as institutional, sometimes called administrative and base support. In contrast, the research and development appropriation funds support activity commonly classed as technical.

First, to give you an idea of the range of functions performed to meet this responsibility, I will list some types of technical support we supply. On this chart—figure F-8—you will notice such technical items as chemical laboratory support, machine shop, and other types of technical shop support. Items like propellants and communications are obviously directly essential to launch operations and tests. These facilities and services are funded by KSC contracts and are paid for by research and development funds.

Representative WAGGONER. How much money are you spending for hurricane protection?

Mr. MILLER. Pardon me?

Representative WAGGONER. How much money are you spending for hurricane protection?

Dr. DEBUS. That's mostly on facilities. It cost much more if they are hurricane proof.

Mr. MILLER. I can't identify the specific dollars, but obviously it varies. When a hurricane warning comes we sandbag, tie down things and, of course, if we have no hurricane alert we don't provide this service.

Dr. DEBUS. We move a lot of things. We took 500 F back because the hurricane was brewing. The alarm came at 1 p.m. and it was secured by 9 or 10 p.m. back in the Vehicle Assembly Building.

Mr. MILLER. It could be very expensive, and, if it were not done, it might be even more expensive.

Mr. SIEPERT. As far as the staff is concerned with this, there are hundreds involved if there is an actual threat, but, in terms of a continuing planning job on it, we focus on one contractor a full-time responsibility, really, on one man to keep constantly thinking of this,

KENNEDY SPACE CENTER

SUPPORT SERVICES

(FUNDED BY RESEARCH & DEVELOPMENT)

CHEMICAL ANALYSIS	MATERIALS TEST & CALIBRATION
MACHINE SHOP	GEOPHYSICAL
ELECTRICAL SHOP	PROPELLANTS
ELECTRONICS SHOP	ELECTRICAL INTERFERENCE MEASUREMENT
MECHANICAL SHOP	TRACKING
HURRICANE PROTECTION	TELEMETRY
COMMUNICATIONS	QUALITY
INSTRUMENTATION	DATA PROCESSING - SCIENTIFIC

FIGURE F-8

but each organization has the part-time commitment of an individual who works specifically on that.

Mr. MILLER. The next chart—figure F-9— lists other support services. These are services of a somewhat less technical nature but nevertheless essential. The title of this chart is somewhat self-explanatory, but I want to cite some examples which stress the importance of these services.

The first listed service, utilities operation and maintenance, takes care of, among other things, the major electrical grid installed here on the KSC.

This grid consists of 85 miles of underground cable, 35 miles of aerial cable, and 326 individual substations and switching centers as a part of the complex. The electricity it supplies is used to operate, for example, all the air-conditioning equipment in our cleanrooms. It operates the cranes and hoists which you will see lifting the elements in the Vehicle Assembly Building and elsewhere. It powers our shops and our numerous other uses for electricity.

Photographic service is another good example of an essential service. Based on an analysis of units produced in the first half of fiscal year 1967, 66 percent of the motion-picture footage, 80 percent of the still photography, and 98 percent of the microfilm production was in direct support of research and development requirements.

With respect to supply operations, which is listed at the bottom of the chart, and on the same 6-month sampling basis, 96 percent of the

issues were made to research and development oriented activities. All of these support services are provided by KSC contract and are paid for by the administrative operations funds.

The third group is purchased by KSC from other Government agencies, as the next chart (fig. F-10) shows.

The services provided by the Air Force are principally related to Eastern and Western Test Range support. (Please note the footnote.) We have considerable technical support from the Air Force, too.

With respect to vehicle service provided by GSA, for example, 72 percent of the vehicles operated, omitting the tour vehicles, are directly assigned and supported by the research and development activities. These services are all obtained by cross-servicing arrangements with the other departments and paid for by administrative operations funds.

The fourth group of services (fig. F-11) is purchased through the KSC Procurement and Contracting Office.

Here I want to cite some examples of support being supplied from our fiscal year 1967 funds. Our electricity used, for instance, runs about 20 million kilowatt-hours per month. This is equivalent to consumption by a city of something like 60,000 people. It will cost us about \$4.2 million this year. Gas will cost about \$200,000, and water about \$64,000. With respect to supplies and materials, our costs will

KENNEDY SPACE CENTER

SUPPORT SERVICES

(FUNDED BY ADMINISTRATIVE OPERATIONS)

UTILITIES OPERATION & MAINTENANCE	MAINTENANCE & REPAIR
PHOTOGRAPHY	ENGINEERING SERVICES
REPRODUCTION	GRAPHICS
FIRE PROTECTION	PUBLICATIONS
SECURITY & POLICE	MAIL SERVICE
SAFETY	ENVIRONMENTAL HEALTH
HURRICANE PROTECTION	INSECT & RODENT CONTROL
TRANSPORTATION	REFUSE COLLECTION
QUALITY	TRAINING
SUPPLY OPERATIONS	DATA PROCESSING - BUSINESS

FIGURE F-9

KENNEDY SPACE CENTER

SUPPORT SERVICES PROVIDED BY OTHER GOVERNMENT AGENCIES

(FUNDED BY ADMINISTRATIVE OPERATIONS)

US AIR FORCE *

MAINTENANCE, REPAIR AND OPERATION OF FACILITIES

SECURITY & POLICE

ENVIRONMENTAL HEALTH

SUPPLY SERVICE

TRANSPORTATION

CONTRACTOR PRICE ANALYSIS

GENERAL SERVICES ADMINISTRATION

VEHICLES AND TRANSPORTATION SERVICES

COMMUNICATION - FEDERAL TELECOMMUNICATION SERVICE

DEFENSE CONTRACT AUDIT AGENCY

AUDIT SERVICES

DEFENSE CONTRACT ADMINISTRATION SERVICE

CONTRACT ADMINISTRATION

*Several Technical Services Funded by Research & Development Appropriation are also provided.

FIGURE F-10

be about \$2.5 million this year. All of these services are paid for by the administrative operations funds.

This chart (fig. F-12) summarizes the proposed KSC funding of requirements in the administrative operations appropriation for fiscal year 1968. They reflect our forecast made in December of greater support requirements for maintenance, repair, and operation facilities, added requirements for security and fire protection, and for supplies, materials, utilities, and communications to support them.

One-third of the increase is attributable to personnel costs such as increased man-years of civil service employment, in-step wage increases, and a pay increase for professional engineers and scientific personnel.

That concludes my presentation, Mr. Chairman.

Chairman TEAGUE. Yes, sir. Thank you, sir.

Representative WAGGONER. I think it would be safe for me to say that it was an oversimplification when you started out by saying that money was the chief commodity in this phase of the operation, was it not?

Dr. DEBUS. We will have lunch at this time, and Mr. Siepert will talk about the Visitor Information Center.

KENNEDY SPACE CENTER

OTHER SUPPORT

(FUNDED BY ADMINISTRATIVE OPERATIONS)

UTILITIES PURCHASED

SUPPLIES & MATERIALS

RENTALS

COMMUNICATIONS

EQUIPMENT

ALTERATION, REPAIR &

MINOR CONSTRUCTION OF

FACILITIES

FIGURE F-11

KENNEDY SPACE CENTER

SUMMARY OF FY 1968 ADMINISTRATIVE OPERATIONS

(IN MILLIONS)

	<u>FY 1966</u>	<u>FY 1967</u>	<u>FY 1968</u>
PERSONNEL COSTS AND BENEFITS	\$29.8	\$33.6	\$35.5
TRAVEL PROGRAM	.8	1.1	1.1
INSTALLATION OPERATION	<u>51.3</u>	<u>58.0</u>	<u>63.0</u>
TOTALS	\$81.9	\$92.7	\$99.6

FIGURE F-12

Mr. SIEPERT. Mr. Chairman, the Kennedy Space Center believes the committee will be interested in a progress report on the plans for handling the general public in their desire to see our facilities while they are in operation.

There is no budget request before you for new money to construct a visitors' facility. What I am going to describe to you is a project that is within currently available appropriations and in accordance with a previous authorization by the Congress to provide visitor information facilities here at Merritt Island.

We want first to give you an idea of the two locations we are discussing. Here (fig. G-1) is the familiar outline of Cape Kennedy. You are here at the present time, in the Merritt Island industrial area.

Over here to the west is the Florida mainland, with route U.S. 1 going north and south. Immediately east of U.S. 1 on the NASA Causeway and directly in front of our KSC gate No. 3 is the site where we presently operate a temporary bus tour terminal. There is also a small space exhibits building of 2,100 square feet where displays are available for visitors to inspect free of charge.

The public tours, which began last July, start from this point and go across the NASA Causeway over the Indian River, then visit the cape, and finally tour complex 39. The total trip occupies about 2½ hours and covers nearly 60 miles. It is conducted by well-trained TWA guides who drive leased, 37-passenger buses. The buses are equipped with sound systems for the escort's use with his own narrative plus appropriate tape-recorded documentary. These tours have

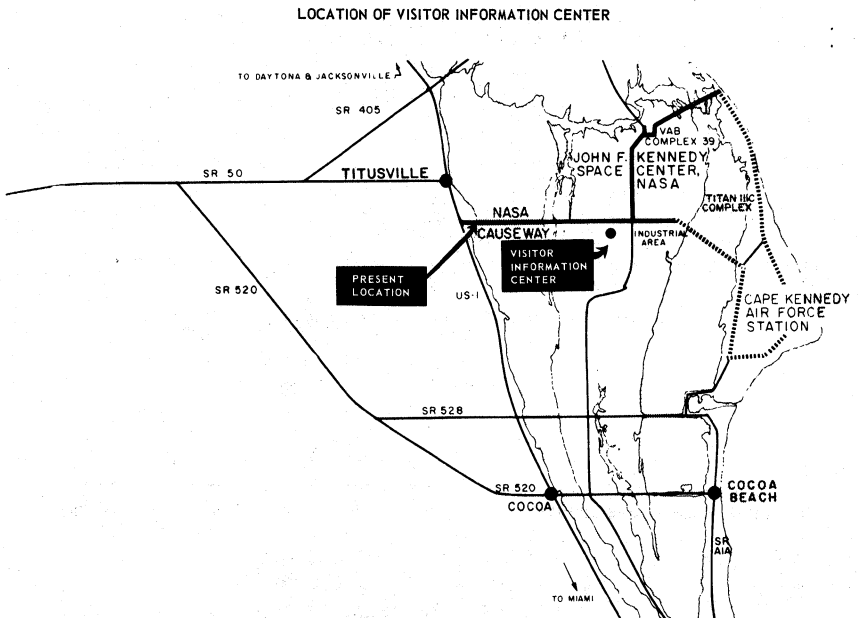


FIGURE G-1

become an outstanding public attraction. They are a superb complement to the Visitor Information Center which is now under construction.

The Visitor Information Center (VIC) project has been located at this site, (indicating) which is about a mile and a half to the west of the Merritt Island industrial area. This means that visitors in the future will be driving their own autos into the Kennedy Space Center, parking here on Merritt Island, and seeing selected space exhibits and orientation films without charge. If they choose to do so, they can take escorted bus tours from this site. This more central location permits us to do a more efficient operation, and we believe it is important for the people to feel they have actually visited inside the Kennedy Space Center, whether or not they choose to take the tour.

Here is an aerial view of the present temporary location on the mainland (fig. G-2). Just beyond is the KSC security control gate No. 3 through which the tour buses will pass.

We built only temporary structures and portable sanitary utilities here: The exhibit structure is a small Butler-type building. Nearby, are chemical toilet facilities mounted on movable skids. There are two trailers with a roofed-over space in between which is used by the tours contractor, Trans World Airlines, to handle ticket sales, briefing of guides, and tour management. Outside, is a Mercury-Redstone rocket in the configuration Alan Shepard and Gus Grissom used for their two suborbital flights.



FIGURE G-2. Aerial View of Temporary Visitor Information Center.

By this coming summer, the present improvised facility will be completely inadequate to handle the crowds who will come to see KSC. These facilities were put up hurriedly in order to meet great pressures to start public tours without waiting some 18 months before a permanent center could be made ready. The idea was that we would use it for a year or two until we had acquired some tour experience plus a permanent visitor information center. Concurrently, design work had been undertaken by Welton Becket Associates of New York City. However, when the permanent design work was finally completed last fall, it was evident that the cost of constructing and equipping that design was substantially above that which the architect had originally programed. The estimated price had risen so much—to an estimated \$2,487,000—that it appeared useless to proceed with the full construction, at least with the limited resources we had available. So, we have proceeded with an alternative approach which gives most of what we need, without raising the costs beyond our current availability of \$1,122,000.

