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CREW TRAINING AND SUPPORT ACTIVITIES

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HEARING

BEFORE THE

SUBCOMMITTEE ON

SPACE SCIENCE AND APPLICATIONS

OF THE

COMMITTEE ON

SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

NINETY-FOURTH CONGRESS

SECOND SESSION

JUNE 22, 1976

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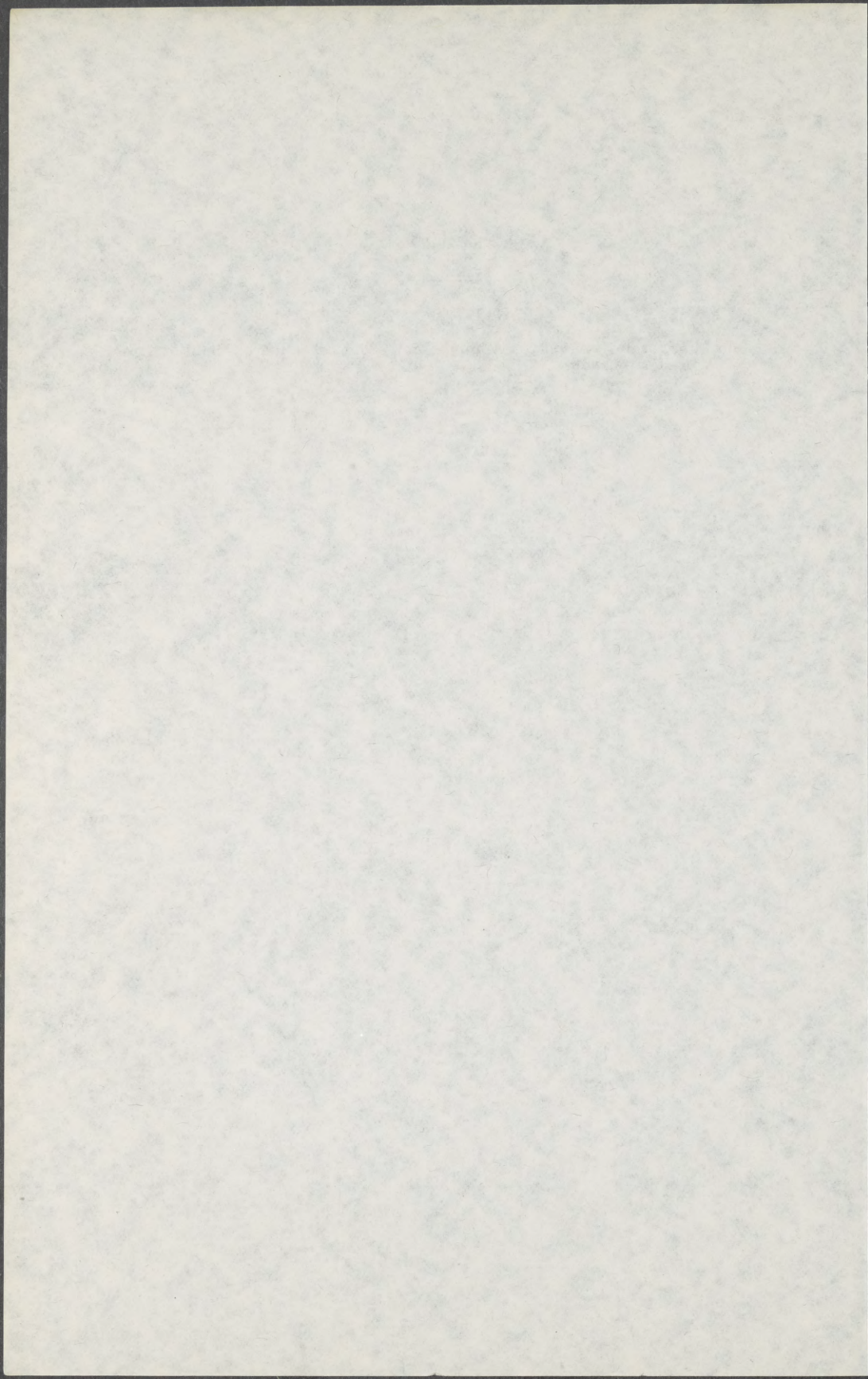
JAMES E. WILSON

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CREW TRAINING AND SUPPORT ACTIVITIES

TUESDAY, JUNE 22, 1976

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE, SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in room 2226, Rayburn House Office Building, Hon. Don Fuqua (chairman) presiding.

Mr. FUQUA. The subcommittee will be in order.

The hearing this morning is for the purpose of reviewing the current status of crew training for the space shuttle program.

This is the first phase of a two-phase review to provide for the subcommittee an up-to-date understanding of all of the factors which are required to conduct the operations and provide support for the Space Shuttle.

Our witness today is Mr. John F. Yardley, the Associate Administrator of the Office of Space Flight, NASA Headquarters, and he is accompanied by Captain Chester M. Lee, Director of Space Transportation System, Operations Office, NASA, and others.

We would be pleased to have you introduce those accompanying you, and I would like to announce that we are subject to the call of the floor because of the House being in session, and we hope these interruptions will be at a minimum.

You may proceed.

STATEMENT OF JOHN F. YARDLEY, ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE FLIGHT, NASA HEADQUARTERS

Mr. YARDLEY. Thank you very much, Mr. Chairman.

With me this morning is Chester M. Lee, who is Director of our Space Transportation System Operations Office in Washington.

Next to him is Glynn Lunney, who is Manager of the Shuttle Payload Integration and Development Program office at the Johnson Space Center, and George Abbey, who is Director of Flight Operations for the Johnson Space Center.

(Fig. A.) What we want to do this morning is give you an overview of the flight crew training program, including our requirements, how we select the crews, how many hours we foresee for training requirements, facilities, simulators, aircraft, et cetera.

Also, we will cover briefly some of the ground personnel training and touch slightly on the mission control center.

As you mentioned, we have received a number of questions from your staff on this whole area, and we are, at the present time, making a study which, hopefully, will give the answers you desire.

Most of these questions center around what alternatives to the baseline are feasible, and which are more or less desirable.

We will not elaborate on these issues to any great extent this morning; however, we will touch on them.

The next slide (figure 1). In the flight crew area, as you know, our crew could number anywhere from 2 to 7 people, and in emergencies, the Shuttle could carry as many as 10 for rescue situations.

The two crew members essential on every flight are a pilot and a copilot. We call them a commander and a pilot. Most flights will also have a mission specialist, who is a specialist in the subsystems of the Shuttle, life support, environmental control, and remote manipulator system activities.

Particularly, for scientific payloads, there are provisions made for up to four payload specialists who will be unique for those particular flights.

They will be selected primarily by the principal investigators for their unique knowledge of the experiment, rather than their particular adaptation to space flight. We will discuss later some of our training requirements for those people.

Now, you will see in this chart, first of all, that we have at the present time 20 pilots on active status, and 9 individuals on active status who are in what we used to call the scientist astronaut category.

We would foresee converting the scientist astronauts to our new mission specialists category, to be used on primarily on complex flights.

The table shows for the first 6 years of operation, including the orbital flight test, the number of pilots available, assuming attrition of two people per year. This rate has been our long time experience, but we have had higher attrition rates than that on occasion.

The next line shows how many pilots we will need at six flights per year per pilot.

Now, that is many more flights per year than pilots have ever made in NASA, but we think we can achieve this rate in the operations era of the Shuttle. You can see in that scenario, we start needing new pilots from around 1980 to 1983.

The mission specialists, we feel, will probably require longer times between flights, because they will have to get used to the particular experiment equipment that happens to be on board for that flight.

Mr. FUGUA. How much time do you anticipate after a flight a pilots turn-around time and retraining will take?

Mr. YARDLEY. Approximately 2 months is what we think will be sufficient for a pilot. That represents six flights a year. It may be that in some of the simpler missions, it will be less. If it is just a delivery mission, it will be less. If it is a more complicated mission, and the mission stays up for 30 days, then it will be longer.

For mission specialists, however, we think it is probably a minimum of 4 months between flights, and in some cases on complex missions, it could be a year, so we show you how many of those we need, depending on which assumption you make. As you see, in 1981 and 1982, we will need more mission specialists.

The next chart (figure 2) shows our present plan for pilots and mission specialists selection and evaluation. Next month we plan to go out with an announcement, and that announcement will identify

all the requirements and selection criteria. It will give people 1 year to apply. Then we will have a 6-month evaluation period and make an initial selection in late 1977.

People will then come on board in the middle of 1978, and will all have a 2-year program of evaluation, during which time they will actually work in various engineering operations jobs at the center, and be evaluated on the job before final selection.

Mr. FUQUA. Is this criteria going to be made public?

Mr. YARDLEY. Yes, sir. It is all in our announcement, which we should be ready to release in the next several weeks.

I am not planning on presenting any detail on these criteria, but in general, they are broader than we have had in the past.

For example, in the past we required that our pilots had passed their flight test training. We do not require that now. We used to require that they have time in jet aircraft—1,000 hours of jet aircraft time—and now we say jet training is desirable but not mandatory. So we have relaxed the requirements considerably.

The next slide, please (figure 3). This chart shows a typical training program for delivery type mission pilots, and more complex rendezvous and EVA pilots. As you can see, prior to being assigned a mission, we anticipate about 1,400 hours of training in classrooms, trainers and simulators, aircraft, et cetera.

After assignment to a specific mission in the early phase, there will be another 350 hours of training for the pilots of the delivery missions, and about 470 hours for the rendezvous and EVA pilots.

Mr. FUQUA. John, after you have selection criteria, are you going to invite outside comments?

Mr. YARDLEY. Prior to the announcement, is that what you are asking?

Mr. FUQUA. Well, yes, when it is made public, before it is implemented, are you going to invite outside comments?

Mr. YARDLEY. We had anticipated circulating it for comments.

We have had many internal discussions. For example, we have met with the space science board people, with respect to the mission specialists, and on how we would select those. If you would like to see in detail what we are going to put out, there is no problem with that. We talked to DOD about it too.

Mr. FUQUA. With whom?

Mr. YARDLEY. The Department of Defense.

I am not sure who else we would coordinate with.

Mr. FUQUA. My point is, once you make the criteria available, then is it hard and fast, or is it still flexible?

Mr. YARDLEY. Since we have a year's time in this, I am sure that people can submit changes if there is some hue and cry on any particular point. We will have time enough to change it.

Let me tell you a little bit about the criteria.

We first thought to make it a criterion that one cannot be over 35. We finally threw that out and now there is no age restriction. Also, we wanted to make sure that we provided ample opportunity for females and minorities to apply, so we have special wording on that. We wanted to make sure we did not eliminate any women on the size criteria, so, for example, a mission specialist can be as short as 60 inches.

On pilots we cannot go much below 64 inches, because of the problems in designing the seat and controls, et cetera. Women pilots will have to be 64 inches. Educational requirements are a minimum of a B.S. At one time we were thinking that mission specialists should have a Ph. D. degree. We now say that advanced education is desirable, but we are not going to eliminate anybody from applying because they do not have an advanced degree.