Figure G-3 shows a proposed temporary facility to be erected on the permanent visitor information center site. This facility is to be placed midway between the permanent visitor information center location and the parking lots in the rear. Under this plan, the site can be substantially developed with utilities, proper grade, adequate roadways, full electrical and sewer connections, and other improvements in line with the master site plan which was a part of the permanent visitor information center design by Welton Becket Associates. We are installing in the present program all site development features which would continue to be used in any subsequent permanent opera-

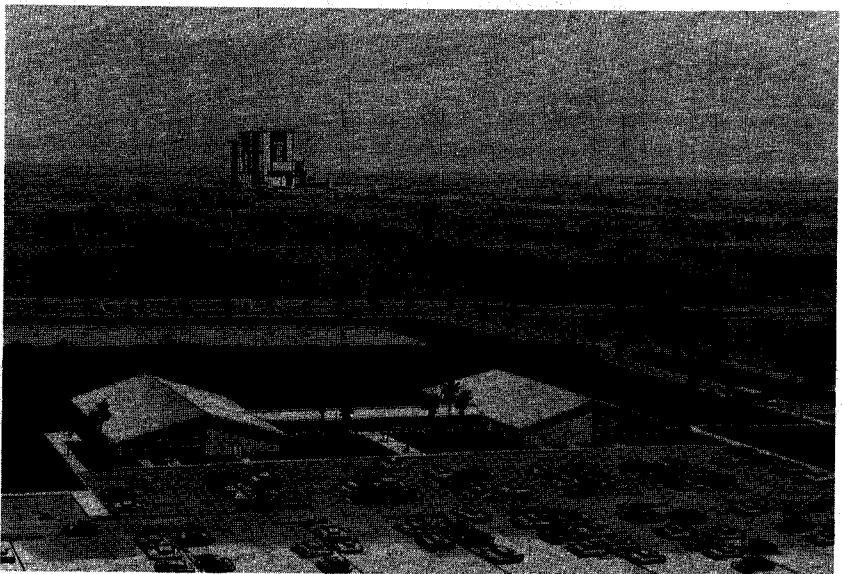


FIGURE G-3. Proposed visitor information center at Kennedy Space Center

tion. At any later time when our experience indicates to the Congress that there should be more adequate tourist facilities, we can erect the permanent facility in the area north of the temporary structures; at no point would we need to disrupt the tours in order to accomplish the permanent construction.

Dr. DEBUS. But we cannot accomplish this within the present allocation of funds.

Mr. SIEPERT. That's right.

Dr. DEBUS. Not the permanent facility.

Mr. SIEPERT. We can prepare the total site and build the temporary buildings for \$1,096,000.

We appreciate that the committee will want to know how these temporary buildings compare with the permanent construction which was designed for us by Welton Becket Associates of New York City.

This—figure G-4—is a model of the winning Becket design which was chosen as superior to four other designs submitted by competing architects. We will retain the basic site plan intact. The water area or moat is needed for land excavation to build up the proper grade. The full moat, however, will not be dredged on all sides unless we later proceed with the permanent design. Nor would the stone curbing around this water area be installed at this time. The temporary exhibit structure is actually being located to the south of the building site of the permanent visitor information center.

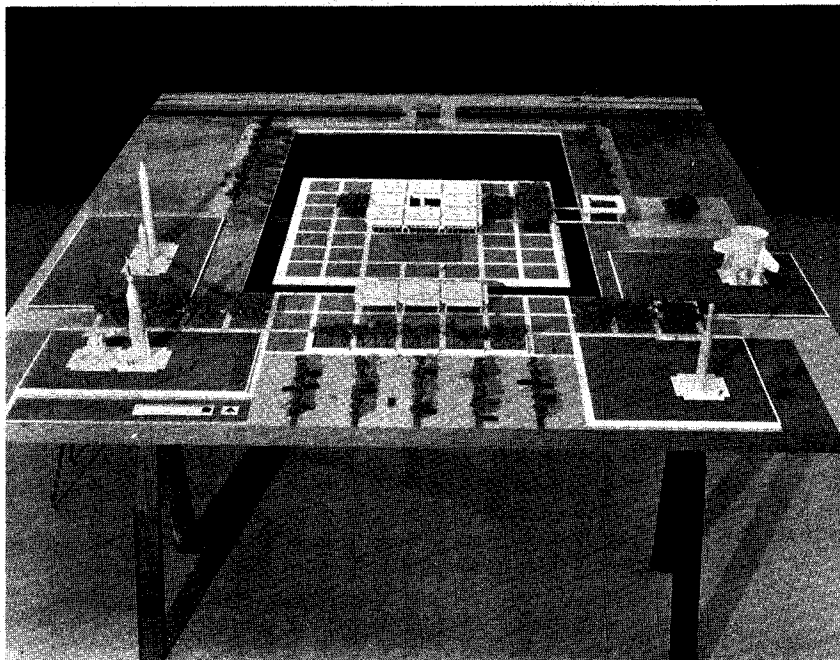


FIGURE G-4.—The design proposed by Welton Becket was selected of five competing designs proposed by nationally known architects.

Chairman TEAGUE. How much will this one cost?

Mr. SIEPERT. This one will cost \$1,096,000.

Chairman TEAGUE. I am talking about this one, up here.

Mr. SIEPERT. Oh, I'm sorry, sir. The total cost of the Becket-designed facility, if constructed on its present scale, would be \$2,487,000. However, our recent experience with public tours has demonstrated that we require more access roads and more parking spaces than the 250 spaces which the original Becket design would provide. To overcome this with better access roads and 800 rather than 500 spaces, the adjusted total cost would be \$2,700,000.

Mr. WINN. I can't tell from here, is that a one or two-story building?

Mr. SIEPERT. The permanent VIC is actually a high-ceiling, single-story poured-concrete structure. It would be built on a modular base with, I believe, 16-foot floor-to-ceiling clearance.

The temporary information center is planned as a prefabricated metal structure. It is adequate in size and layout to take care of our visitor load to the same extent as would the permanent Becket design. The structure on the left has two small theaters with benches for 250 people each and capable of showing orientation films on the space program. It also has space for some exhibits. In the building on the right are the main exhibits and visitors' services for our tour ticket sales, restrooms, vending machines, and souvenir articles. Finally, at the far right, is the bus loading shelter. Although these are "prefabs," they will be quite satisfactory, from a deterioration standpoint, for the next 4 to 5 years. By that time, it should be evident the extent to which this area does become a permanent tourist attraction as a national historical site and operational spaceport.

The National Park Service has told us to plan on as many as 3 million visitors a year. If it reaches 3 million, this will not be an adequate facility, but it is adequate, we believe, to handle comfortably in excess of a million people a year.

Mr. WINN. What does it run now?

Mr. SIEPERT. The current rate we have had since July on the public tours would be about a half million visitors annually who actually do take the tour.

Mr. WINN. Yes.

Mr. SIEPERT. There has been a gradual buildup to date; some 230,000 people have made the tours since the end of July. However, that is only a portion of those who would come through a visitor information center—

Mr. WINN. I realize that.

Mr. SIEPERT (continuing). Which is free to them. The National Park Service estimates that only 50 percent of those who would come to such a visitor and exhibit center would, in fact, take the tours. The other half, for reasons of time and money, will be quite satisfied if they can see dramatic exhibits and brief orientation films of what NASA is doing at this launch site. So if nearly 250,000 persons have already visited for the tours alone, the total VIC load by next summer will be at an annual rate of at least 1 million visitors.

Dr. DEBUS. We have registered visitors by a sampling technique which covers about 50 States, haven't we?

Mr. SIEPERT. Figure G-5 shows visitors by major geographical regions.

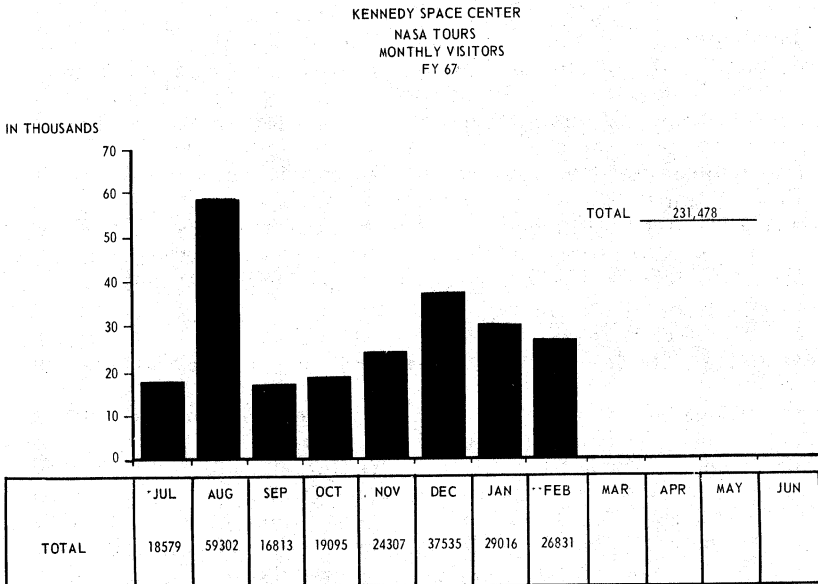
Chairman TEAGUE. If I understand what you are saying correctly, we are going to go ahead with a million dollar temporary facility?

Mr. SIEPERT. We have underway a construction project under which \$613,000 will be invested in improvements that are directly usable now, as well as later, for the permanent site. We are going to develop the permanent site with all the grading, roads, utilities, and most of the parking needed for a permanent VIC operation. That is half the cost right there. In addition, the present contract includes \$243,000 for the structures. These are temporary, but they are reusable.

If at any point, it is decided by the Congress to replace them with permanent construction, these prefabs will have a salvage value when placed somewhere else on Merritt Island for warehousing, office, or shops space. The recovery value would be in the neighborhood of \$150,000.

The interior finishing and outfitting of the exhibit, projection space, and tourist accommodations will be a separate contract. The estimated cost is \$240,000, and much of this would probably not be salvagable if the temporary VIC were abandoned.

We have at the present time a fixed price contract for work which started about 2 weeks ago. The contractor is Houdaille-Duval of Jacksonville, Fla. They bid for the first two phases that I mentioned: site grading, utilities and road development, and the prefab structures. Their bid was \$838,550. The construction is on an accelerated basis so that we can move into these facilities in June 1967, at the start of the major influx of summer visitors.



* 7 DAYS ONLY

** 20 DAYS ONLY

FIGURE G-5

There is one other comparison to explain: Did we select a less-adequate facility in terms of space and function when we shifted to a more economical type of construction? The Beckett design (fig. G-4) is a permanent and esthetically pleasing type of construction. It's beautifully done, as you see. But the actual space in that building is 20,500 square feet of net space. The comparable space in the alternate or prefabricated structures is 20,800 net square feet, so we are able functionally to do at least as good a job as we could with the other building.

I think the committee might like to see how the tour volume fluctuates by months. A high-quality tour business depends upon precisely trained escorts who cannot easily be dropped or hired depending on sudden fluctuations in volume. Tourists, however, accept Florida's welcome mat on a seasonal basis. July and August are peak months. As soon as Labor Day arrives, the bottom drops out temporarily. Then it builds in December, drops back a little in January, and then builds up steadily until Easter. It will drop drastically just after Easter and then rebuild rapidly as soon as the children are out of school and the families visit Florida. We have quite a seasonal operation here.

These people come from all over the United States and the world. We have no practicable way to identify the origin of everyone who comes in. We obtain statistics by analyzing the voluntary registration book. One-third of all the people who take the tour make it a point to register. That's rather interesting, because most of them don't register before they tour. They could. They make the tour first and, before returning to their cars, voluntarily go into the Exhibits Building, evidently to put into focus what they have seen here. There we have a guest book available, and about one-third sign it on their own initiative.

This sample shows us (fig. G-6) that in the past 7 months, approximately 31 percent are coming from the State of Florida, compared to 25 percent from the Midwest and 15 percent from the Mid-Atlantic States. It would be expected that Florida would be the best represented, particularly in the initial phase when our families have not previously had the opportunity to see where their fathers work.

Florida tourist statistics show that, as far as visitor volume is concerned, the largest number of out-of-State tourists come from New York; the second largest is Illinois. But, they come from every State.

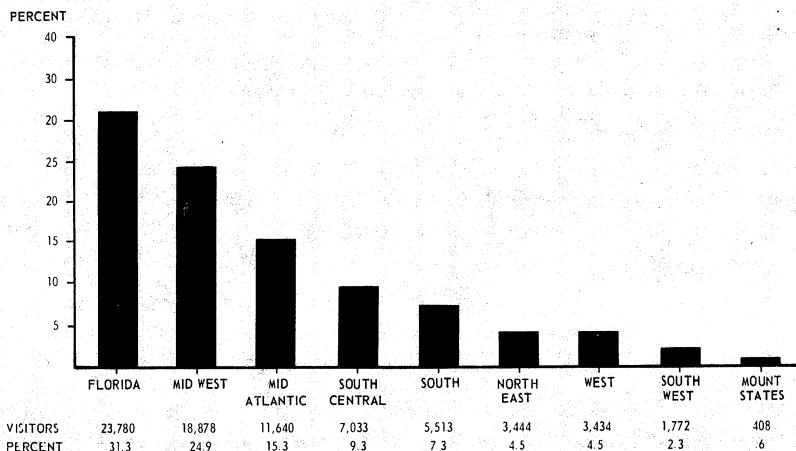
Mr. WAGGONER. They may not be tourists; just be people wising up, looking for a better place to live.

Mr. SIEPERT. We are happy to have them come, in view of the present weather up North. They are what you might call welcome snow-birds.