Physical requirements are based on the standard pilot physical which the Air Force gives. For a mission specialist, it is the NASA class II space flight physical. There was argument about the eye sight criterion for a while, and I think it was resolved to be 20 over 100 uncorrected for the mission specialist, which is not perfect.

The current drafts of our announcement of opportunities for pilot astronauts and mission specialists is in near final form and we can furnish them for the record. I cannot think of any other groups that we would want to send it to, but you may have some ideas.

Mr. FUQUA. Okay.

[The information follows:]

OPPORTUNITIES AS CANDIDATES FOR PILOT ASTRONAUT—POSITIONS AT THE
LYNDON B. JOHNSON SPACE CENTER, HOUSTON, TEX., REVISED JUNE 22, 1976

SPACE SHUTTLE DESCRIPTION

The Space Shuttle will usher in a new era of space transportation in the 1980's opening the doors to routine operations and expanded experimental investigations in space. The Shuttle, its gross liftoff weight exceeding four million pounds, will be launched like a rocket and will maneuver into Earth orbit where it will perform its assigned missions lasting up to 30 days and then return to Earth in a manner similar to that of the X-15 research vehicle. The reusable Shuttle spacecraft will then be readied for another flight with new payloads and flight crew. The crew could consist of as many as seven people. The commander and pilot will be selected from the NASA Astronaut Office and will be responsible for control of the Shuttle during launch, reentry and all other required maneuvers, and for maintenance of Shuttle systems. The mission specialist will also be selected from the NASA Astronaut Office and will be responsible for the management of all Shuttle resources supporting the payloads during flight. The remainder of the crew will consist of one to four payload specialists who will be nominated by the sponsor of the payload being flown, certified for flight by NASA, and will be in charge of the operation of specific payload equipment where their special skills are needed. Payload specialists need not be members of the NASA Astronaut Office; however, NASA astronauts may fly as payload specialists at the discretion of the payload sponsor.

The Shuttle will perform a variety of missions including deployment and retrieval of satellites to and from orbit, service and refurbishment of existing satellites while in orbit, and operation of specialized laboratories including astronomy, earth sciences, space processing and manufacturing. These missions could also include supporting the development and servicing of a permanent space station. The Shuttle will also provide a staging capability for utilizing other rocket sources to inject satellites into higher orbits than can be achieved by the Shuttle. Potential users include both government and private industries from the United States and abroad.

The National Aeronautics and Space Administration (NASA) announces the availability of a minimum of 15 astronaut (pilot) candidate positions at the Lyndon B. Johnson Space Center in Houston, Texas. These positions offer successful applicants a 2-year training and evaluation assignment after which in July of 1980 pilot astronauts will be selected. The closing date for filing for these positions is June 30, 1977.

Shuttle pilot astronauts will serve as both Shuttle commanders and pilots and in some cases mission specialists or payload specialists. During flight the Shuttle commander will have onboard responsibility for the space vehicle, crew, mission success, and safety of flight. The Shuttle pilot will assist the commander in

controlling and operating the Shuttle. In addition, Shuttle pilots may deploy and retrieve payloads using a remote manipulator system, participate in extravehicular activities, and support specific payload operations where appropriate.

Successful applicants will join the Johnson Space Center and be assigned to the Astronaut Office. They will then be placed in responsible technical or scientific positions for a period of up to 2 years where they will receive assignments allowing them to contribute substantially to the Shuttle Program while under evaluation. They will also be enrolled in the basic astronaut training program allowing development of background knowledge and skills that will be required in their formal mission training upon selection for their first flight. Pilots will be required to maintain proficiency in NASA aircraft during their candidate period.

Applicants should be aware that selection as astronaut candidates does not insure selection as astronauts. Final selection will depend on satisfactory completion of the 2-year evaluation period. Civilian candidates successfully completing the indoctrination period and who are then selected as astronauts will be expected to sign an agreement to serve NASA as an astronaut for a minimum period of 5 years. The obligation under such service commitment may be waived by the NASA Administrator. The tour length for military candidates will be established by NASA/DOD Memorandum of Understanding.

NASA has an affirmative action program and our goal is to have qualified minorities and women among the newly selected astronaut candidates. Therefore, women and minority candidates are encouraged to apply.

QUALIFICATIONS OF APPLICANTS

For appointment as an astronaut (pilot) candidate, an applicant must meet the following minimum qualifications:

1. Bachelor's degree from an accredited institution in engineering, physical science, or mathematics or have completed all requirements for a degree by December 31, 1977. An advanced degree or equivalent experience is desired. Quality of academic preparation is important.

2. At least 1,000 hours first pilot time, with 2,000 or more being desirable. High performance jet aircraft and flight test experience is highly desirable.

3. Ability to pass NASA Class I space flight physical (similar to military and civilian flight physicals) to include the following specific standards:

Distant visual acuity: 20/50 or better uncorrected; correctable to 20/20 each eye.

Hearing loss not to exceed: Frequency (H_z)—500, 1000, 2000; Loss (db)—30, 25, and 25 per ISO, 1964 Standard.

Blood pressure: Preponderant systolic not to exceed 140, nor diastolic to exceed 90mm Hg, measured in sitting position.

4. Applicant height between 64 and 76 inches.

PAY AND BENEFITS

Salaries for successful civilian candidates will be based on the Federal Government's General Schedule pay scale and will include grades GS-7 through GS-15 with approximate salaries from \$11,000 to \$34,000 per annum. Candidates will be compensated in consonance with prevailing Federal requirements based on their individual academic achievements and experience. Other benefits include vacation and sick leave and participation in the Federal Government retirement, group health, and life insurance plans.

Successful military candidates would be detailed to the Johnson Space Center but would remain in an active military status for pay, benefits, leave, and other similar military matters.

APPLICATION PROCEDURE

Civilian applications for appointment to astronaut (pilot) candidate positions must be postmarked no later than June 30, 1977. Military personnel will submit applications through their respective military department using procedures which will be disseminated by their service later this year. The completed application form must be supported by complete college transcripts of grades, summary of flight experience, and completed medical forms. A packet of application materials including a synopsis of the medical standards may be obtained by completing the form included in this pamphlet and returning it to the address indicated. After preliminary screening, additional information may be requested from applicants. Also, personal interviews will be required for those under final consideration.

Before final selection for appointment by NASA as astronaut candidates, applicants will receive a thorough physical examination. All applicants will be informed no later than December 1977 whether or not they have been selected as astronaut (pilot) candidates.

Successful applicants will be asked to report to the Lyndon B. Johnson Space Center, Houston, Texas, on July 1, 1978.

REQUEST FOR APPLICATION PACKAGE FOR CIVILIAN ASTRONAUT (PILOT)
CANDIDATES

To: Astronaut (Pilot) Candidate Program, Code AHX, NASA Johnson Space Center, Houston, Tex.

Please provide me with forms necessary to apply for consideration as an astronaut (pilot) candidate.

First, Middle, Last Name

Number and Street or P.O. Box No.

City, State, and Zip Code

OPPORTUNITIES AS CANDIDATES FOR MISSION SPECIALIST ASTRONAUT—POSITIONS
AT THE LYNDON B. JOHNSON SPACE CENTER, HOUSTON, TEX., REVISED JUNE 22,
1976

SPACE SHUTTLE DESCRIPTION

The Space Shuttle will usher in a new era of space transportation in the 1980's opening the doors to routine operations and expanded experimental investigations in space. The Shuttle, its gross liftoff weight exceeding four million pounds, will be launched like a rocket and will maneuver into Earth orbit where it will perform its assigned missions lasting up to 30 days and then return to Earth in a manner similar to that of the X-15 research vehicle. The reusable Shuttle spacecraft will then be readied for another flight with new payloads and flight crew. The crew could consist of as many as seven people. The commander and pilot will be selected from the NASA Astronaut Office and will be responsible for control of the Shuttle during launch, reentry and all other required maneuvers, and for maintenance of Shuttle systems. The mission specialist will also be selected from the NASA Astronaut Office and will be responsible for the management of all Shuttle resources supporting the payloads during flight. The remainder of the crew will consist of one to four payload specialists who will be nominated by the sponsor of the payload being flown, certified for flight by NASA, and will be in charge of the operation of specific payload equipment where their special skills are needed. Payload specialists need not be members of the NASA Astronaut Office; however, NASA astronauts may fly as payload specialists at the discretion of the payload sponsor.

The Shuttle will perform a variety of missions including deployment and retrieval of satellites to and from orbit, service and refurbishment of existing satellites while in orbit, and operation of specialized laboratories including astronomy, earth sciences, space processing and manufacturing. These missions could also include supporting the development and servicing of a permanent space station. The Shuttle will also provide a staging capability for utilizing other rocket sources to inject satellites into higher orbits than can be achieved by the Shuttle. Potential users include both government and private industries from the United States and abroad.

The National Aeronautics and Space Administration (NASA) announces the availability of a minimum of 15 astronaut (mission specialist) candidate positions at the Lyndon B. Johnson Space Center in Houston, Texas. These positions are available to individuals with backgrounds in engineering and the sciences and offer successful applicants a 2-year training and evaluation assignment after which in July of 1980 mission specialist astronauts will be selected. The closing date for filing for these positions is June 30, 1977.

Mission specialist astronauts will have the overall responsibility for the coordination, with the commander and pilot, of Shuttle operations in the areas of crew activity planning, consumables usage, and other Shuttle activities affecting experiment operations. Thus, the mission specialists will be proficient in payload operations and will be required to have a detailed knowledge of the Shuttle systems as well as the operational characteristics, mission requirements and objectives, and supporting systems and equipment for each of the experiments that will be conducted on their assigned mission. Mission specialists may participate in extra-vehicular activities, perform special payload handling or maintenance operations utilizing a remote manipulator system, and assist in specific experiment operation at the discretion of the experiment sponsor. In some cases the mission specialist may serve as payload specialist for a particular experiment with responsibility for conduct of that particular experiment. Additionally, those candidates chosen as astronauts will have the opportunity to continue in their chosen fields of research and to propose, develop, and conduct their own or other experiments on orbit as payload specialists.

Successful applicants will join the Johnson Space Center and be assigned to the Astronaut Office. They will then be placed in responsible technical or scientific positions for a period of up to 2 years where they will receive assignments allowing them to contribute substantially to the Shuttle Program and to continue work in their scientific or technical fields, where practicable, while under evaluation. They will also be enrolled in the basic astronaut training program allowing development of background knowledge and skills that will be required for their formal mission training upon selection for their first flight.

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1. Bachelor's degree from an accredited institution in engineering, biological or physical science, or mathematics *or* have completed all requirements for the degree by December 31, 1977. An advanced degree or equivalent experience is desired. Quality of academic preparation is important.

2. Ability to pass NASA Class II space flight physical (similar to military and civilian flight physicals) to include the following specific standards:

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Successful applicants will be asked to report to the Lyndon B. Johnson Space Center, Houston, Texas, on July 1, 1978.

REQUEST FOR APPLICATION PACKAGE FOR CIVILIAN ASTRONAUT (MISSION SPECIALIST) CANDIDATES

To: Astronaut (Mission Specialist) Candidate Program, Code AHX, NASA Johnson Space Center, Houston, Tex.