Mr. WINN. It may be because people from the Midwest are well aware of the space program, too.

Mr. SIEPERT. We hope so. I also have the actual numbers from each State. It impresses us that so many come from places quite far away, particularly the representation from Texas and California is surprising. Perhaps the fact that the aerospace industry is heavily located there means they come to visit old friends who now work in launch services at the cape and Merritt Island, and so they come to see for themselves. We have also had many visitors from over 50 nations.

KENNEDY SPACE CENTER
NASA TOURS
VISITORS BY GEOGRAPHICAL ORIGIN



BASED UPON VOLUNTARY GUEST BOOK REGISTRATION
(APPROXIMATELY ONE-THIRD OF TOTAL ATTENDEES)

AS OF FEBRUARY, 1967

FIGURE G-6

The comments that we have received are frankly loaded with praise. The appreciation of people who now have a chance to see launch sites in operation, where history is in the making each week—it just overwhelms them. Quite frankly, instead of sampling so much favorable comments, we try to track down every complaint.

For example, our bathroom facilities are quite primitive at this outpost site near U.S. 1. Our drinking water is bottled; and our buses are noisy, because they are well-worn Greyhound-type buses which were acquired on short notice. There are occasional complaints about these creature comforts, and these can be corrected with the new facilities. However, on the substance of the tour itself, it is very gratifying to see the kind of grateful pilgrimage people make to come down to see what this new space age is all about.

Mr. WAGGONER. What do you charge for a tour?

Mr. SIEPERT. The price for the tour is \$2.50 for an adult, and we have a youth rate of \$1.25, and a child's rate, below 12 years of age, of 50 cents. This is for a tour that lasts between 2¼ and 2½ hours, and covers, as I indicated, both the Apollo facilities on Merritt Island and the Cape Kennedy launching sites. They go up ICBM row, see the Air Force Space Museum's collection of ballistic missiles, and stop off at the sites of the first space flight of Explorer I and the Mercury-Redstone manned launches. This is one of the reasons we want to re-create and re-equip pad 56 as it was when Shepard flew from there.

Chairman TEAGUE. What about groups? Boy Scouts?

Mr. SIEPERT. We have developed a special educational lecture program for Boy Scouts and other organized youth groups. They make the tour at a special group rate of \$1 per student. In addition, we use

our own civil service people and some LTV contractor staff to give special space lectures in our auditorium to such school age groups. By advance registration, these groups are beginning to make trips from all over Florida and the nearby Southeastern States. Mr. Gordon Harris, the public affairs officer, can probably tell us the maximum number of students we have had on one day.

Mr. HARRIS. About 550 in these groups.

Mr. SIEPERT. The special lecture lasts about 40 minutes and displays various launch vehicle and spacecraft models, and explains their development and the mechanics which govern their flight into space. These lectures are well received. It is, however, as the contractor points out to us, what would be called a loss leader, because this special program idles vehicle equipment and bus escorts while the lecture is presented. But we feel these special arrangements for student age groups are something we ought to do, and do well.

Mr. WAGGONNER. In consolidating the support services, one of the proposals was for reducing the number of contracts from seven to four. You isolated two areas. One was transportation for tours, you were going to detach yourself from this, and go to a separate contractor.

If the Government is going to spend this money and going to charge a reasonable fee for the tours, we are not going to provide the facilities and give somebody a contract to get fat, also?

Mr. SIEPERT. Our present tour experience gives us a good base for gaging what kind of money a concessionaire will make.

Mr. WAGGONNER. You are going to monitor the control and not let him charge what he likes?

Mr. SIEPERT. We control or approve his fee scales, the tour routes, the accuracy of the tour commentaries, and the prices of any products, services, or souvenirs that we approve for sale. We feel this is essential in order that NASA can indeed retain responsibility for the character and quality of the tours.

Mr. PARKER. But the contractor will have to furnish the buses, where the Government is now going in.

Mr. SIEPERT. This is a significant capital investment. The buses to do this job may run into several millions of dollars. That's why we had the General Services Administration initially lease buses on a short-term contract. No operator could take the risk to buy buses for an uncertain and short-term operation.

Mr. WAGGONNER. The attitude prevalent is that it is the taxpayer's dollars; they should be able to see your installation for nothing?

Mr. SIEPERT. Some people feel this way. We do not really believe that it is national policy, with respect to free admittance to national parks and other historical places.

Mr. WAGGONNER. There is now. It's in the law.

Mr. PETRONE. In the tours we have arranged you can drive your own car.

Mr. WAGGONNER. We are rid of that policy. We have a set fee established by Congress for national parks in those areas now.

Mr. SIEPERT. But there is a fee?

Mr. WAGGONNER. Right. Two years old.

Mr. SIEPERT. We have straddled this point for those folks who believe they should not spend money to see such a tour. Every Sunday these facilities are open and you may drive through in your own car without charge. You may not stop, because we can't control the operation that well. Visitors are given some explanatory literature, drive around, and get an idea of the general layout.

Mr. WINN. What do you give to them?

Mr. SIEPERT. To take away?

Mr. WINN. Yes. What do they take home as a souvenir?

Mr. SIEPERT. They receive a very brief pamphlet at the gate. From our standpoint, this is quite inadequate, and will be improved once a new concessionaire contractor is operating on a sound economic basis.

Mr. WINN. Do these educational groups receive anything besides that?

Mr. SIEPERT. Mr. Harris, the Director of Public Affairs? Do they give them anything there?

Mr. HARRIS. Just the same, again.

Mr. WINN. I think, this is my personal opinion, that if you are going to specialize in education groups you should give them something to take home that is of educational benefit, and not a picture or brochure.

Mr. SIEPERT. One suggestion which I might mention, is one of the many ideas that died. We considered this about a year and a half ago. It was suggested that we give these youngsters a paper cutout for assembly into a Saturn V rocket. It was a beautiful cutout. When we put it out for experimentation in certain classrooms, we found it was too frustrating to complete its assembly.

Mr. WINN. That's a gimmick. I'm talking about something educational.

Mr. SIEPERT. That's the conclusion we reached. It was a gimmick.

Mr. WAGGONNER. I am talking about something that they could study in their classes. This is a gimmick.

Mr. HARRIS. We have developed it for the schools.

Mr. WAGGONNER. I see.

Mr. HARRIS. We have material for the schools to use and special material designed to meet the needs of advanced educational activities.

Mr. SIEPERT. There are extensive educational kits, but your suggestion is a good one. Why don't we produce a specific piece of material for certain age groups?

Mr. WINN. You will have to do it with certain age groups. What are your age groups on the tour? What are their ages?

Mr. HARRIS. We take them from babies up. As far as the school is concerned, we start with kindergarten and run on up.

Mr. SIEPERT. Would you have any judgment as to what proportion of youngsters, Mr. Harris?

Mr. HARRIS. No, I do not have the figures. Most of them fall in the group from the seventh grade to the 12th grade.

Mr. SIEPERT. Well, that is the picture, and we believe that after this concessionaire competition, we will have a good, sound contract; any doubts as to whether we can control what the contractor does have been resolved in this particular experience.

Mr. WAGGONNER. You are not going to let the contractor have the souvenir concession?

Mr. SIEPERT. Everything he sells must be approved by us. At the present time, the average revenue per participant is \$2.57 per person, including tour costs.

Mr. WINN. Haven't I seen in the papers somewhere that some of these vendors have set up on the highway, with merchandise, selling souvenirs outside?

Mr. SIEPERT. There are none, let us say, hawking goods directly outside the gate. None of that area has been commercially built up, but all of the community drugstores and motels have various kinds of souvenirs about the spaceport.

Chairman TEAGUE. What comments do you hear about the cost of the tours by people who go through them?

Mr. SIEPERT. You can hardly pick out that type of complaint in the noise of it. There are a very few folks who complain on whether the tour was worth the cost; or the other question arises: "I shouldn't have to pay to see what I, as a taxpayer, have already invested in." You might get that complaint, but TWA tells us this frequency is less than one out of every thousand visitors.

Mr. Chairman, one of the complaints we have heard more frequently than others is that they do not feel that they should pay for the use of a toilet. We had authorized the contractor to put in coin-operated facilities, but both we and the contractor now agree that the revenue does not pay for the upkeep of the restrooms. We are eliminating the complaints by closing the coin boxes.

Mr. PARKER. That has been done.

Mr. SEIPERT. And so, the toilet facilities in the new project will not be on a pay basis.

Mr. WAGGONNER. Don't let the initial proceeding for your transportation and concession contracts, and so forth, be so long that you can't adjust them as the program builds, develops, and improves.

Mr. SIEPERT. We have developed, in our procurement plan, which is now in Washington for review and approval, a priority on the uses of any revenue which the concessionaire collects.

The priorities on revenue use would be as follows: First, out-of-pocket direct costs; second, when revenues exceed direct expenses, a preagreed minimum fee; third, expenditures to improve the quality of the tours and services to the visitors; fourth, a reduction, whenever possible, in the tour fees charged the public.

And fifth, contractual provisions to transfer any surplus to miscellaneous receipts to the Treasury.

We do not feel that the public's opportunity to see the national spaceport should be set up as a money-raising venture for the Federal Government. Nor should the operating costs of such tours be subsidized by continuing appropriations, when reasonable fees can make this function self-sustaining. We will make certain that there are definite limitations on the profit the concessionaire may make, but do believe that if he does a good job, he is entitled to a fair return for his efforts.

Mr. WINN. For the length of time, particularly on buses and guides, you have to sign a pretty good contract for the buses.

Mr. SIEPERT. This is an important consideration. The contract will be set up for a 5-year-minimum term, renewable or extendable annually up to a total period of 10 years, so he is assured time for reasonable amortization of his vehicle equipment.

Chairman TEAGUE. I get the impression you people are fairly well satisfied with your construction plan and everything.

Mr. SIEPERT. Yes, we are. It was our judgment that it would be inadvisable to request the additional funding for permanent visitor information center at this time, because it was considerably more money than we think is necessary at this time in order to properly handle public visitors in the next few years. This plan will give us the experience on which we should be able to come forward at the proper time with any necessary refinements or changes which should be included in permanent visitor information center.

Mr. WINN. Maybe I missed it. I think you gave the square footage of the temporary building.

Mr. SIEPERT. 20,800 square feet.

Mr. WINN. Each building?

Mr. SIEPERT. No. This is the total usable space.

Mr. WINN. Total, 20,800?

Mr. SIEPERT. That's right.

Mr. WINN. How much money did you say?

Mr. SIEPERT. The building itself? The building is \$243,000.

Chairman TEAGUE. Dr. Debus, is there any kind of proposal for a memorial for astronauts? I sure wish you people would do something about a museum down here, as a memorial.

Dr. DEBUS. Well, some proposals already have been offered on behalf of the astronauts' families. I think Mr. Webb at the present time does not want to press any particular approach—let it rest several months—and whatever the memorial is going to be, whether it might be in Houston, here, or any other place, he wishes the families to have a say in that. And so, NASA is collecting any ideas, presently looking forward to a time for decision.

Chairman TEAGUE. My guess is, unless Congress does something, we won't do anything. I haven't heard anything that appeals to me as much as a museum down here, that you can add to as the years go by, in line with the history which is made through our progress in space.

Thank you very much, Kurt, and all you good people.

Hearing adjourned at 1:45 p.m.

CONTRACTOR BRIEFINGS FOR CONGRESSMAN OLIN E. TEAGUE, CHAIRMAN, AND THE HOUSE SUBCOMMITTEE ON MANNED SPACE FLIGHT

JOHN F. KENNEDY SPACE CENTER, FEBRUARY 25, 1967

INTRODUCTION

A series of presentations were made to Mr. Teague and other members of the Subcommittee on the morning of February 25. These presentations were made during visits to some of the work areas in the Vehicle Assembly Building at Launch Complex 39. Dr. Kurt H. Debus, the Center Director, and other members of his staff accompanied Mr. Teague on these visits. Attached is a short summary of each presentation with appropriate charts and photographs. The following presentations were made:

Douglas Aircraft Company: Mr. K. J. Young, Deputy Senior Director of Florida Test Center.

Bendix: Mr. F. W. Vaughn, General Manager, Launch Support Division.

TWA: Mr. R. W. Wilson, Staff Vice President and KSC Project Manager.

RCA: Mr. Edward Sears, Project Manager of KSC Communications Project.

Each presentation was followed by a question and answer period. Subjects discussed during these periods included:

- a. Manpower including source, attrition, training, morale and capabilities.
- b. Amount of subcontract work and the relationship to small businesses.
- c. Interfaces with government personnel and with other contractors.
- d. Relationship of KSC contractor element with their parent corporation.

BRIEFING FOR CONGRESSMAN OLIN E. TEAGUE, CHAIRMAN, AND THE HOUSE SUBCOMMITTEE ON MANNED SPACE FLIGHT

JOHN F. KENNEDY SPACE CENTER, FEBRUARY 25, 1967

By K. J. YOUNG, DEPUTY SENIOR DIRECTOR OF FLORIDA TEST CENTER,
DOUGLAS AIRCRAFT CO.