Please provide me with forms necessary to apply for consideration as an astronaut (mission specialist) candidate.

First, Middle, Last Name

Number and Street or P.O. Box No.

City, State, and Zip Code

Mr. YARDLEY. Next slide, please (figure 4). This chart shows the mission specialist training requirement. I have put them alongside the pilot requirements so you can make a comparison.

I would like you to bear in mind that these are training requirements in the Shuttle and not for a specific mission. A mission specialist will probably have to spend a lot of hours with the payload. You can see the pretraining is less than half than the pilots, and for the specific flights it is a little less, 314 hours as opposed to 349.

We do not require that mission specialists be pilots, or that they be trained as pilots after they come to the program. That is a difference from the approach we took with scientist astronauts selected previously. We did not require that they be pilots when they entered the program, but we taught them to fly.

We do not plan to do that with the mission specialists to be selected. It would be expensive, and we see no need for such training. There may be some unusual cases where we will have mission specialists who are also pilots and there will be some cross training, but in general, we do not plan to require it.

Now, here (figure 5) are the major facilities that we plan to use in the Shuttle program. I will not go down this list in detail, because I have more charts that show pictures. These are much the same kinds of facilities we used in previous programs.

Next slide, please (fig. 6).

The first simulator has been built especially for the Shuttle. It is what we call an orbiter aeroflight simulator, shown on the right screen (fig. 7), being installed right now at the Johnson Space Center.

It is a full crew cabin that has a movable base and will be used by the primary training crew for the Approach and Landing Test (ALT) which will take place next year.

The simulator has been delivered and will be operational by September. We will have a mission control center (MCC) interface tie-in completed by November.

The shuttle mission simulator shown schematically on the right screen (fig. 8), is currently in procurement. You will notice where it says "motion base" and "crew station," that is an updated version of the orbiter aeroflight simulator I just mentioned. This one will be operational in 1978.

Now, this simulator differs from the motion base because it has a fixed base, and is a much more complete crew station.

The actual orbiter aeroflight simulator is just a cockpit, whereas this one includes the entire aft deck, the mission specialist station, the tie-ins into the other simulators, which will be for the Spacelab, IUS, et cetera.

The next simulator (fig. 9), is called a crew procedures evaluation simulator, which is sort of a warmed-over piece of equipment which we have been using to develop approach and landing test procedures. We will phase this out after the approach and landing test. At that time, the full Shuttle mission simulator and other training devices will be operational and we will have no need for it any longer.

Next charts, please (figs. 10 and 11). This is a Shuttle procedure simulator, which is used as a guidance navigation flight procedures trainer. It does not have any MCC tie-in. This equipment is already in place. It was an early Shuttle development tool which we have used quite successfully. We are upgrading it to get the latest configuration, both in hardware and software. It will be ready in its new configuration by April 1978.

(Fig. 12.) We will also have a spacelab support module simulator consisting of a core segment and an experiment segment which will simulate Spacelab subsystems and which can operate with the MCC or by itself. We expect that one to be operational about 1 year before the first Spacelab flight.

We also plan to have simulators ready for the interim upper stage (IUS) about 6 months before the first IUS flight.

We also plan to train large groups of people with trainers which have some functional components, et cetera (fig. 13).

In the overall non-mission-related training area, as opposed to the mission simulators, we will have high fidelity trainers including an orbiter cabin, as you see in figure 14, a payload bay and a spacelab. These trainers will have fairly hi-fidelity configurations. They will be used in activities where the crew must learn the interrelationship of many components but does not require functional action to be taken.

We also plan to have neutral buoyancy trainers (fig. 15). Our plan provided for a water immersion facility at Johnson, but this has been deferred by action in the Congress.

I would like to point out that our studies comparing the use of this facility versus the one at the Marshall Space Flight Center, indicate quite a cost benefit, and we will include that detail in our report.

For the Spacelab trainer, we will use the Spacelab mockup and will also have a remote manipulator part-task trainer. The mockup

trainer of the Spacelab will be nonfunctional. It will include the pallet configuration of the Spacelab. This is why we need a remote manipulator task trainer.

This is a fairly demanding crew training task, and we will have a manipulator available as shown in figure 16. We will actually use inflated models of payloads, so that we can have a light payload, but still permit the crews to simulate the delicate manipulation task.

We also have a Shuttle training aircraft (fig. 17). The picture on the right screen (fig. 18) shows one of our Gulfstream II's which has been modified to be used as a Shuttle training aircraft. You can see the large blades extending down over the wing. This permits the aircraft to simulate a Shuttle flight.

We have been having some problems in getting these airplanes to fly properly in a Shuttle mode, but, after some modifications I think we are about out of the woods on that.

We took delivery of the first aircraft last month, and it is flying well enough to be useful. We expect to get the other one in July, fully modified, and so by the end of July, we should have both of these Shuttle training aircraft on line.

Let me now discuss payload specialist training (fig. 19). The payload specialist is a person who does not have to know a lot about space flight. He is probably a scientist, who has a thorough knowledge of a particular experiment.

We want to be able to fly people with a minimum of training, but it is still necessary that they learn something about the Shuttle, such as how to live in it, how to housekeep in it, and how to execute appropriate safety procedures. This chart shows the kind of safety course we envision. It is about 16 hours on basic orientation and systems, and high performance flight experience.

We feel it is desirable to take the specialists up in the aircraft and perform a few maneuvers to be sure they will react suitably to spaceflight.

And then in advanced training, payload specialists will get emergency survival training, how to live in the system, and how to read flight plans, and how to interface with crew activities. For a specific flight there will be training for their particular part of the mission.

Next slide, please (fig. 20).

Now, in the area of flight control training, we have the experience gained in training controllers in the past. The specific curriculums are not completed yet, but we think it will take about 250 hours of training for the approach and landing test (ALT) flight controllers. This will include classrooms, various simulations and on-the-job training.

Flight controllers will be certified through testing, prior to their participation in flight.

In the flight control area, I thought it would be wise to familiarize you with our thoughts, and what approach we plan to take.

As figure 21 shows we will start out in the flight control operations area, in a mode similar to the Apollo program. That requires a fairly large crew, support for all subsystems, all experiments, all of the staff rooms being manned on a three-shift basis.

We will then transition into the operations phase requiring a much smaller crew by standardizing most of the flight phase to simplify operations.

Next slide, please (fig. 22).

In our ground operations training at the Kennedy Space Center we have to train personnel to test and check out the vehicle, not only the Shuttle, but the Spacelab and other STS elements to be flown. This will be done by the types of training shown on this chart which include training, safety, rescue, and so forth.

The next chart (fig. 23) shows the tools which will be used. We have an extensive experience base at Kennedy, so much of this training has already been accomplished by many of these people, and they will have to undergo only refresher courses.

We have a large onsite plan, but we will also require a large contingent of Kennedy people at the Flight Research Center on the ALT program.

There will be classroom training exercises that will go through checkout of the first vehicle. After launch of the first vehicle, we plan to continue this training on other flights, and there will be, of course, the countdown demonstration.

The next slide, please (fig. 24).

We turn to mission control, for a moment—

Mr. FUQUA. John, we have a live quorum that we have to go to meet.

This will be a good point to break, and we will be back as soon as we can.

[Whereupon, the subcommittee was in short recess.]

AFTER RECESS

Mr. FUQUA. The subcommittee will resume its hearing.

Please proceed, John.

Mr. YARDLEY. I want to touch on the mission control center (MCC) a little bit here, just to outline our concept; how we will start, and how we will transition into the operational period.

The chart on the screen shows, on the upper part, the initial operations of the mission control center during our flight test program, and probably for a few flights after that. It can handle a single orbiter, one at a time, and works with our standard ground network, the spacecraft tracking and data network (STDN).

The MCC will have very little payload support, and will use a lot of existing equipment. We are getting some new computers which we will use for the next phase. During the operational phase we will handle two orbiters and the interim upper stage in flight at any one time, with either the tracking and data relay satellite system (TDRSS) or the present ground network.

The agency decided that the Spacelab payload operations control center should also be at Johnson, and so that will be another task that the MCC is performing during the operational phase.

The next chart, please (fig. 25).

Now, this chart describes some of the functions performed by the control center, by various flight phases, the first phase comprising the first six flights which are the orbital flight tests. It is similar to Apollo and other flight programs in the sense that the total system is supported there on a three-shift basis. We have all of the systems specialists following the flight, we have all of the data displayed, and it is a fairly large and complex operation.

We plan to go through a transition phase where we reduce this support, and finally end up with an operations phase, where essentially we have a small team, I think it is four men, following the mission on three shifts all the time with an on-call support team for any problems that come up.

The next slide, please (fig. 26).

This chart shows our current MCC development schedule. We are going to be installing a new network information processor, because we have a new type of data stream coming in. The software will be under development for the next 2 years. We are also utilizing our present 360/375 computers.

Next slide, please (fig. 27).

I mentioned earlier that we were making a study to respond to the definition of alternatives, and the pros and cons of these various alternatives in both the training and the MCC areas. Specifically, it has been suggested that all training functions be located at the Kennedy Space Center rather than the Johnson Space Center. We want to look into all of the reasons as to why that may be good or bad to do, and report the results to you.

The other main activity we will look at is the MCC function, and determine whether it should be located at Kennedy, or at the Goddard Space Flight Center, or at the Johnson Space Center. We are just getting into that now. We hope to have it finished by mid-August, and we will brief you at that time.

Mr. Chairman, that concludes my prepared remarks.

If you have any questions, I would be happy to deal with them.

Mr. FUQUA. Thank you very much.

Regarding the crew training facilities when we were in Houston at the Johnson Space Center, back in the spring. We were informed that the National Guard was going to take over Ellington Air Force Base, and it would be operated by the State of Texas, and that it would be used by general aviation.

You are going to be using the field for Space Shuttle aircraft training. What impact will general aviation using that field have on that training?

Mr. YARDLEY. George, do you want to handle that?

Mr. ABBEY. We are presently operating out of Ellington AFB with the National Guard. If general aviation or some commercial users do move into it—

Mr. FUQUA. It is anticipated, is it not?

Mr. ABBEY. That is what the State of Texas is intending. They do not have it arranged at this time, but if it does occur we would be located at one end of the field, and would still be able to utilize Ellington as we do now.

There would, however, be additional traffic. Our flying training is accomplished over the gulf, and our shuttle training aircraft flying would be at White Sands Test Facility in New Mexico. I do not envision that will have a great impact on our training.

Mr. FUQUA. Talking about White Sands, if you are going to be doing practice landings, et cetera, would it not be better to do it at the place you are doing the actual Space Shuttle landing?

Mr. ABBEY. With the type of approaches we are flying, you need to be operating in restricted area. At White Sands, we have a large

dry lake we can utilize. We are under radar control all the time. There are no unauthorized aircraft flying that would hinder our operation. As far as practicing and the training for Shuttle approaches, we would rather do that in that kind of environment.

Mr. YARDLEY. George, you do plan to do some training on the actual field?

Mr. ABBEY. There will be site-specific training at Edwards AFB and Kennedy. We will deploy to Edwards Air Force Base, for example, and train there a week or 2 weeks at a time.