Douglas mission at the Kennedy Space Center is checkout and launch of the SIVB stage on the Saturn Uprated IB and Saturn V vehicles. This is accomplished in conjunction with NASA and the industry team illustrated on the chart.

Checkout and launch at the Kennedy Space Center on a typical stage is accomplished in three phases: (1) a short period in the low bay position, (2) a relatively long period in high bay on the mobile launcher, and (3) a final period of activity at the launch pad. The stage is erected in low bay directly after arrival from the Sacramento Test Center where the stage was static fired. In this position, receiving inspection and initial preparation for testing is performed. After completion of low bay activity, stacking of the stages occurs in the high bay. SIV, SIVB and IU are erected and subsystem testing of the individual stages begins. Final modifications resulting from recent design or flight data are accomplished during this period.

It is at this time in the high bay that the various stages of the launch vehicle and their respective GSE and software have their first opportunity to functionally, physically, and procedurally interface. Integrated vehicle tests are conducted to simulate prelaunch and flight sequences within the earth defined environmental and operational limits. At the launch pad, final installation of ordnance devices occurs in conjunction with various propellant loading operations. Flight readiness testing simulating mission sequence is again accomplished prior to entering into launch countdowns to assure successful accomplishment has been obtained of all previous preparations, arming and checkout operations.

This chart depicts actual headcount of Douglas personnel at the Kennedy Space Center versus headcount projected against the 4D Contract Schedule. Difference in levels has been heavily influenced by Saturn/Apollo schedule changes. Staffing of personnel has been restricted to usage requirements by Douglas management direction to avoid personnel being added to the program prior to need.

This chart indicates manufacturing personnel are being primarily hired within the Kennedy Space Center area. Engineering, however, places emphasis on obtaining personnel from other Douglas locations to assure prior technical development and design familiarity before operational involvement. Experience from Saturn I, Thor-Delta and other non-Douglas programs in the area is a significant contribution to the SIVB team.

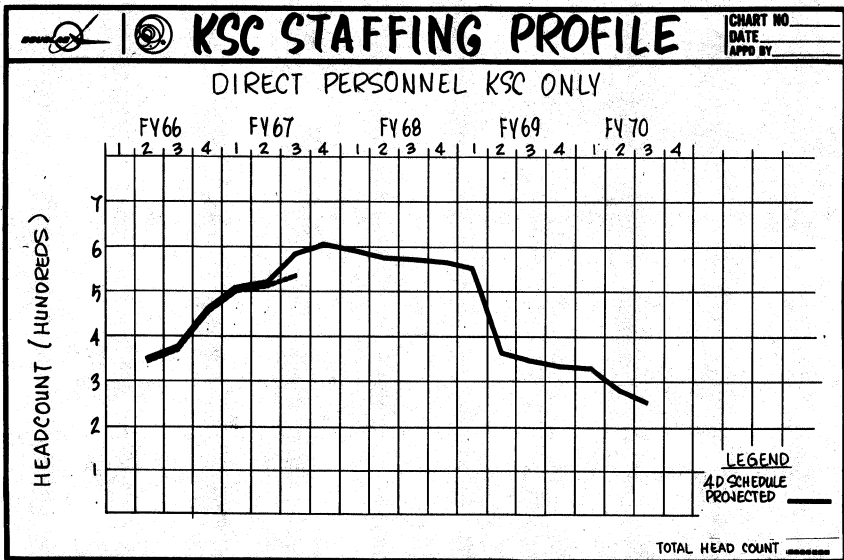


CHART 3.—SIVB KSC staffing profile.

STAFFING PLAN-		
DOUGLAS PERSONNEL AT KENNEDY SPACE CENTER ARE BOTH LOCALLY HIRED AND TRANSFERRED FROM OTHER DOUGLAS LOCATIONS		
	MANUFACTURING PERSONNEL	ENGINEERING PERSONNEL
LOCAL HIRES	79 %	21 %
LOCAL HIRES WITH MISSILE EXPERIENCE OBTAINED WITH OTHER CONTRACTORS	45 %	10 %
HAVING SATURN I EXPERIENCE	33 %	43 %
HAVING THORDELTA EXPERIENCE	60 %	25 %
TOTAL S-IVB PERSONNEL	187	241

CHART 4.—Staffing plan.

BRIEFING FOR CONGRESSMAN OLIN E. TEAGUE, CHAIRMAN, AND THE HOUSE SUBCOMMITTEE ON MANNED SPACE FLIGHT

JOHN F. KENNEDY SPACE CENTER, FEBRUARY 25, 1967

By F. W. VAUGHN, GENERAL MANAGER, LAUNCH SUPPORT DIVISION, THE BENDIX CORP.

The Launch Support Division of The Bendix Corporation, under Contract NAS10-1600, provides mission launch support services to all NASA programs at the Kennedy Space Center. This division, in its third contract year, is presently staffed with over 2,000 engineering and technical personnel who are widely dispersed at KSC due to the complex operations of various systems and facilities of test, checkout, and launch. The key activities or functions under Bendix' responsibility are:

Technical Shops.—This department provides spacecraft and stage contractors with technical support services by operation of the following major shops: Machine, Mechanical Repair, Electronic, Electrical, Paint, Pneumatic, Wire Cable, and Heavy Equipment.

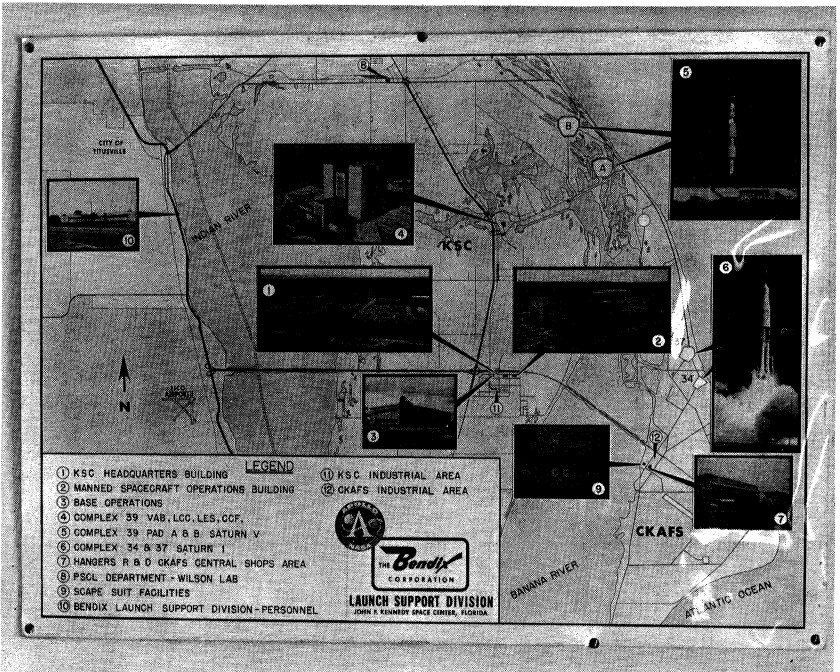


FIGURE 1

Propellant Systems Components Laboratory.—This department handles sampling and analysis of propellants and gases, in-place field cleaning and component cleaning of propellant system hardware, and non-destructive testing of equipment and materials.

Propellant, Life Support and Ordnance.—The task of transferring, storage, and delivery of cryogenic and hypergolic fluids is an operation performed by this department and also maintaining the integrity of the spacecraft gas and propellant lines at the launch pad. This organization receives, stores, and delivers ordnance items, and provides life support equipment for all KSC personnel requiring splash suits, self contained atmospheric protective ensembles used in the presence of toxic fuels, and provides maintenance, testing, and refilling of portable astronaut ventilators.