Mr. FUQUA. Will you need any additional hangar facilities at Ellington?

Mr. ABBEY. Right now we are using an additional hangar vacated by the Air Force Reserves. The Reserves were moved to Bergstrom Air Force Base and their hangar became vacant. We have an arrangement with the State of Texas that allows us to use that hangar.

Mr. FUQUA. How long will you be able to use it?

Mr. ABBEY. Until the State has a commercial user come in. We will be given notice in sufficient time that will allow us to move back into other buildings, that were being utilized before the hangar became available.

Mr. FUQUA. Is the State of Texas anticipating making that a commuter-type airport?

Mr. ABBEY. They are trying to get commercial users to move in, rather than general aviation.

Mr. FUQUA. But it will still be general aviation then?

Mr. ABBEY. Perhaps an airline will come in and operate out of that field, to use Ellington for a maintenance facility; that kind of general aviation.

Mr. FUQUA. Can the facilities at Patrick be utilized for any of this?

Mr. ABBEY. We intend to fly, as Mr. Yardley said, the Shuttle training aircraft at the cape, using the runway that has been put in, and making the approach to this runway.

I am not that familiar at this time with all of the facilities that might be available at Patrick, whether or not they could accommodate all of the aircraft we have.

Mr. YARDLEY. We will be taking a look at that in the study.

Mr. FUQUA. The other question that comes to my mind is that it appears this is what you are planning, if the crew training is in Houston, that the crew, mission specialists, as well as the pilots, will arrive on the day before the flight, or the morning before the flight, and walk out like an airline pilot does, climb on board, and go?

In the Apollo program, as soon as one crew moved out, you had another crew move in, including simulators and the vehicle, getting checked out.

What is the procedure you are going to use when you get into the Space Shuttle operational stage?

Mr. ABBEY. We will be operating as we did at the cape on previous programs where we will have a crew involved, and they will participate in checkout before launch.

Mr. FUQUA. So the crew will be there some time prior to, some considerable time prior to the launch?

Mr. ABBEY. They will be there before the launch, when those tests occur.

Mr. YARDLEY. Let us say we are talking about the operational phase, where we are turning an orbiter around every couple of weeks. There will be an opportunity for about two days, when we are running some checks in the orbiter process facilities, and that will be 10 days before launch, and then during the last 2 days on the pad when we are running the integrated test. As you can see, it is not the same sort of thing as in the past, when the vehicle was available for 6 months. There would be payload activities going on that would be of interest to the payload specialists and to the mission specialists, but of lesser interest to the pilot and copilot, because they do not have any defined tasks with payloads.

Mr. FUQUA. What do you mean by that?

Mr. ABBEY. In our operational concept, the pilots are flying the vehicle.

Mr. FUQUA. But he has to know what he is supposed to do?

Mr. ABBEY. In flying, but his duties do not include being intimately familiar with the payload.

Mr. FUQUA. Suppose he is going to retrieve a satellite?

Mr. ABBEY. That is a mission specialist's job.

Mr. FUQUA. But the pilot has to get him in position?

Mr. ABBEY. Yes. This requires integrated training on the simulators. We do not do that at the cape.

Mr. WINN. Why don't you do it at the cape?

Mr. ABBEY. We have a simulator, where the crew can operate as a team. The mission specialist will be training with the remote manipulator, and flying with the commander and the pilot, training as a team to do that kind of activity. You could not do that very well on a vehicle at the cape.

If you did it at the cape, you would have to relocate the simulator and its associated facility.

Mr. YARDLEY. I think the question is why not locate all of that activity at the cape.

Mr. ABBEY. The flight crew has a good deal of interchange with support personnel on a daily basis. This interchange is with the people who designed and tested the subsystems and control the flight. That kind of interaction goes on continually. The flight control team is located at the control center in Houston, along with the engineers. They are as much a part of the flight operations team as the flight crew, and they operate together as a team.

Mr. WINN. They could not be moved down to Kennedy?

Mr. ABBEY. If you talk about moving one part of it, you are really talking about moving much more, because you will lose that interaction, when you start moving parts away.

Mr. YARDLEY. The interaction between mission control, flight planning, crew training, all that kind of thing, says you would like to have those crewmen in Houston. On the other hand, there is the crew's interaction with the hardware at Kennedy. It is a matter of judgment as to which of those is the most important to a smooth-running system.

Now, obviously, what we are proposing is that our base line is identical to what we have been doing for 18 years, ever since we tried putting mission control at Kennedy for the Mercury program. It is still there, and at that time we had large numbers of people from

Langley instead of from Houston living there all the time. It was determined by the people who were running the show at that time, that it was an inefficient operation. Don't ask me why they did not locate the Johnson Space Center functions in Florida at the Kennedy Space Center, but they did not.

Mr. FUQUA. It seems to me that mission control and crew training can be separated.

It is only a matter of a telephone line.

Mr. ABBEY. Not really. The interaction you have does not really occur that way. In the past, we have had a tremendous number of people working with the crew when they were located at another site. We had personnel supporting them, with procedures and flight planning. Engineering personnel have to go out, for example, for the test and checkout at Palmdale along with the crew for the Orbiter. We have to relocate a lot of our engineering people to Palmdale to support checkout along with the flight crew.

Mr. FUQUA. It seems to me you are going to duplicate a lot of what you are already doing, and that is what I am most concerned about.

Now, you have the mission specialist, for instance. You want to move all of that to Houston, yet, the experiments of Spacelab and all that is going on at Marshall.

The Spacelab and the experiments will be at Marshall.

Mr. YARDLEY. Marshall will never see the Spacelab.

Mr. FUQUA. All this training, the interaction you are talking about—

Mr. ABBEY. The experiment will be operated in space by payload specialists and they will receive training where the payload is developed. We are going to do integrated training in Houston, using a simulator. The operations team, the payload specialists, the mission specialists, the pilot and commander, the flight controllers and engineering personnel will operate as a team and get training at Houston.

Mr. YARDLEY. Let me make a comment on the Spacelab matter.

The Marshall Space Flight Center function on Spacelab, let us say in the long operation, will be a major one. It will be probably one of three different Centers that manage different Spacelab missions. The management of the Spacelab involves management of experiments developed all over the country.

Now, there will be a time period when those experiments go to Marshall, probably for pallets, and then they will go to Kennedy to be assembled for testing. They will not be at Marshall for any length of time. Marshall is sort of a staging area. What George is saying, is that the mission specialists, and the payload specialists will have to be out at the University of Utah, or wherever somebody is putting experiments together.

Mr. FUQUA. Glenn, do you have an observation?

Mr. LUNNEY. I wanted to give you a slightly different viewpoint on locating them together.

The work we have done on planning for the future has really served to impress me with the effect of the high flight rate, and, even if it is not a particular number, the fact of its intensity convinces me that the planning, training and execution process has to be done extremely efficiently. For example, we do not really assign the STS flight control planning, or even crew teams, until probably just a few months before a given flight.

In these few months, the job the STS team would have to do has to be understood by all parties, trained for, and then executed.

There will be a period of maybe 3 to 4 months, when you have a team of people dedicated to getting ready for a particular flight, and while they are getting ready for that flight we will probably be involved in flying another flight. When somebody has a program to go in and support, the efficient use of the people, in compressing the planning, and getting ready for the flight phase down to just a few months before the flight itself, argues very hard for having all of the people involved in that process located together, because you only have a few months to bring each flight together with the full attention of the full team. To have them all separated, would involve tremendous coordination and travel problems in order to bring them all together as required for each flight.

Mr. WINN. What if you just move them all down to the cape?

Mr. LUNNEY. You almost begin a discussion whether you should relocate the Center.

Mr. YARDLEY. That gets into a large expense.

Mr. WINN. Has that ever been discussed as far as cost savings?

Mr. YARDLEY. Not to my knowledge.

Mr. WINN. With Mission Control in Texas, and all of the other stuff elsewhere, it looks to me there is something somewhere you guys ought to study.

Mr. YARDLEY. You have to remember, we will have two launch sites.

Mr. WINN. Not out of Texas.

Mr. YARDLEY. No, wherever it is located, the facility cannot be at both launch sites.

Mr. WINN. Yes. Well, when you are doing your training, you have the neutral buoyancy experiment that could be done in Marshall? Is not that where the big tank is?

Mr. YARDLEY. Yes, that tank has to be modified if we are going to use it.

Mr. WINN. What are they going to use for a tank?

Mr. YARDLEY. Well, we had proposed something for \$780,000 at Johnson.

Johnson has a small tank now which can be used for scuba training, and that sort of thing. We have studies which indicate that in the first 5 years of the program, something like \$4 million could be saved on the assumption that you trained at Houston. You lose time, when you go to a remote facility for that kind of training because of restrictions on flight time, and other medical problems. We will take a look at it, as to what else you could put at Marshall, to make use of the 2 hours of recovery time after coming out of the tank so that the crew is not wasting its time. There may be something you can put there, but basically it still comes back to the fundamental thing, that if you have all of this activity together, it is more efficient.

You could say it would be or could be together anywhere, and you are right. It just is not, and it is a big expense to go from where it is to some other place, and, of course, if all of the people who are experts, the world's greatest experts in manned space flight, do not wish to move from Texas to somewhere else, it could create a big retraining problem.

Mr. WINN. I understand that, and it is a problem, but it also looks to me, just on this very short hearing, without any deep study, that we are setting this program up for the convenience of the people in Texas, and it is fine, you can use some of the arguments, some of the answers given, and then turn around and say you will do the flight training out of White Sands.

Mr. ABBEY. That is only a day's flight out and back.

Mr. WINN. Yes, but how many flights are you talking about?

Mr. ABBEY. You go out there in the morning, make approaches into White Sands, land, refuel, and you can be back at Houston within an hour and a half.

Mr. WINN. How many total flights, do you know?

Mr. ABBEY. About 50 flying hours for the initial checkout

Mr. WINN. I was just thinking of fuel, for instance, have you done any fuel cost analysis?

Mr. ABBEY. We did a very detailed cost analysis, looking at all kinds of different sites considering fuel, operating around the country.

Mr. WINN. There is not that much difference?

Mr. ABBEY. If you go to Edwards, and fly out at Edwards, you would certainly save fuel, because you do not have to go out to a location, you just take off, so there would be a saving there, or at the cape. You do, however, have problems with other aircraft at Edwards, and traffic in the cape area.

Mr. WINN. Traffic was your main priority?

Mr. ABBEY. You make descents at very high rates from say 30,000 down. You are not in a position where you can do a lot of observing of other aircraft. You want to operate in a restricted area, so you can have the pilot devote his attention to the primary training task. We have talked to the FAA about such approaches. The FAA was very concerned with various locations in Texas that we looked at, because of the fact that we were descending down into areas where there was considerable traffic.

Mr. YARDLEY. Don't we have a way to restrict that cape traffic when we want to?

Mr. ABBEY. They have to work that out.

Mr. YARDLEY. Which is all right for flights, and that kind of thing, but may not be for routine day-to-day training.

Mr. FUQUA. But you say to go back and forth from Huntsville and Houston if you used the neutral buoyancy facility, will cost \$4 million or some such amount over a 5-year period.

How much additional dollars will it cost out at White Sands?