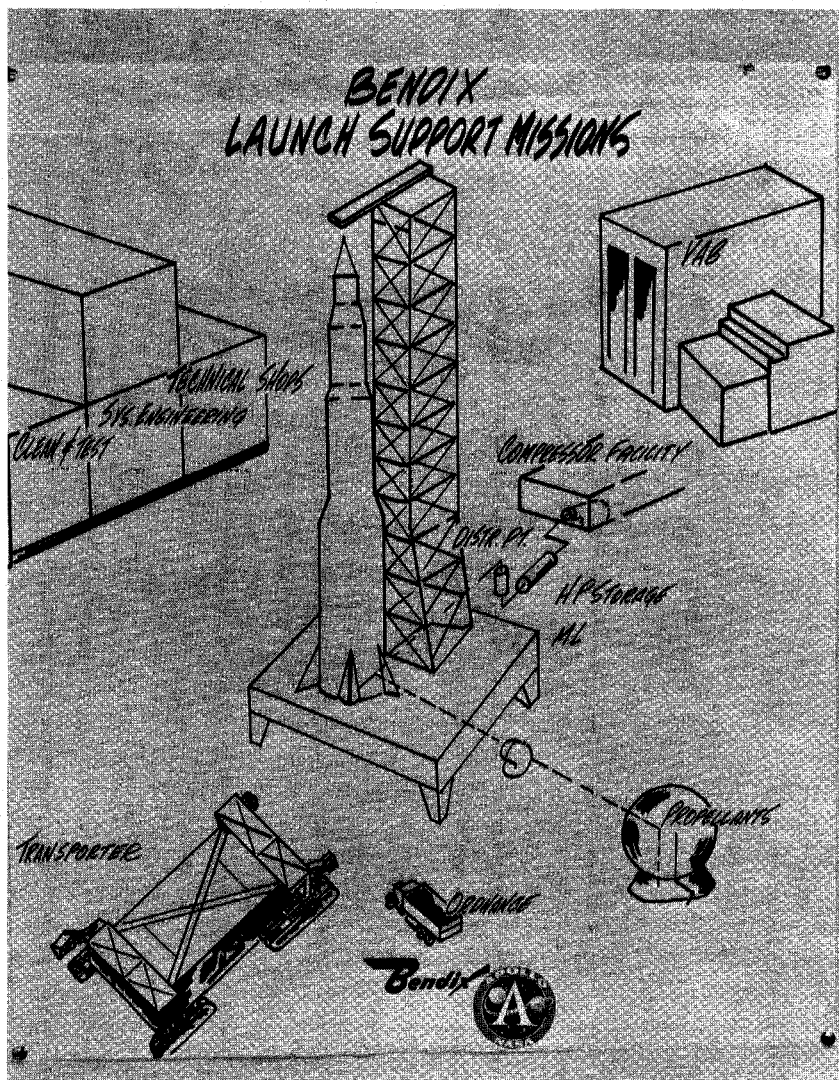


FIGURE 2

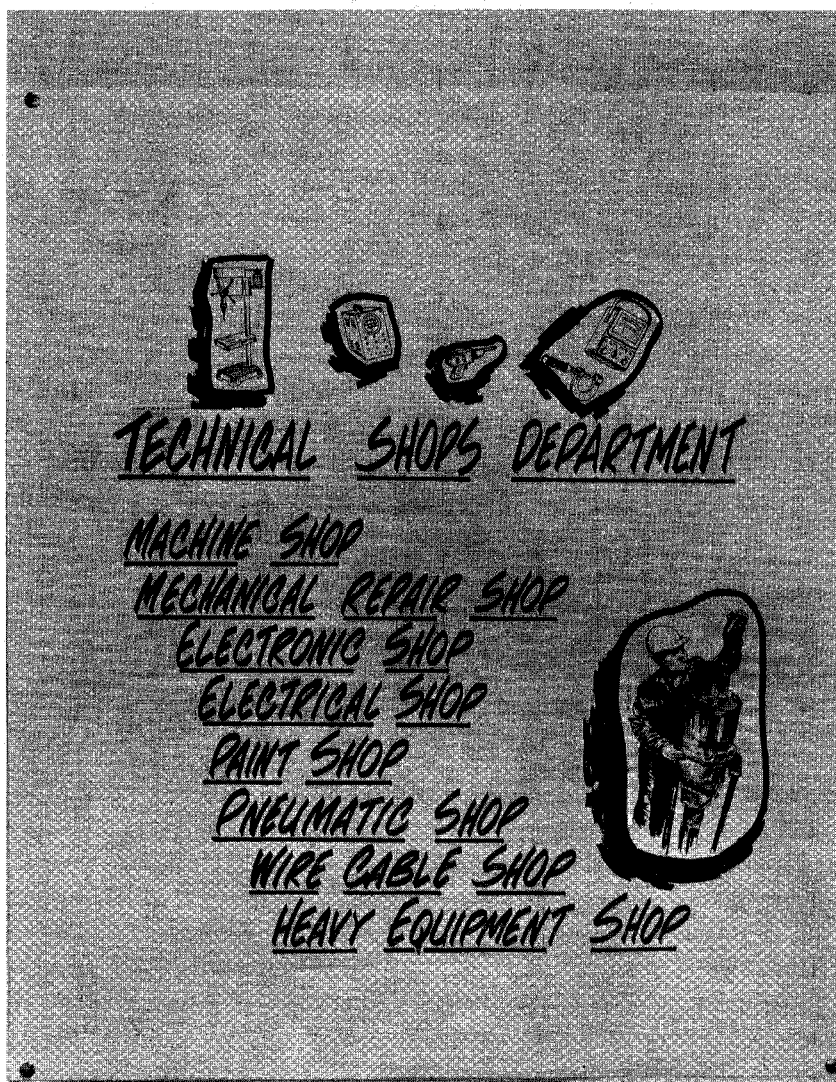


FIGURE 3

PROPELLANT SYSTEMS COMPONENTS LABORATORY DEPARTMENT

SAMPLING AND ANALYSIS
IN-PLACE FIELD CLEANING
LABORATORY CLEANING

DISASSEMBLY
REPAIR
CLEANING

NON-DESTRUCTIVE TESTING
X-RAY
ULTRASONICS
DYE PENETRANT



FIGURE 4

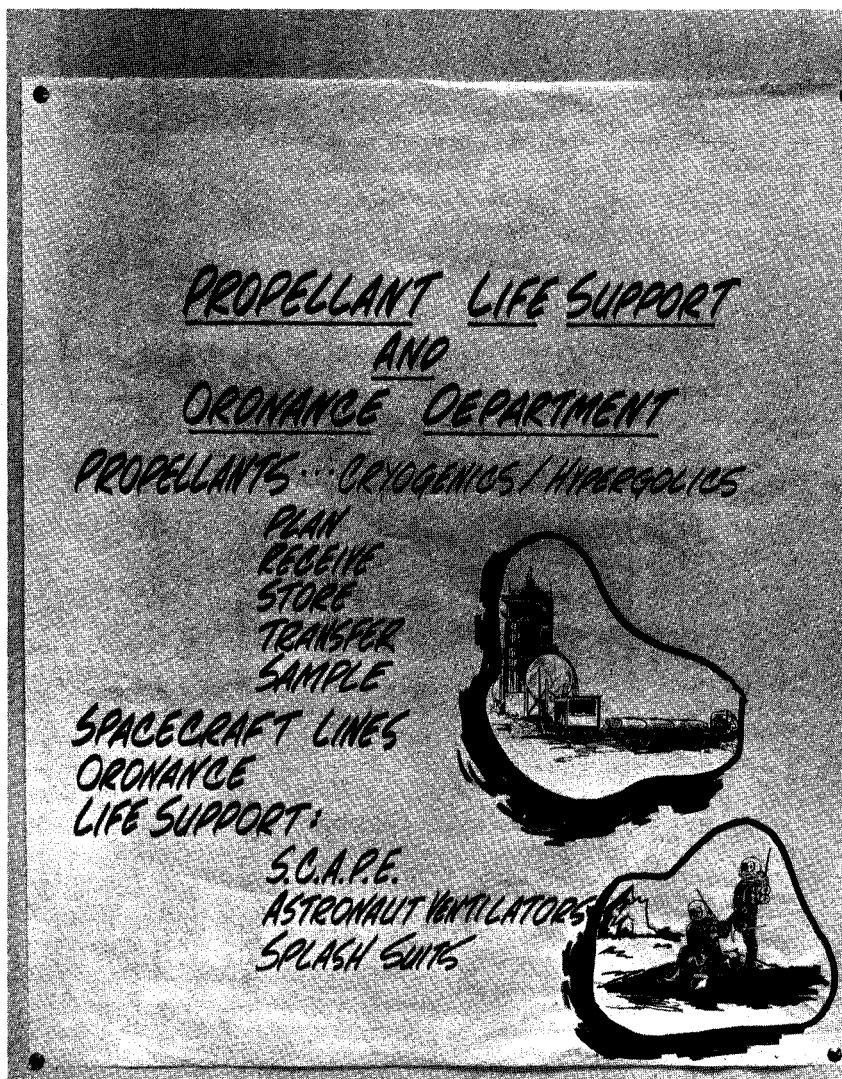


FIGURE 5

Systems Safety Support.—This element insures safety of test operations at KSC and assures compliance with Safety Directives by surveillance of activities involving Saturn IB and Saturn V vehicles, manned spacecraft, and propellant/ordnance operations.

Industrial Operations.—This department provides site management of spacecraft checkout facilities, operates and maintains technical systems consisting of access doors, bridge cranes/hoists, cryogenics and high pressure gas systems, altitude chambers, and furnishes miscellaneous mechanical/electrical support in the Manned Spacecraft Operations, System Test, Hypergolic, Cryogenics, Pyrotechnics Installation, and Flight Crew Training Buildings.

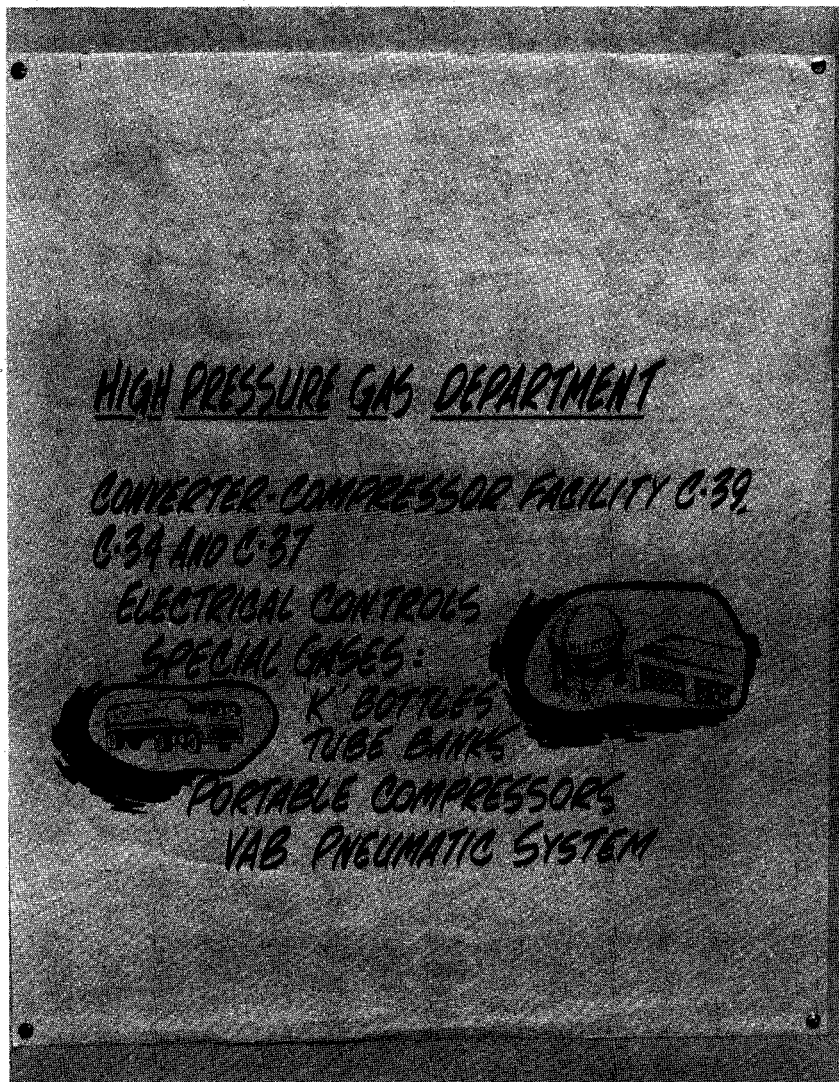


FIGURE 6

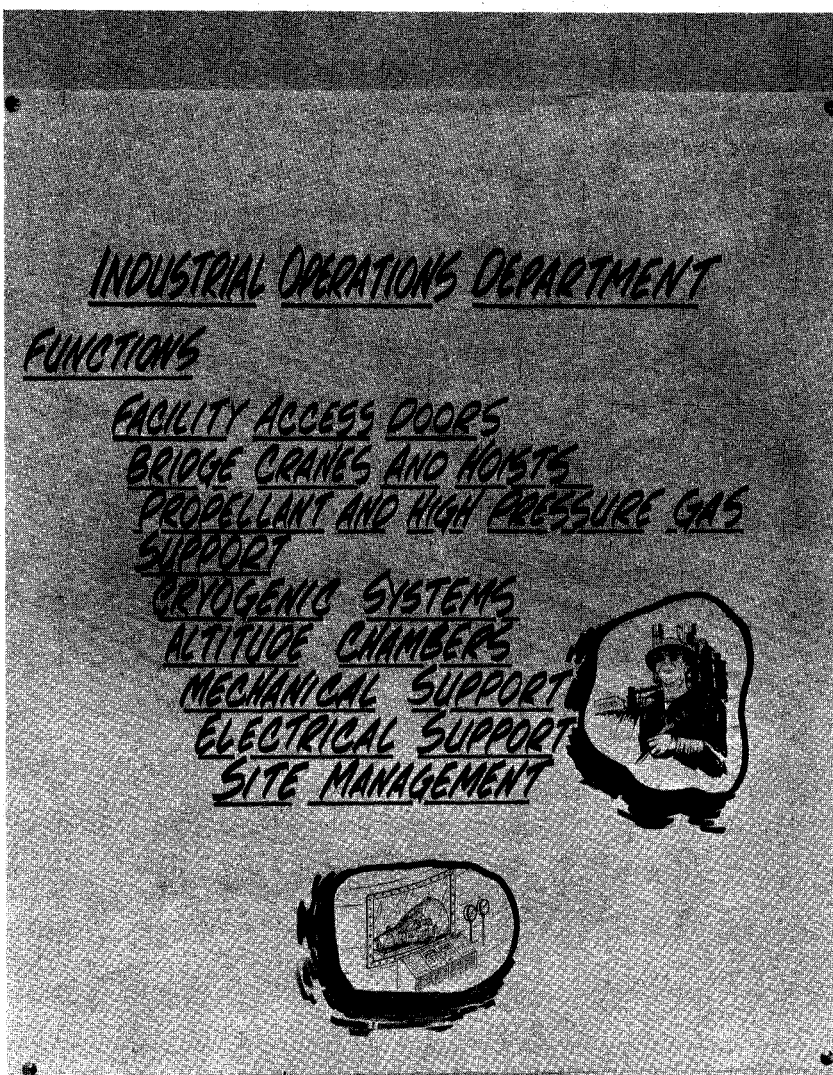


FIGURE 7

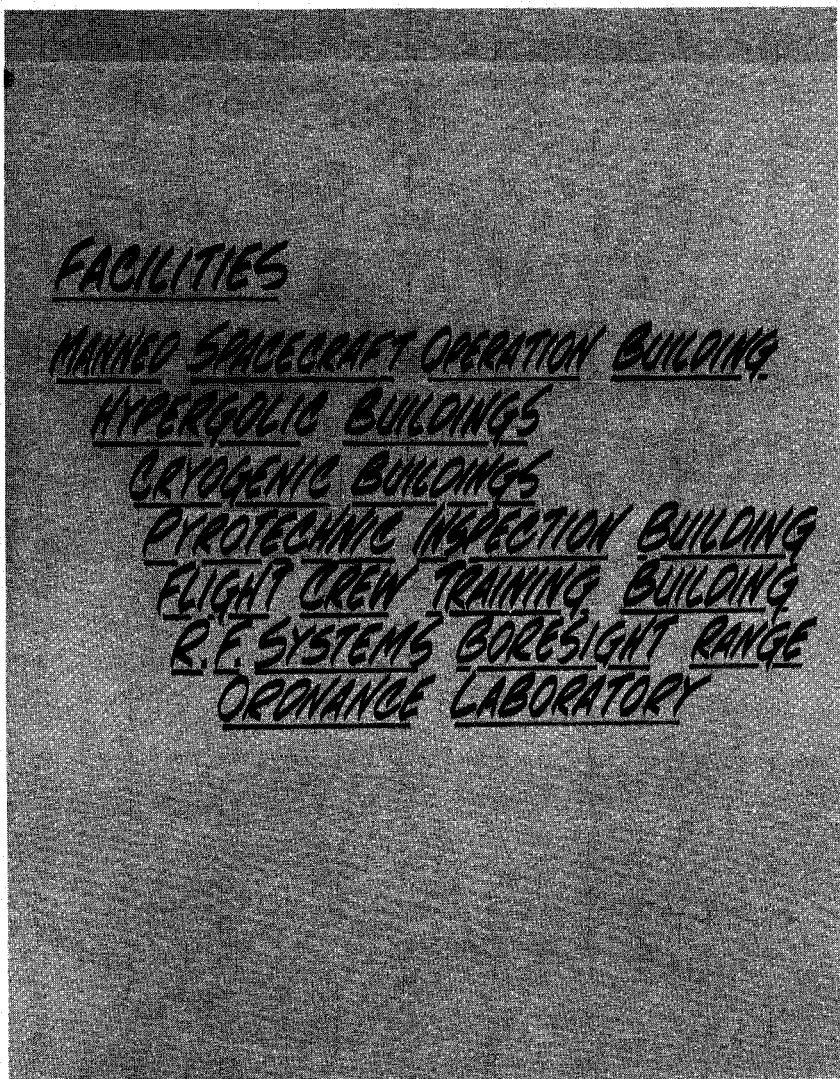


FIGURE 8

High Pressure Gas Support.—This organization operates and maintains converter compressor facilities at Complexes 39, 37 and 34 for gaseous nitrogen, & helium used for purge, pressurization and environmental control of launch facilities and vehicles. Additionally, they maintain and operate portable compressors, pressurized K-bottles and tube banks used throughout the Center, and assure the integrity of numerous high pressure pneumatic systems.

Complex 39.—This department provides site management in the Saturn V checkout and launch facilities, operates and maintains bridge cranes, hoists, 28V/400 cycle DC power, cathodic and lightning protection, air conditioning at pad terminal connection rooms, hydraulic controls, compressed air, access doors and vehicle access platforms, firex and industrial water systems, foam generation equipment, flame deflectors, diesel pumps and generators. The facilities

involved for these functions are the Vehicle Assembly Building, Launch Control Center, Mobile Service Structure, Complex 39, Pads A and B, Mobile Launchers, Crawler Transporters, Water Pump Stations, and Mobile Refrigeration Units.

The division also has Engineering Services, Reliability and Quality Assurance personnel for system analysis and configuration control in the assigned areas. Bendix provides logistic support of mission peculiar equipment spares for the systems under its control.

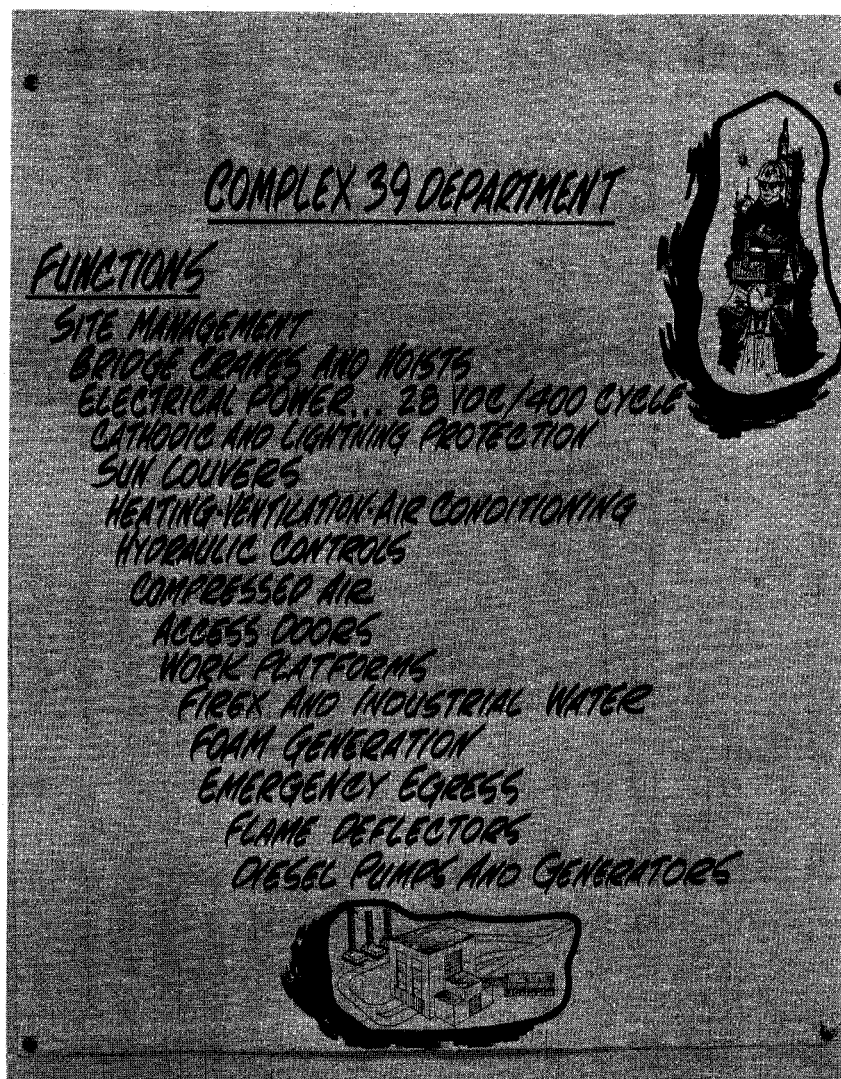


FIGURE 9

FACILITIES

VEHICLE ASSEMBLY BUILDING
LAUNCH CONTROL CENTER
MOBILE SERVICE STRUCTURE
COMPLEX 39 PADS... A (and) B
MOBILE LAUNCHERS
TRANSPORTERS
WATER PUMP STATION
MOBILE REFRIGERATION UNITS
KSC BARGE

FIGURE 10

BRIEFING FOR CONGRESSMAN OLIN E. TEAGUE, CHAIRMAN, AND THE HOUSE SUBCOMMITTEE ON MANNED SPACE FLIGHT

JOHN F. KENNEDY SPACE CENTER, FEBRUARY 25, 1967

By R. W. WILSON, STAFF VICE PRESIDENT AND KSC PROJECT MANAGER, TRANS WORLD AIRLINES, INC.

TRANS WORLD AIRLINES, INC., KENNEDY SPACE CENTER

MISSION HIGHLIGHTS

GENERAL MANAGEMENT

The Project Manager, a TWA Vice President, is responsible for total TWA performance at Kennedy Space Center. He is supported locally by an Administrative Support Staff composed of Industrial Relations; Finance & Accounting; and Contract Administration.

Industrial Relations is responsible for the direction of the following: Labor Relations, Employment, Personnel Services, Community Relations, Training and Wage & Salary Administration.

Finance & Accounting is responsible for the direction of the following: General Accounting, Financial Planning and Control, Payroll, Business Systems and Internal Audit.

Contract Administration is responsible for the administration of the prime contract and for administering all TWA subcontracts and for TWA purchases.

OPERATIONS SUPPORT

This department is responsible for coordinating the efforts of launch-related TWA personnel, assuring the advance identification of all launch support requirements, the effective and timely response to such requirements and the precise scheduling and reporting required for overall integration of TWA effort into the launch operation.

Quality Assurance, safety and management engineering are also functions of the department.

MAINTENANCE & OPERATIONS

The M & O Department maintains and operates all buildings, ground facilities, facility equipment, utilities, mobile equipment (other than equipment maintained by Technical Support contractors), and provides other primary and secondary launch support services related to centralized functions. Included are:

Mail, Postal & Courier service

Plant Engineering

Central Shops (Electrical, Plumbing, Carpenter, Welding, Sheetmetal, Machine, Paint)

Building Maintenance

Relocation and Modifications

Janitorial and Special Cleaning

Heavy Mobile Equipment Maintenance & Operations, (cranes, generators, tractors, etc.)

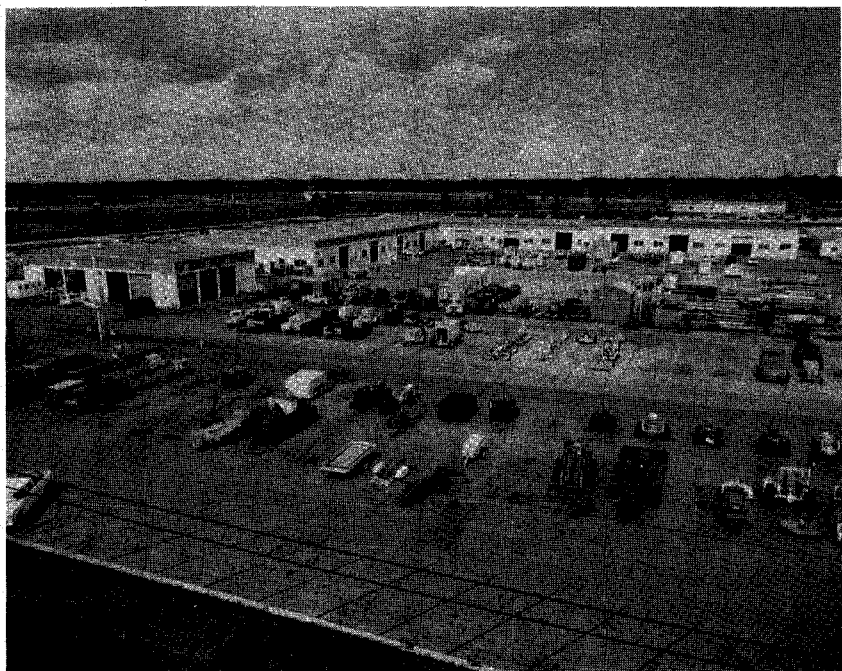


FIGURE 1.—TWA Heavy Equipment area showing a portion of the 1,000 vehicles used in various KSC Base Maintenance support mission.



FIGURE 2.—Interior of TWA's Maintenance and Operations Building showing one of the seven TWA shop areas.

Roads, Grounds and Land Maintenance
Sanitation and Pest Control
Canals and Waterway Maintenance
Mechanical Utilities (Air Conditioning, Heat Plants, Water & Sewage Systems)
Electrical Power Distribution

FIRE PROTECTION

Fire Protection Services include launch facility and systems inspection, fire prevention programs, rescue (including astronaut and missile recovery) and hazard monitoring functions. In addition to normal structural application these services and functions are incorporated into launch operations procedures and are an integral part of fueling and fuel transfer operations, liquid oxygen and other hazardous material handling operations and all general launch and test activities where fire potential exists.

SUPPLY OPERATIONS

TWA provides and operates the centralized supply function which supports NASA and all contractors at KSC. Included is material handling (receipt, storage and delivery), warehousing operations, transportation, cataloging, material management and logistics planning for all Government furnished materials used at KSC.

SECURITY

TWA provides launch area security and launch operations traffic control together with all other security and police functions at the Kennedy Space Center. This includes safeguarding of classified information, badging, area control, traffic control, plant protection, guide and escort service and contraband control.



FIGURE 3.—A portion of the fire and rescue equipment used at KSC. This mission is subcontracted by TWA to The Wackenhut Corporation.

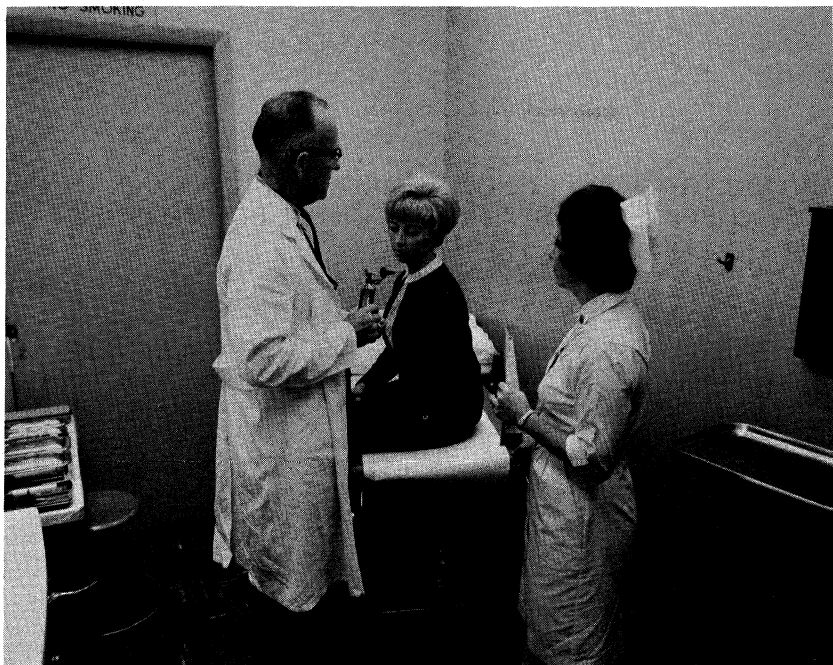


FIGURE 4.—One of the more than 10,365 examinations performed annually by the TWA operated KSC Occupational Health Facility.

OCCUPATIONAL HEALTH PROGRAM

The Occupational Health Program is geared to provide a wide spectrum of special physical examinations, laboratory tests and medical treatment of contractor and Government personnel involved in launch activities, e.g., propellant and fuel handlers, altitude chamber workers, solderers and welders, aircraft flight crews, etc. In addition, the Environmental Health Engineering Section performs field surveys and laboratory evaluations of KSC operational health hazards such as exposures to toxic solvents and proprietary chemicals, noise, radiation, oxygen deficient atmospheres, explosive mixtures and the spacecraft drinking water systems.

NASA TOURS

TWA in behalf of NASA operates guided daily bus tours of the Kennedy Space Center facilities and the Cape Kennedy launch areas. An average of 1500 people per day representing a majority of our states are taking the tour. Public reaction has been overwhelmingly favorable with the volume of participation forecast to increase sharply as information on the tours availability spreads.

In addition, TWA maintains space exhibits, models and graphic displays and provides supporting food, restroom and appropriate souvenir and sundry services.

The objective of the KSC Tours is to familiarize the public with the achievements and goals of their National Space Program. Since July 1967, over 200,000 individuals have toured the Kennedy Space Center.

BRIEFING FOR CONGRESSMAN OLIN E. TEAGUE, CHAIRMAN, AND THE HOUSE SUBCOMMITTEE ON MANNED SPACE FLIGHT

JOHN F. KENNEDY SPACE CENTER, FEBRUARY 25, 1967

BY EDWARD SEARS, PROJECT MANAGER OF KSC COMMUNICATIONS
PROJECT, RCA

SUMMARY OF BRIEFING

Presented to: Manned Space Flight Sub-Committee of the Committee on Aeronautical and Space Science.