Mr. ABBEY. There are other advantages at White Sands that must be considered. We have looked at sites very close to Houston, about 45 minutes away; a Navy training facility for example. Here we had student flying training and weather restrictions. A primary advantage at White Sands is weather.

In New Mexico, we will be in an area where we can count on training on a specific day, because the weather is much better there. You are away from the coast and associated coastal weather. That kind of factor entered into our thinking as well. Looking at sites closer to Houston, you get into a weather problem, and I think we will get into a weather problem at the cape as well.

Mr. WINN. On the chart there, you showed us all the schedules and everything for the training aircraft.

Will the training aircraft, and simulators under procurement be sufficient for crew training in the foreseeable future, and when do you think you would have to look for additional appropriations?

Mr. ABBEY. Part of the answer to that question is related to how many hours we can get out of the simulators, and looking at the history, we have made projections which I think are fairly conservative.

I think when we get up to a flight rate of say two per month, we might have to look at an additional fixed base crew station to go with the simulator complex we have.

Mr. WINN. Where would that fit in timewise, what year?

Mr. YARDLEY. About 25 a year, and that would probably be 1982.

Mr. ABBEY. Again, if we were more efficient, and we get more hours out of our simulator—

Mr. YARDLEY. We do not have to do it for several years, but it is a distinct possibility, and we might have to have an extra Shuttle mission simulator and I think an extra Shuttle training aircraft.

Mr. WINN. How much money?

Mr. ABBEY. Approximately 7 to 9 million for a crew station.

Mr. YARDLEY. You could use the same computers by proper scheduling.

Mr. ABBEY. Yes.

Mr. WINN. It should be looked at closely I think.

Mr. YARDLEY. I think we are pretty well settled on the roles and missions. What we have not addressed is the question should we have one center that provides central management for operations, or should we manage from NASA Headquarters. I tend to think we will want to have a center responsible for day-to-day managing.

A lead center does not imply that it decides who will assign roles and missions to other centers.

Mr. WINN. That is what I was wondering, why not a lead center.

Mr. YARDLEY. A lead center was designated in the Shuttle program but the roles and missions of all the centers were spelled out in the program directive that established the lead center. Incidentally, we did not call it a lead center.

Mr. FUQUA. But it just seems to me with a large number of missions, you are going to have a high frequency of flights. I cannot really see that it has to be where crew training takes place. It does seem to me with the high flight frequency, although I have not entered into any studies, costs, tradeoffs, that it could be concentrated where the flights will take place. That is where the crews come in, the mission specialists, as well as the pilots, those that need to familiarize themselves with the space craft. I am sure that the pilots are going to want to talk to the previous pilots that flew. What the the idiosyncricies, those are all important, because each vehicle will probably be a little different, in its characteristics of flying, the checkout in time spent, it seems before we get committed, the neutral buoyancy facilities, and we get installation of all of the simulators, and so forth, that these questions should really be looked at very hard, and I hope that that is what you are doing.

Mr. YARDLEY. As I said, we have not made a lot of studies. To people in NASA who have been there a long time and participated in this planning, I do not mean just the lead center, it was not necessary

to do this to know what was the best thing for the Government, but we will put all this down, and give you our best recommendations and you can judge for yourself.

Now, with respect to timing, we are getting pretty well committed.

The simulators are being bolted to the floor, and there are going to be some problems in scheduling at this stage, which we would not have had a year or two ago, but we will try to identify all of this for you.

Mr. FUQUA. That completes the hearing. The subcommittee will adjourn and meet on Thursday, July 1, at 10 o'clock, in room 2247, to review NASA's planning program control with GAO and NASA.

[Figure A and figures 1-27 follow:]

AGENDA

- FLIGHT CREW TRAINING
 - CREW REQUIREMENTS AND SELECTION
 - TRAINING PROGRAM HOURS
 - TRAINING FACILITIES, SIMULATORS, TRAINERS AND AIRCRAFT
- GROUND PERSONNEL TRAINING
- MISSION CONTROL

FLIGHT CREW REQUIREMENTS

- CREW COMPLEMENT: 2 - 7 INDIVIDUALS
 - COMMANDER, PILOT PLUS MISSION SPECIALISTS AND PAYLOAD SPECIALISTS
 - ALL BUT PAYLOAD SPECIALISTS ARE NASA EMPLOYEES; PAYLOAD SPECIALISTS MAY BE NASA EMPLOYEES.
- PRESENT COMPLEMENT
 - PILOTS: 20 INDIVIDUALS ON ACTIVE STATUS
 - SCIENTIST ASTRONAUTS: 9 INDIVIDUALS ON ACTIVE STATUS

REQUIREMENTS VS. FLIGHT RATES:

REQUIREMENTS \ YEAR	1979	1980	1981	1982	1983	1984
PILOTS AVAILABLE	16	14	12	10	8	6
PILOTS REQ'D AT 6 FLT/YR	4	4	6	8	16	20
MS AVAILABLE	-	9	8	6	4	2
REQ'D AT 1 FLT/YR	-	7	15	24	48	60
REQ'D AT 3 FLT/YR	-	3	5	8	16	20
FLIGHT RATE	3	8	15	24	48	60

FIGURE 1.

SELECTION AND EVALUATION PHASE

● ANNOUNCEMENT FOR PILOTS AND MISSION SPECIALISTS: JULY 1976

● CANDIDATES SELECTION:

PILOT AND MISSION SPECIALISTS: MINIMUM OF 15 CANDIDATES IN EACH CATEGORY
2 YEARS OF EVALUATION PRIOR TO FINAL SELECTION

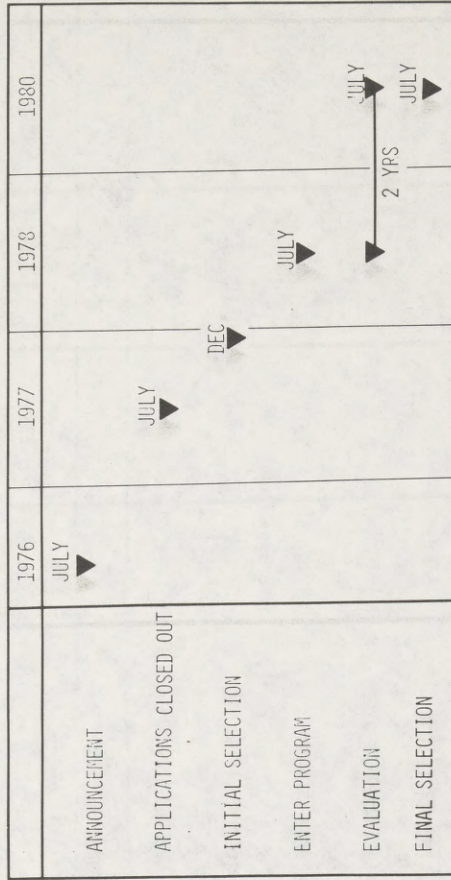


FIGURE 2

PILOT TYPICAL TRAINING PROGRAM

HOURLY SUMMARY

RENDEZVOUS &
EVA MISSION

IUS
TYPE MISSION

● ADVANCED TRAINING

CLASSROOM	378	S
SYSTEMS TRAINERS	177	A
SHUTTLE PROCEDURES SIMULATOR/CREW PROCEDURES	190	M
EVALUATION SIMULATOR		E
SHUTTLE MISSION SIMULATOR		
MOVING BASE	96	
FIXED BASE	343	
TRAINERS/MISC	176	
AIRCRAFT	68	
SUBTOTAL	1428	176*
		<u>1428</u>

● MISSION SPECIFIC

CLASSROOM	91	103
SHUTTLE PROCEDURES SIMULATOR	31	65
SHUTTLE MISSION SIMULATOR		
MOVING BASE	60	60
FIXED BASE	104	173
TRAINERS/MISC	63	87*
SUBTOTAL	349	<u>468</u>
GRAND TOTAL	1777	1916

- AT 20 HR/WK = 95 WK OR 1.85 YR TO TRAIN
- AT 25 HR/WK = 76 WK OR 1.46 YR TO TRAIN
- AT 30 HR/WK = 63 WK OR 1.21 YR TO TRAIN

*APPROXIMATELY 14 HOURS ADVANCED TRAINING AND 35 HOURS MISSION SPECIFIC TRAINING ARE DEVOTED TO EVA NEUTRAL BUOYANCY TRAINER.

FIGURE 3

MISSION SPECIALIST TRAINING REQUIREMENTS

● ADVANCED TRAINING	
● CLASSROOM	255
● SYSTEMS TRAINER	101
● SHUTTLE PROCEDURES SIMULATOR	30
● MISSION SIMULATOR	
● SHUTTLE	89
● SPACELAB	32
● TRAINERS, MISC	136 *
SUBTOTAL	643
● FLIGHT SPECIFIC	
● CLASSROOM	61
● SHUTTLE MISSION SIMULATOR	122
● SPACELAB MISSION SIMULATOR	22
● OTHER	109 *
SUBTOTAL	314
GRAND TOTAL	957

* IF EVA TRAINING IS REQUIRED, APPROXIMATELY 50 HOURS TOTAL NEUTRAL BOUANCY TRAINING TIME (SIMILAR TO PILOT) REQUIRED.

FIGURE 4

TRAINING FACILITIES IN SHUTTLE PROGRAM

- NO NEW BUILDINGS OR FACILITIES TO HOUSE SIMULATORS CONSTRUCTED.
- **FACILITIES & SIMULATORS**
 - CLASSROOMS
 - SHUTTLE PROCEDURES SIMULATOR (SPS)
(PART TASK GN&C AND PHASE SIMULATOR)
 - SHUTTLE MISSION SIMULATOR (SMS)
 - FIXED BASE (SMS FB)
 - MOVING BASE (SMS MB) OR (OAS)
 - SPACELAB SUPPORT MODULE SIMULATOR (SSMS)
 - INTERIM UPPER STAGE SIMULATOR
 - SINGLE SYSTEMS TRAINER
 - SHUTTLE TRAINING AIRCRAFT (STA)
- **TRAINERS**
 - ORBITER ONE-G TRAINERS
 - CABIN
 - PAYLOAD BAY
 - SPACELAB ONE-G TRAINER
 - AIRLOCK, SUIT TRAINER
 - NEUTRAL BUOYANCY TRAINERS
 - ORBITER
 - PAYLOAD BAY
 - SPACELAB
 - REMOTE MANIPULATOR TASK TRAINER