Place: Communications Control Room, Launch Control Center, John F. Kennedy Space Center.

Mr. Sears explained that RCA's responsibilities as a Mission Support Contractor at KSC under Contract NAS10-1052 include operation and maintenance, planning, and engineering assistance to the design agency for ground communications systems at KSC and at NASA operated facilities at Cape Kennedy. The RCA Project at KSC is a member of the Field Projects branch of the RCA Government Services Division. In reference to the NASA KSC organization, the Project is responsible to the Director of Technical Support for contract performance. The Project was formed in January 1964 and now has a strength of approximately 500 personnel.

The Project is responsible for those communications systems used in direct support of tests and launches and indirect support systems. Direct support systems include Operational Intercommunication Systems (OIS) used to coordinate critical operations and Operational Television (OTV) used to monitor hazardous operations. The direct support systems are identified in the Apollo Ground Support Equipment Criticality list as Category II systems. This means that a failure in these systems could result in damage to the space vehicle and/or launch complex, or rescheduling of the test or launch date. Indirect-support systems are administrative intercommunications, public address and paging, and mobile radio, to name a few. Due to the vastness of KSC, the systems are quite far flung.

It was stressed by Mr. Sears that, due to the division of work among contractors at KSC, coordination of efforts is of the utmost importance. Since no one contractor can perform independent of the others, responsiveness and cooperation form the key to successful attainment of the objectives. To gain the needed coordination, all test and launch support is identified and programed in advance so that all contractors know exactly what they are to provide.

For each test and launch, the RCA Project reviews all communications support requirements submitted by user activities and determines whether existing resources are capable of providing the support. For those cases where resources are not adequate, coordination with user activity is accomplished to develop alternate methods of support or the requirements are submitted to the design agency, who provides for the needed modification or expansion of facilities. Following review of support requirements, the Project submits documentation through channels to the Test Support Management Office of the Technical Support Directorate committing the necessary resources and thereby assuring adequate provision of support.

Prior to the test or launch, the Project establishes the proper system configurations (in accordance with the support commitments described in previous paragraph) and validates the system to ensure operating parameters are met. Once validated, the systems are protected to ensure that no action is taken that could interrupt operation of communications needed for critical operations.

During test and launch operations, Project personnel man stations to assist user activities in operation of communications and to effect immediate corrective action in the event of trouble. To provide maximum support to the Test Conductor, single point communications control is exercised. The Communications Control point keeps the Test Conductor advised on the status of communications and coordinates to provide rapid response to new or changed support requirements.

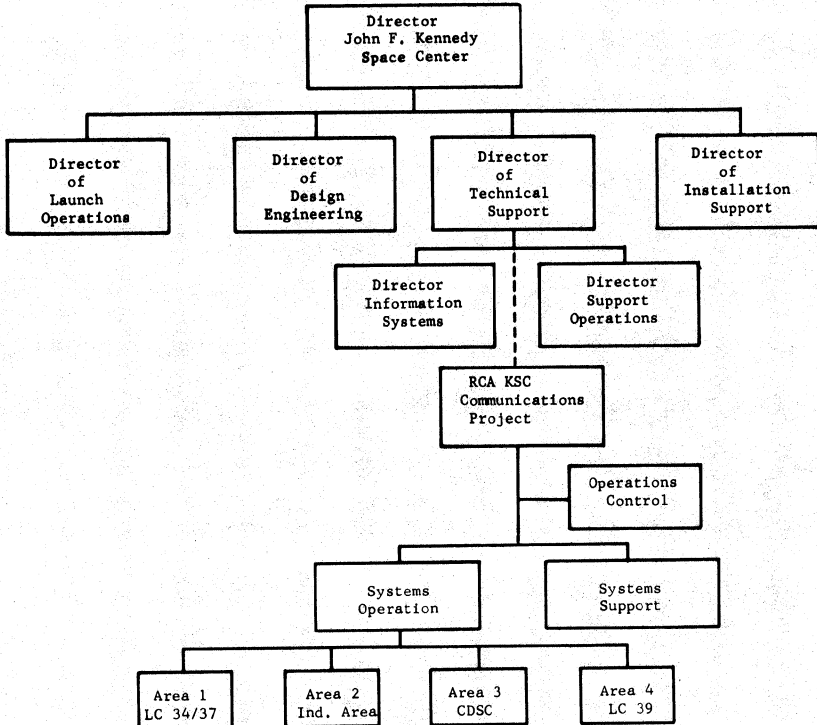
ATTACHMENTS TO SUMMARY OF BRIEFING

RCA RESPONSIBILITIES

UNDER CONTRACT NAS10-1052

- OPERATE AND MAINTAIN GROUND COMMUNICATIONS AT KSC AND NASA OPERATED FACILITIES AT CAPE KENNEDY.
- PERFORM COMMUNICATION PLANNING TO ASSURE DEVELOPMENT OF AN OVERALL INTEGRATED COMMUNICATIONS SYSTEM THAT MEETS KSC'S PRESENT AND FUTURE NEEDS.
- PROVIDE ENGINEERING SERVICES FOR THE MINOR INSTALLATIONS, REARRANGEMENTS, AND MODIFICATIONS OF COMMUNICATIONS EQUIPMENT NECESSARY TO MEET TEST AND LAUNCH SUPPORT REQUIREMENTS.

RCA Responsibilities under Contract NAS10-1052



Relationship of RCA KSC Communications Project to NASA KSC Organization

TYPES OF COMMUNICATION SYSTEMS USED AT KSC

DIRECT MISSION SUPPORT

OPERATIONAL INTERCOMMUNICATIONS SYSTEM(OIS)
 OPERATIONAL TELEVISION (OTV)
 POINT-TO-POINT TELEPHONE
 CABLE PLANT AND ASSOCIATED EQUIPMENT
 OFF-SITE INTERFACES
 TEST AND SWITCHING CENTER
 COMMUNICATIONS CONTROL

INDIRECT MISSION SUPPORT

ADMINISTRATIVE TELEPHONE
 ADMINISTRATIVE INTERCOM
 MOBILE RADIO
 PUBLIC ADDRESS(FA)AND PAGING
 TELETYPE
 FACSIMILE
 RECORDING
 BROADCAST VAN
 NEWS CENTER
 TELEVISION FOR SECURITY AND VISITOR
 INFORMATION CENTER

Types of KSC Communications Systems

TYPICAL USES OF DIRECT

SUPPORT COMMUNICATION SYSTEMS

OIS

COMMUNICATIONS DURING:

- . UNLOADING OF NEWLY ARRIVED VEHICLE AND HARDWARE
- . STACKING IN VAB
- . CHECKOUT OPERATIONS IN VAB
- . TRANSFER TO PAD
- . CHECKOUT AT PAD
- . COUNTDOWN, LAUNCH AND POST LAUNCH OPERATIONS
- . SCAPE SUIT OPERATIONS

OTV

MONITOR TANKING OPERATIONS

MONITOR ENGINE START

MONITOR CRITICAL CLEARANCES DURING LAUNCH

MONITOR PAD PERIMETER FOR SAFETY AND SECURITY

MONITOR HYPERGOLIC AND CRYOGENIC STORAGE AREAS

RECORD SIGNIFICANT EVENTS FOR ANALYSIS AND TRAINING PURPOSES

PROVIDE LIVE PICTURES FOR RELEASE TO NEWS MEDIA

Typical uses of KSC Communications Systems

COORDINATION OF OPERATIONS

- . CONTRACTORS WORK IN INTEGRATED SUPPORT TEAMS.
- . RESPONSIVENESS AND COOPERATION IS KSC MOTTO.
- . TEST AND LAUNCH SUPPORT REQUIREMENTS ARE IDENTIFIED AND PROGRAMMED IN ADVANCE OF NEED SO THAT EACH CONTRACTOR KNOWS WHAT IS EXPECTED OF HIM.
- . MAJOR TEST AND LAUNCHES ARE SIMULATED FIRST TO CHECKOUT EQUIPMENT, AS WELL AS ENSURING THAT SUPPORT PROGRAMMED IS ADEQUATE.

Coordination of Operation

SEQUENCE OF EVENTS

FOR LAUNCH SUPPORT

1. REVIEW COMMUNICATIONS REQUIREMENTS AND SUBMIT INPUTS TO KSC SUPPORT DIRECTIVE.
2. CONFIGURE COMMUNICATION SYSTEMS IN ACCORD WITH PUBLISHED SUPPORT DIRECTIVE.
3. VALIDATE SYSTEMS TO ENSURE SATISFACTORY OPERATION.
4. PROTECT SYSTEMS UNTIL SUPPORT IS COMPLETED TO ENSURE CRITICAL CIRCUITS ARE NOT DISTURBED.
5. PROVIDE ASSISTANCE TO USER ACTIVITIES IN PROPER USE OF SYSTEMS.
6. TAKE IMMEDIATE CORRECTIVE ACTION SHOULD A MALFUNCTION OCCUR.
7. BE PREPARED TO MEET ADDITIONAL SUPPORT REQUIREMENTS AS REQUESTED BY TEST CONDUCTOR.

Sequence of Events for Test and Launch Support

PRESENTATION TO THE CONGRESSIONAL SUBCOMMITTEE ON MANNED SPACE FLIGHT BY THE JOHN F. KENNEDY SPACE CENTER, NASA, FEBRUARY 24, 1967

INDEX TO COMPILED INFORMATION IN REPLY TO INQUIRIES

I. Programs and Projects:

(a) Fiscal:

- (1) 1968 budget allocation by major programs with consistent comparable budget for fiscal years 1965, 1966, and 1967, including current total cost to completion estimates for each major program.
- (2) Analysis of fiscal year 1967-68 budget realignment by programs.
- (3) Actual versus planned expenditure by programs for fiscal years 1965, 1966, and 1967 (to date).
- (4) Budget requested by Center for fiscal year 1968, amount reduced and final budget.
- (5) "No-year" funds carryover by programs for fiscal years 1964, 1965, and 1966.
- (6) List of research and development contracts in order of dollar value currently in force.
- (7) List of construction contracts with estimated completion date and total costs.

(b) Procurement for research and development:

- (1) Number of procurement plans submitted to Center director (less than \$5 million).
- (2) Number submitted to NASA Headquarters (more than \$5 million).
- (3) Exceptions to (1) and (2) above.

(c) Contracts (calendar year 1966):

- (1) Number of competitive participants in each R. & D. negotiated contract.
- (2) Fixed price contracts converted to CPIF.
- (3) Contracts scheduled to be converted to CPIF.
- (4) Contracts to a review board to determine final fee.
- (5) Contracts renegotiated.
- (6) Organization identification of contract approval authority (organization level and type of authority).
- (7) Percentage of contracts to small businesses.

(d) Facilities:

- (1) Status of facility planning, design and construction for fiscal years 1965, 1966, 1967, and 1968.
- (2) Listing of cost-plus-fixed-fee contracts entered into for facility management, services and construction.
- (3) Estimated future construction fund requirements for facilities and general description of probable work.

II. Management:

- (a) Changes in organization chart from 1966 with identification of mission relationship of each major subarea.
- (b) Number and cost of contracts administered by other Government agencies identified in 0-\$100,000, \$100,000-\$500,000, and over \$500,000 contract value groupings.
- (c) Percent of overtime of total time on individual projects or programs over \$50,000.
- (d) Average annual cost of each direct Center employee, with comparison to previous year.
- (e) Listing of each support contract pertaining to KSC.

BUDGET SUMMARY, FISCAL YEARS 1965-68

REQUEST I(a) (1).—1968 budget allocations by major Manned Space Flight programs with consistent comparable budgets for fiscal years 1965-67

[In thousands of dollars]

	1965	1966	1967	1968
Research and development: Manned Spaceflight.....	56, 110	128, 859	224, 050	232, 200
I. Apollo.....	55, 610	128, 109	223, 450	228, 500
(1) Saturn I.....	5, 130	0	0	0
(2) Up-rated Saturn I.....	6, 625	25, 786	36, 800	28, 300
(3) Saturn V.....	12, 018	28, 386	83, 800	88, 800
(4) Launch operations and instrumentation.....	29, 917	65, 573	92, 600	100, 700
(5) Space operations.....	(¹) 7, 255	7, 255	9, 000	10, 200
(6) Supporting development.....	1, 920	1, 109	1, 250	2, 500
II. Apollo Applications.....	0	250	250	3, 300
III. Advanced missions.....	500	500	350	400
Construction of facilities: Manned Spaceflight.....	85, 004	6, 030	34, 021	22, 595
Administrative operations.....	52, 416	81, 952	92, 658	99, 575
I. Personnel costs.....	21, 462	29, 848	33, 579	35, 476
II. Operation of installation.....	30, 954	52, 104	59, 079	64, 099
Total.....	193, 570	216, 841	350, 729	354, 370

¹ Funded by MSC.

ANALYSIS OF FISCAL YEAR 1967-68 BUDGET REALINEMENT BY PROGRAM

REQUEST 1(a) (2).—Analysis of fiscal years 1967-68 budget realignment by programs

In both fiscal year 1966 and fiscal year 1967 the Apollo Applications activity was authorized as part of the Apollo program. In fiscal year 1967 funds were budgeted for Apollo Applications project definition. This activity has been combined into the Apollo Applications program.

ACTUAL VERSUS PLANNED MANNED SPACE FLIGHT OBLIGATIONS (R. & D. AND ADMINISTRATIVE OPERATIONS), FISCAL YEARS 1965-67

REQUEST I(a) (3).—Actual versus planned expenditure by programs for fiscal years 1965-67 (to date)

[In thousands of dollars]

	1965		1966		1967	
	Planned	Actual	Planned	Actual	Planned	Actual (through Dec. 31, 1966)
Research and development: Manned spaceflight.....	56, 110	56, 798	121, 109	128, 859	224, 050	116, 474
I. Apollo.....	55, 610	56, 329	120, 509	128, 109	223, 450	116, 474
(1) Saturn I.....	5, 130	5, 130	300	0	0	0
(2) Up-rated Saturn I.....	6, 625	6, 625	25, 700	25, 786	36, 800	24, 431
(3) Saturn V.....	12, 018	12, 018	32, 620	28, 386	83, 800	46, 055
(4) Launch operations and instrumentation.....	29, 917	30, 636	52, 080	65, 573	92, 600	41, 774
(5) Space operations.....	(¹) 7, 255	7, 255	9, 000	7, 255	9, 000	3, 929
(6) Supporting development.....	1, 920	1, 920	809	1, 109	1, 250	285
II. Apollo Applications.....	0	0	0	250	250	0
III. Advanced missions.....	500	469	600	500	350	0
Administrative operations.....	52, 416	52, 416	79, 723	81, 952	92, 658	50, 390
I. Personnel costs.....	21, 462	21, 462	30, 476	29, 848	33, 579	15, 995
II. Operation of installation.....	30, 954	30, 954	49, 247	52, 104	59, 079	34, 395
Total.....	108, 526	109, 214	200, 832	210, 811	316, 708	166, 864

¹ Funded by MSC.

STATUS OF MANNED SPACE FLIGHT FISCAL YEAR 1968 BUDGET, R. & D.

REQUEST I(a)(4).—*Budget requested by Center for fiscal year 1968, amount reduced and final budget*

[In thousands of dollars]

	Requested	Amount reduced	Final
Research and development: Manned spaceflight.....	246,800	-14,600	232,200
I. Apollo.....	242,500	-14,000	228,500
(1) Up-rated Saturn I.....	(26,800)	0	(26,800)
(2) Saturn V.....	(98,500)	(-5,000)	(88,500)
(3) Launch operations and instrumentation.....	(108,700)	(-8,000)	(100,700)
(4) Space operations.....	(11,200)	(-1,000)	(10,200)
(5) Supporting development.....	(2,500)	0	(2,500)
II. Apollo applications.....	3,800	0	3,800
III. Advanced missions.....	1,000	-600	400
Administrative operations.....	135,612	-36,037	99,575
I. Personnel costs.....	36,150	-674	35,476
II. Operation of installation.....	99,462	-35,363	64,099
Total.....	382,412	-50,637	331,775

STATUS OF FISCAL YEAR 1968 MANNED SPACE FLIGHT C. OF F. BUDGET AS OF JAN. 1, 1967

[In thousands of dollars]

Project title	KSC budget request	Amount reduced	Final budget
Manned space flight.....	53,092	-30,497	22,595
Launch complex 39.....	20,000	-3,340	16,660
Maintenance staging and heavy equipment building.....	1,865	-1,865	0
Propellant servicing area.....	2,875	-2,875	0
Utility installations.....	6,395	-6,185	210
Addition to plant maintenance facility.....	1,500	-1,500	0
Launch equipment shop additions.....	922	-922	0
Launch complex 39 operational spares building.....	500	-500	0
Addition to base operations building.....	3,391	-3,391	0
Launch complex 39 support building.....	381	-381	0
Alteration and rehabilitation of launch complex 34/37.....	14,585	-8,860	5,725
Gaseous helium storage and loading station.....	678	-678	0

FUNDS CARRYOVER, FISCAL YEARS 1964-66

REQUEST I(a)(5).—*No-year funds carryover by programs for fiscal years 1964-66*

[In thousands of dollars]

	1964		1965		1966	
	Available appropriations	Carry-over	Available appropriations	Carry-over	Available appropriations	Carry-over
Research and development.....	55,058	30	56,798	115	128,859	2,789
I. Apollo.....	54,646	30	56,329	114	128,109	2,539
(1) Saturn I.....	7,843	0	5,130	2	0	0
(2) Up-rated Saturn I.....	6,902	1	6,625	21	25,786	1,114
(3) Saturn V.....	9,788	0	12,018	1	28,386	61
(4) Launch operation and instrumentation.....	27,992	17	30,636	90	65,573	1,270
(5) Space operations.....	(¹)	(¹)	(¹)	(¹)	7,255	68
(6) Supporting development.....	2,121	12	1,920	0	1,109	26
II. Apollo Applications.....					250	0
III. Advanced missions.....	412	0	469	1	500	250

¹ Funded by MSC.

CURRENT R. & D. CONTRACTS

REQUEST I(a)(6). *List of R. & D. contracts in order of dollar value currently in force*

Contractor	Description	Amount
Boeing Co.....	Saturn V S-IC Stage support.....	\$55,277,263
Chrysler Corp.....	Operations and maintenance support, Uprated Saturn I.....	45,648,318
General Electric Co.....	Apollo integration reliability and checkout.....	39,779,597
Bendix Corp.....	Launch operations support.....	27,486,130
IBM.....	Launch support sources for Apollo-Saturn program.....	22,127,000
Bechtel Corp.....	Specialized launch complex support.....	15,207,155
Federal Electric Co.....	Instrumentation repair and calibration.....	10,550,125
Radio Corp. of America.....	NASA communications support.....	7,524,626
Dow Co.....	Facility planning support.....	5,779,078
North American Aviation.....	Launch support services for Apollo-Saturn program.....	3,620,037
Beech Aircraft Corp.....	Cryogenics.....	787,071
Douglas Aircraft.....	Saturn S-IVB Stage launch support.....	644,725
Wyle Laboratories, Inc.....	Reliability testing of Saturn ground support equipment components.....	274,435
Hayes International Corp.....	Development of high pressure pneumatic piping.....	266,662
The Boeing Corp.....	LH ³ loading system test program.....	257,295
Martin Marietta Corp., Denver.....	Study on SPREE, pt. II, phase II.....	228,641
Beech Aircraft Corp.....	Engineering services and studies of cryogenic systems and criteria.....	225,743
IBM Corp. Federal Systems.....	Study concerning transmitting information by optical electron.....	165,183
International Harvester Co.....	Design study of high-pressure low-flow-rate flexible connector systems.....	159,717
Lockheed Missile & Space Corp.....	Study concerning space checkout and launch equipment (scale).....	158,047
Martin Marietta Corp., Denver.....	Study determine detrimental effects solid propellant rocket.....	111,796
Do.....	Study of contamination sensors.....	96,664
The Boeing Co.....	Study concerning electromagnetic compatibility of launch vehicles.....	93,680
Lockheed Aircraft Georgia Co.....	Saturn V Q-ball cover removal system.....	87,844
TRW Space Technical Laboratories.....	Study neutralization suppression technique toxic and thermal hazards.....	82,363
Air Products & Chemicals.....	Design study of a helium recovery system for MILA.....	56,568
Thiokol Chemical Corp.....	Design study of flexible connector systems.....	52,867
Martin Marietta Corp.....	Gemini activation.....	50,537
Lockheed Missiles & Space Corp.....	Design study of high-pressure large-flow-rate flexible connector systems.....	29,900

CURRENT CONSTRUCTION CONTRACTS

REQUEST I(a)(7).—*List of construction contracts with estimated completion date and total costs*

Contractor	Location	Completion month, 1967	Amount
Collins Radio Co., design, manufacture, and install closed-loop radio frequency carrier operational intercommunication system for O. & C. building and LC-39.	Dallas, Tex.....	October.....	\$10,951,526
Pacific Crane & Rigging, install GFE over \$1,000,000 value.	Titusville, Fla.....	August.....	14,188,000
Akwa-Downey Construction Co., outfitting assembly bay No. 2 LC-39, VAB.	Milwaukee, Wis.....	April ¹	6,592,295
General Dynamics, Convair Division, operational TV system for LC-39.	Fort Worth, Tex.....	February.....	2,688,318
Gulton Industries, data transmission system.	Albuquerque, N. Mex.....	November.....	2,659,000
Morrison-Knudsen Co., Inc., Perini Corp. (joint venture), propellant systems component laboratory complex.	Stanton, Calif.....	June.....	2,345,838
Zero Manufacturing Co., furnish and install interference shielded radio frequency modular enclosures for LC-39 and MILA.	Burbank, Calif.....	March.....	2,265,926
General Electric Co., wideband transmission links.	Lynchburg, Va.....	January.....	1,572,935
Heyl & Patterson, install flame deflectors.	Pittsburgh, Pa.....	April.....	1,464,945
Otis Elevator Co., elevators for towers A and B, HB No. 2, VAB, LC-39.	Atlanta, Ga.....	December.....	1,129,338

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REQUEST I(a)(7).—List of construction contracts with estimated completion date and total costs—Continued

Contractor	Location	Completion month, 1967	Amount
Akwa-Downey Construction Co., flight crew training building additions.	Milwaukee, Wis.....	November.....	\$886, 882
Kahn & Co., distribution panels and associated hardware.	Withers Field, Conn..	May.....	848, 709
J. Carner Co., LM activation, O. & C. building.	Gardena, Ga.....	January.....	838, 716
I-T-E Circuit Breaker Co., LC-39A, redundant power phase II (lots 1 and 3) supply contract.	Winter Park, Fla.....	June.....	525, 601
Remler, communications equipment.....	San Francisco, Calif..	October.....	504, 000
Akwa-Downey Construction Co., addition to central dispensary.	Milwaukee, Wis.....	August.....	450, 610
MevA Corp., redundant power modifications, LC-37.	Titusville, Fla.....	May.....	443, 000
American Scientific Corp., operations intercommunication system audio equipment.	Alexandria, Va.....	March.....	429, 049
Smith & Sapp Construction Co., GN-2 air pressure system and air conditioning platform 3 and 4, MSS LC-39.	Orlando, Fla.....	do.....	404, 163
Houdaille-Duval-Wright Co., crawlerway surfacing, audio-video cables, and miscellaneous work, pad B, LC-39.	Jacksonville, Fla.....	May.....	387, 000
Smith & Sapp Construction Co., additions and modifications to air conditioning system, CIP.	Orlando, Fla.....	February.....	364, 599
Smith & Sapp Construction Co., construction of utility installations.	do.....	do.....	295, 579
Akwa-Downey Construction Co., redundant industrial power for launch complexes 34 and 37.	Milwaukee, Wis.....	March.....	189, 666
Sperry Rand Corp., LC-39 color TV system..	Salt Lake City, Utah..	February.....	181, 000
Fire Detection Service, Inc., standby water chilling units, redundant remote air supply and EMC van parking LC-39, pads A and B.	Spokane, Wash.....	January.....	172, 210
Fidelity Sound Inc., LC-39 paging system modifications and additions.	Titusville, Fla.....	do.....	126, 128
The Cosmodyne Corp., Apollo spacecraft and ground support equipment fluid distribution system VAB, high bays 1 and 3.	Cocoa Beach, Fla.....	March.....	123, 970
Climate Conditioning Corp., miscellaneous access platforms and ladders, VAB, LC-39.	Stanton, Calif.....	May.....	119, 500
Behe & Umholtz, central instrumentation facility alternate power.	Orlando, Fla.....	January.....	114, 347
Behe & Umholtz, miscellaneous exterior electrical alterations.	do.....	March.....	99, 500
Unit Electric Control Inc., LC-39, pad A, redundant power phase II.	do.....	May.....	76, 467
Voight Construction Co., modifications to VAB jib crane trusses and paint storage building plumbing; additions to VAB snack bar and 10,000 gallon water tank.	Chuluota, Fla.....	February.....	71, 576
Construction Services, construction of O. & C. building calibrations laboratory.	Merritt Island, Fla....	January.....	65, 456
Akwa-Downey Construction Co., operational intercommunications system cabling conversions, O. & C. building.	Milwaukee, Wis.....	do.....	62, 769
General Electric Co., 15-Kv.-a. power capacitors for 69-kv. substation.	Lynchburg, Va.....	do.....	52, 948
Holloway Corp., instrumentation communication cables LC-39, MSS fuel and oxidizer transfer areas.	Titusville, Fla.....	do.....	44, 928
General Electric Co., additions to LC-39 industrial water system control console.	Lynchburg, Va.....	March.....	38, 617
Frank A. Kennedy, Inc., extension of additional 2 lanes, Kennedy Parkway, South.	Cocoa Beach, Fla.....	January.....	30, 750
Holloway Corp., LC-39 temperature and humidity alarm system, LCC; acoustical, lighting and air-conditioning modifications, VAB.	Titusville, Fla.....	do.....	12, 981