FIGURE 5

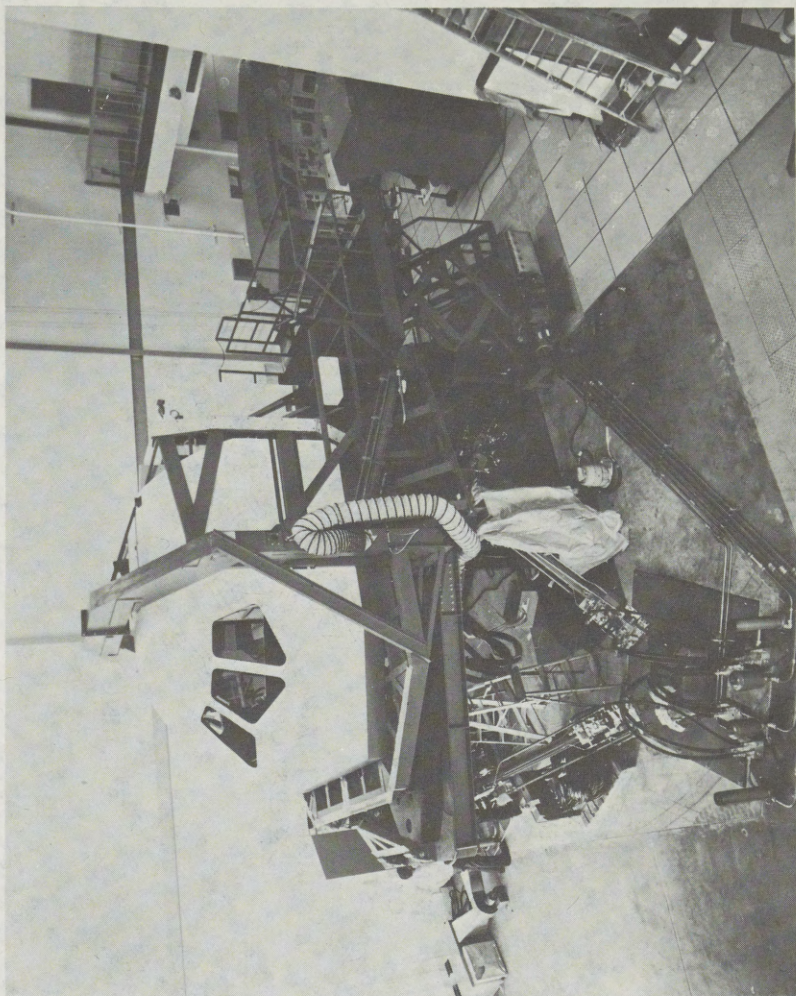
MISSION SIMULATORS

SIMULATOR

STATUS

● ORBITER AEROFLIGHT SIMULATOR (OAS)	- HARDWARE DELIVERED - MAY '76
● AFTER ALT BECOMES MOTION BASED SIMULATOR	- BASIC SIMULATOR OPERATIONAL - SEPT. '76
● TIE-IN WITH MCC	- MCC INTERFACE OPERATIONAL - NOV. '76
● SHUTTLE MISSION SIMULATOR (SMS)	- ACCEPTANCE TEST COMPLETE - AUG. '76
● FIXED BASE CREW STATION FOR FULL FLIGHT DECK SIMULATION CAPABILITY	- FIXED BASE OPERATIONAL - MARCH '78
● TIE-IN WITH MCC	- MOTION BASE OPERATIONAL - AUG. '78
● ORBITER AEROFLIGHT SIMULATOR INCORPORATED	- UPGRADE COMPLETE - MARCH '79
● CREW PROCEDURES EVALUATION SIMULATOR (CPES)	- PHASEOUT AFTER ALT - JAN. '78
● MODIFIED APOLLO SIM HARDWARE	
● NO MCC TIE-IN	
● EVALUATE CREW PROCEDURES	

FIGURE 6



SHUTTLE MISSION SIMULATOR

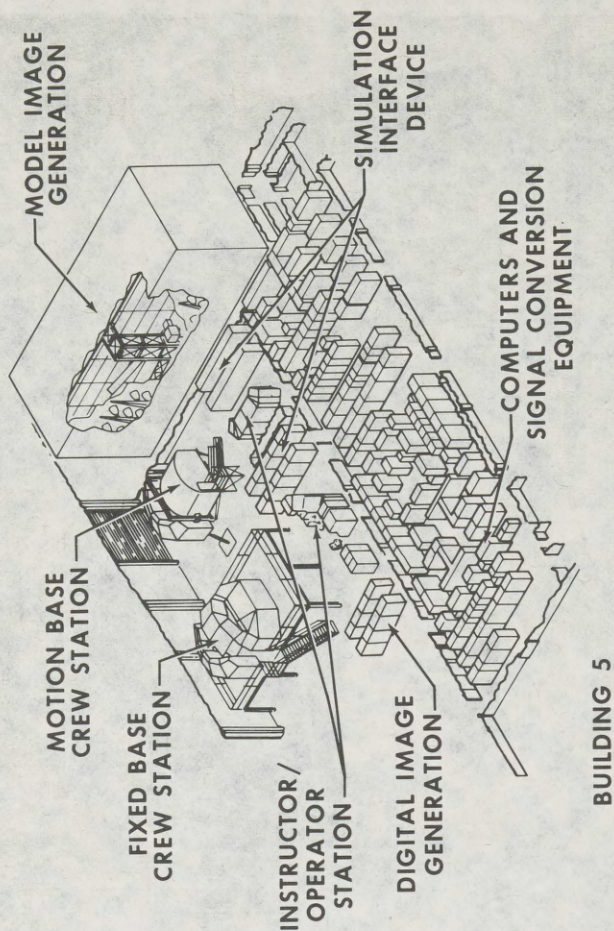
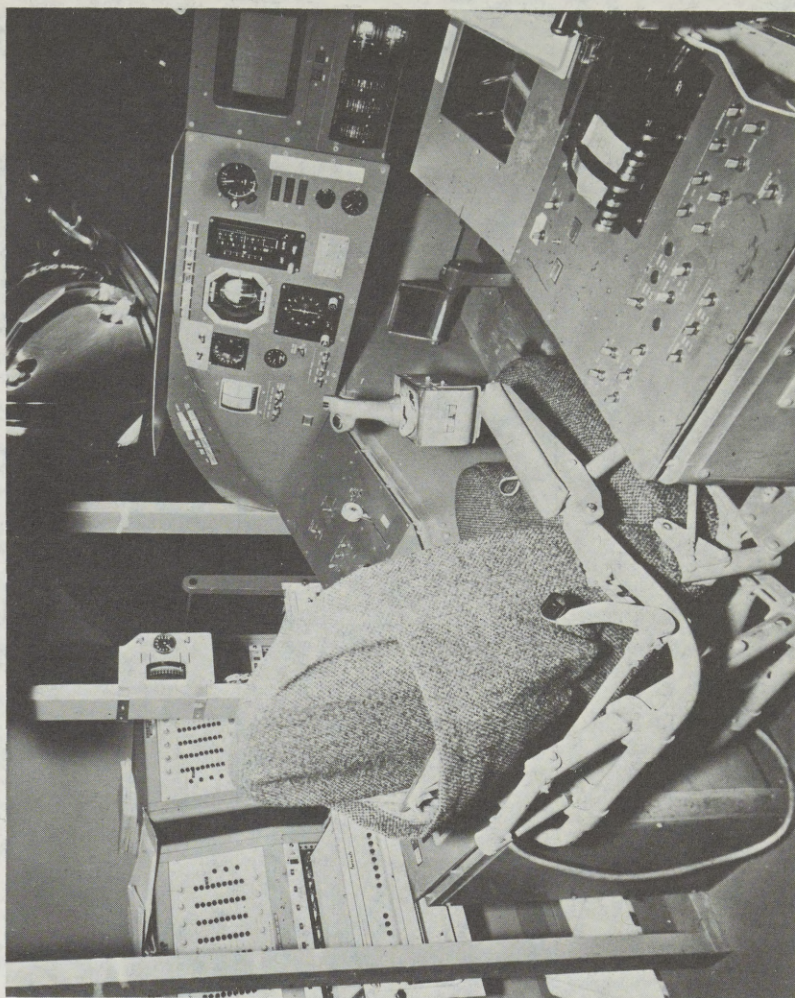


FIGURE 8



MISSION SIMULATORS (CONTD)

SIMULATOR

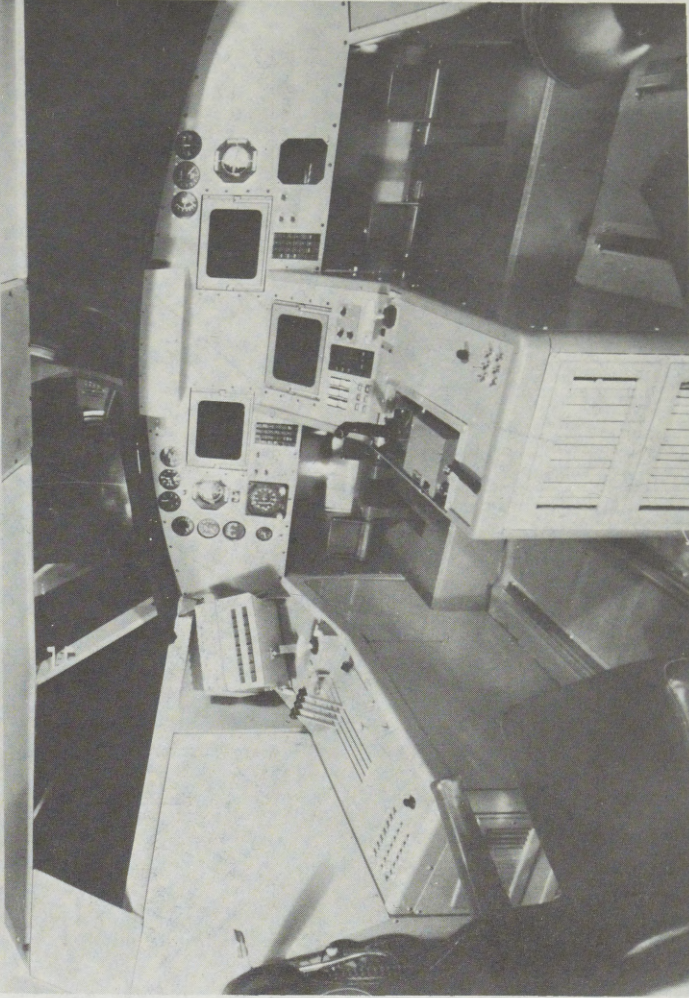
STATUS

● SHUTTLE PROCEDURES SIMULATOR (SPS)	- SIMS IN PROGRESS (ENTRY, ASCENT, ABORTS)
● GNC FLIGHT PROCEDURES TRAINING	
● INCLUDES ON-BOARD COMPUTERS/FLIGHT SOFTWARE	- UPGRADE FOR FLIGHT HARDWARE/SOFTWARE APRIL '78
● NO MCC TIE-IN	
● SPACELAB SUPPORT MODULE SIMULATOR (SSMS)	- SPECS PREPARATION - JUNE '76 - MARCH '77
● SPACELAB CORE SEGMENT AND EXPERIMENT SEGMENT	- DESIGN, DEVELOP, INTEGRATE - JAN. '78 - AUGUST '79
● SPACECRAFT SUBSYSTEMS SIMULATED	
● OPERATES ALONE, WITH SMS, OR MCC TIE-IN	- OPERATIONAL - AUGUST '79
● OPERATIONAL ONE YEAR PRIOR TO FIRST MISSION	
● INTERIM UPPER STAGE SIMULATOR (IUSS)	- SPECS PREPARATION - JAN. '77 - JAN. '78
● SOFTWARE SIMULATION TO SMS	
● SIMULATE SPACECRAFT SUBSYSTEMS	- DESIGN, DEVELOP, INTEGRATE - OCT. '78 - FEB. '80
● INTEGRATED WITH SMS, OR SMS AND MCC	
● OPERATIONAL SIX MONTHS PRIOR TO FIRST IUS MISSION	- OPERATIONAL - FEB. '80
● SINGLE SYSTEMS TRAINER	
● CONCEPT STAGE ONLY	
● TRAINING ON SINGLE SPACECRAFT SYSTEM	

FIGURE 10

NASA-S-76-10480

SHUTTLE PROCEDURES SIMULATOR



NASA-S-76-10445

MAJOR SPACELAB 1g TRAINER ELEMENTS

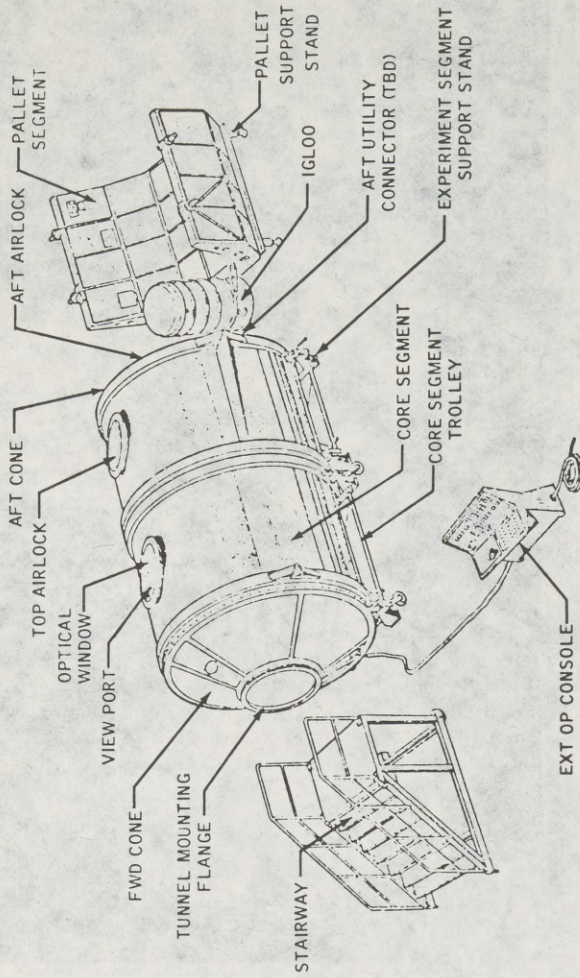


FIGURE 12

TYPES OF TRAINERS

● ONE-G TRAINERS:

- TASKS PRIMARY RELATED TO POSITION, ATTACHMENT, MOVEMENT, AND RESTRAINTS
- FULL SCALE MODELS
- HIGH FIDELITY OF CREW EQUIPMENT INTERFACES AND AIRLOCK

● NEUTRAL BUOYANCY TRAINERS:

- REPRESENTS CREW EQUIPMENT INTERFACES TO SUPPORT EXTRAVEHICULAR ACTIVITY TRAINING
- FULL SCALE MODEL TO BE USED IN WATER IMMERSION FACILITY

● SPACELAB TRAINER:

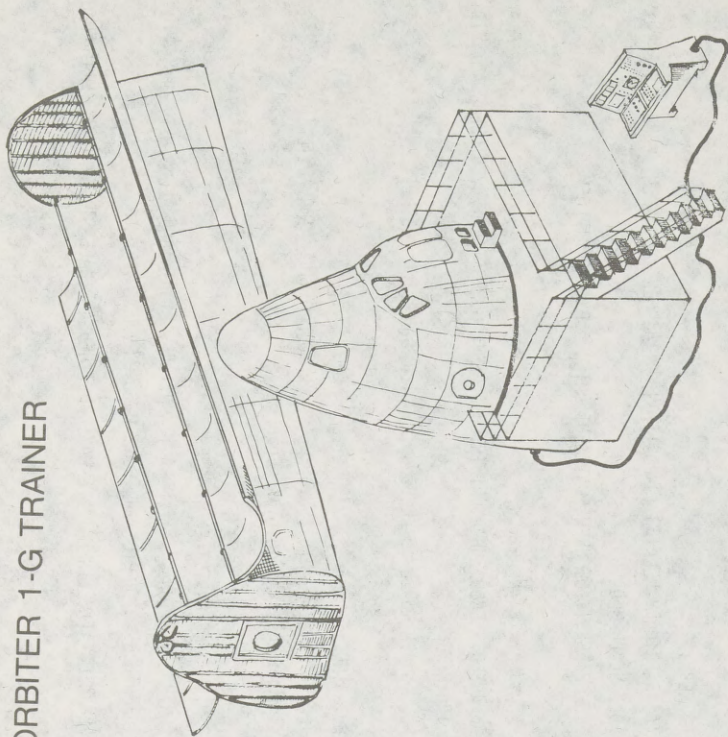
- ACCURATE REPRESENTATION OF PRESSURE MODULE (INTERIOR, EXTERIOR, AND EXPERIMENT SEGMENTS) AND PALLET SEGMENTS

● REMOTE MANIPULATOR PART TASK TRAINER:

- CONTROL STATIONS, TV CAMERAS, MONITORS, LIGHTS AND ALL OTHER SUPPORTING FEATURES TO DEPICT THE FUNCTIONAL CONTROL SYSTEM
- REPRESENTATIVE INFLATABLE PAYLOADS (HE_2 AND BALLASTING) TO BE TRAINED-ON

FIGURE 13

NASA-S-76-3207
ORBITER 1-G TRAINER



NASA-S-76-3206

TRAINER (CONCEPTUAL) ORBITER NEUTRAL BOUYANCY

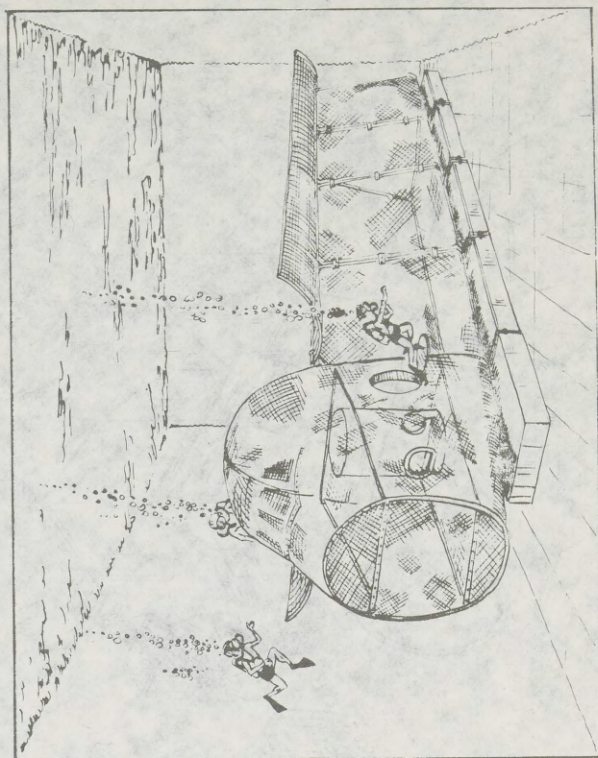


FIGURE 15

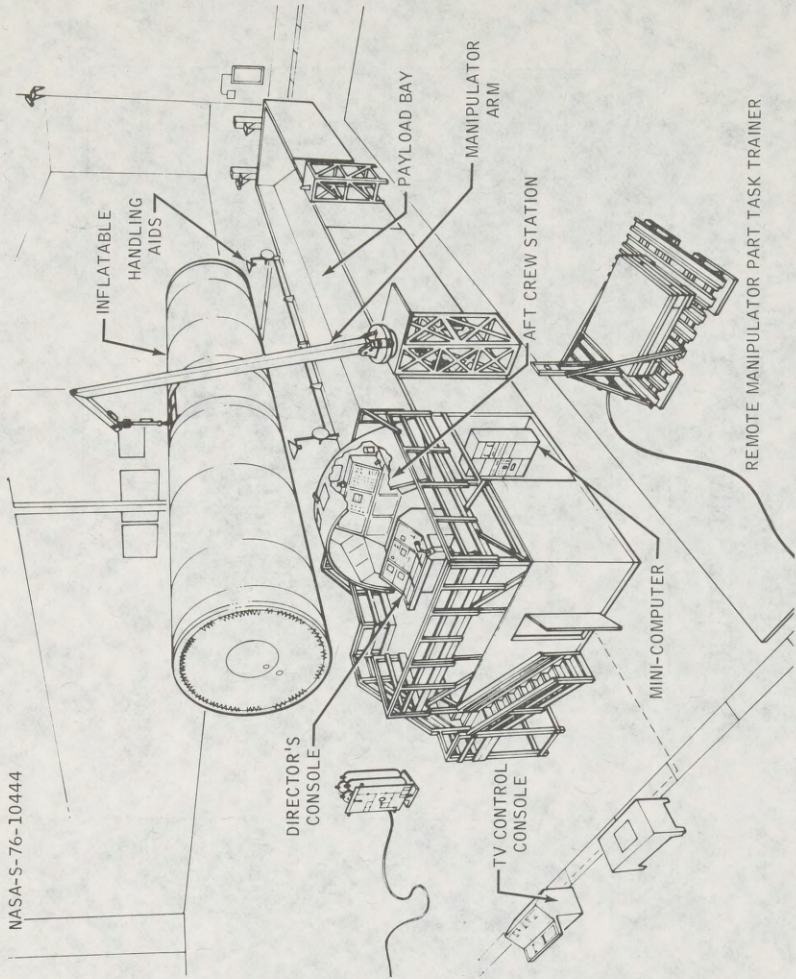


FIGURE 16

SHUTTLE TRAINING AIRCRAFT (STA)

DESCRIPTION

THE STA IS A GULFSTREAM II TURBOJET AIRCRAFT MODIFIED TO PROVIDE AN INFLIGHT SIMULATION OF ORBITER PERFORMANCE AND FLYING CHARACTERISTICS IN TERMINAL AREA OPERATIONS (< 40K FEET).

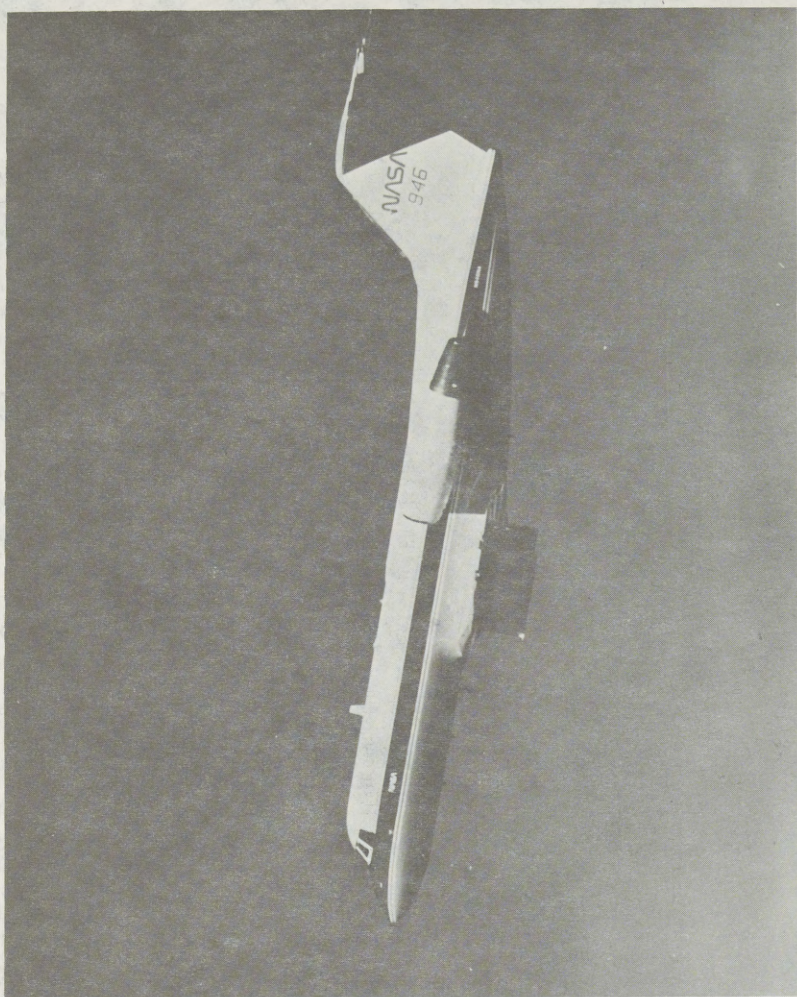
PURPOSE

- ORBITER PILOT TRAINING
- PROCEDURES DEVELOPMENT AND VERIFICATION
- INITIAL AND CURRENT PILOT CHECKOUT AND TRAINING AT PRIMARY STA TRAINING SITE
- PERFORM SPECIFIC MISSION TRAINING AT SHUTTLE OPERATIONAL SITES

DELIVERY

- ANTICIPATE JULY 1976 FOR BOTH AIRCRAFT

FIGURE 17



PAYLOAD SPECIALIST TRAINING REQUIREMENTS

BASIC	16 HOURS
• SHUTTLE PROGRAM ORIENTATION	
• STS SYSTEMS OVERVIEW	
• HIGH PERFORMANCE FLIGHT EXPERIENCE	
ADVANCED	75 HOURS
• EMERGENCY/SURVIVAL	
• STOWAGE	
• HABITABILITY	
• ORBITER SYSTEMS	
• SPACELAB SYSTEMS	
• CREW ACTIVITY PLANS	
FLIGHT SPECIFIC	63 HOURS
• PHASE TRAINING	
• MCC SIMULATIONS	
TOTAL	159 HOURS

FIGURE 19

FLIGHT CONTROL TRAINING

- TRAINING EXPERIENCE FROM PRIOR PROGRAMS APPLIED TO SHUTTLE OPERATIONS FLIGHT CONTROLLER TRAINING TO INSURE SAFETY OF FLIGHT .
- CURRICULUM FOR STS ERA BEING DEVELOPED. FOR APPROACH AND LANDING TESTS ABOUT 250 HOURS OF TRAINING DEVOTED PER FLIGHT CONTROLLER.
- TYPES OF TRAINING ARE :
 - CLASSROOM
 - SIMULATIONS
 - JOB DEFINITION
 - ON THE JOB TRAINING
 - EXPERIMENTS
- CERTIFICATION AND TESTING OF EACH FLIGHT CONTROLLER IS REQUIRED PRIOR TO THEIR PARTICIPATION ON A FLIGHT .

FLIGHT CONTROL OPERATIONS

- TRANSITION PHASE BETWEEN OFT AND STS OPERATIONS ERA WILL STREAMLINE FLIGHT CONTROLLER SUPPORT TO A MINIMUM NUMBER OF PERSONNEL
 - STAFF SUPPORT ROOMS NO LONGER UTILIZED
- STANDARDIZATION OF FLIGHT PHASES WILL BE ATTEMPTED FOR PLANNING PURPOSES

GROUND OPERATIONS TRAINING

● KSC TRAINING RESPONSIBILITY

- TRAIN THE GROUND OPERATIONS TEAM TO SAFELY: TEST, CHECKOUT, LAUNCH, RETRIEVE, AND MAINTAIN THE SHUTTLE, SPACELAB, IUS, PAYLOAD AND ASSOCIATED GROUND SYSTEMS.

● TYPES OF FORMAL TRAINING AT KSC

- FLIGHT SYSTEMS
- GROUND SYSTEMS & GSE
- OFFLINE MAINTENANCE
 - FLIGHT & GSE
- INGRESS-EGRESS
- FIRE/RESCUE
- SAFETY
- STANDARD HAND SKILLS
- RETRIEVAL

FIGURE 22

KSC TRAINING CONCEPT OVERVIEW

- PREVIOUSLY EXPERIENCED CREWS
- OFFSITE INVOLVEMENT PRE-OFT
- CLASSROOM TRAINING - PRE-ALT, PRE-OFT
- ON STATION TEST & CHECKOUT SIMULATION
- FLIGHT READINESS FIRING - FRF
- COUNTDOWN DEMONSTRATION TEST - CDDT
- FLIGHT CREW PARTICIPATION IN TEST & CHECKOUT
- ORBITAL FLIGHT TEST - OFT
- OPERATIONS PERIOD - PROFICIENCY TRAINING
- NASA/DOD JOINT TRAINING APPROACH

FIGURE 23

MISSION CONTROL CENTER SUPPORT

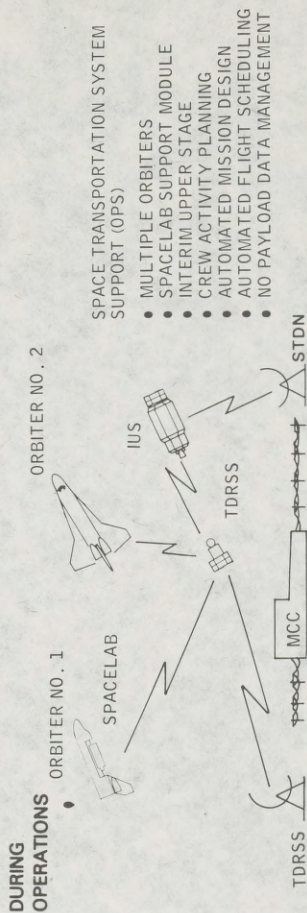
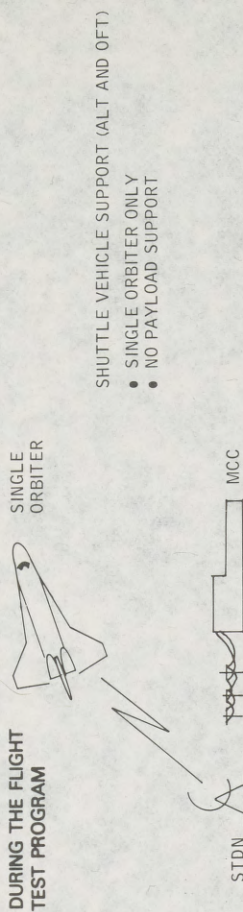


FIGURE 24

**MISSION CONTROL OPERATIONS CONCEPT
FOR
REAL-TIME SUPPORT**

TYPE OF SUPPORT	OFT PHASE	TRANSITION PHASE	OPERATION PHASE
ORBITER SYSTEMS SUPPORT	CONTINUOUS AS PER PRIOR PROGRAMS	INITIATE ON CALL SUPPORT	ON CALL SUPPORT
TRAJECTORY	CONTINUOUS MONITOR- ING	PHASE MONITORING	PHASE MONITORING
FLIGHT ACTIVITIES	PHASE SPECIALISTS	SPECIALISTS ON-CALL	FLIGHT FOLLOWING
PAYLOAD(P/L) SUP- PORT	CONTINUOUS MONITOR- ING	P/L DEPENDENT + FLIGHT FOLLOWING	P/L + FLIGHT FOLLOWING
CONTROL ROOM TEAMS	3	FOR 18 MISSIONS/YR: 4 ORBIT TEAMS 2 LANDING/ENTRY TEAMS	FOR GREATER THAN 45 MISSIONS 7 ORBIT TEAMS 3 LANDING/ENTRY TEAMS
SUPPORT ROOM TEAMS	3	3	5

FIGURE 25

MCC DEVELOPMENT SCHEDULE & MAJOR MILESTONES

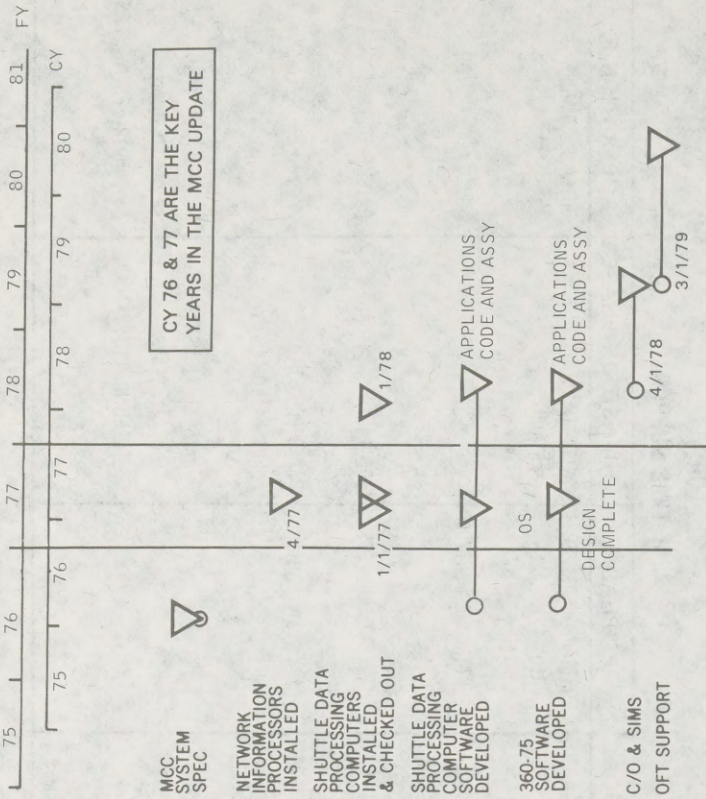


FIGURE 26

SEQUENCE OF EVENTS

- JUNE 22 BRIEFING TO SUBCOMMITTEE ABOUT CURRENT CONCEPT OF CREW TRAINING AND MISSION CONTROL.
- NASA IS CONDUCTING A STUDY TO DETERMINE THE IMPACT ON STS OPERATIONS IF THE CREW TRAINING FUNCTION IS TRANSFERRED TO KSC OR IF THE MISSION CONTROL FUNCTION IS TRANSFERRED TO KSC OR GSFC.
- STUDY AND REPORT OF IMPACT IS PLANNED TO BE AVAILABLE IN MID-AUGUST; A BRIEFING WILL BE GIVEN TO THE SUBCOMMITTEE AT YOUR CONVENIENCE SUBSEQUENT TO MID-AUGUST.

[Whereupon, the subcommittee was recessed at 11:45 a.m.]



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