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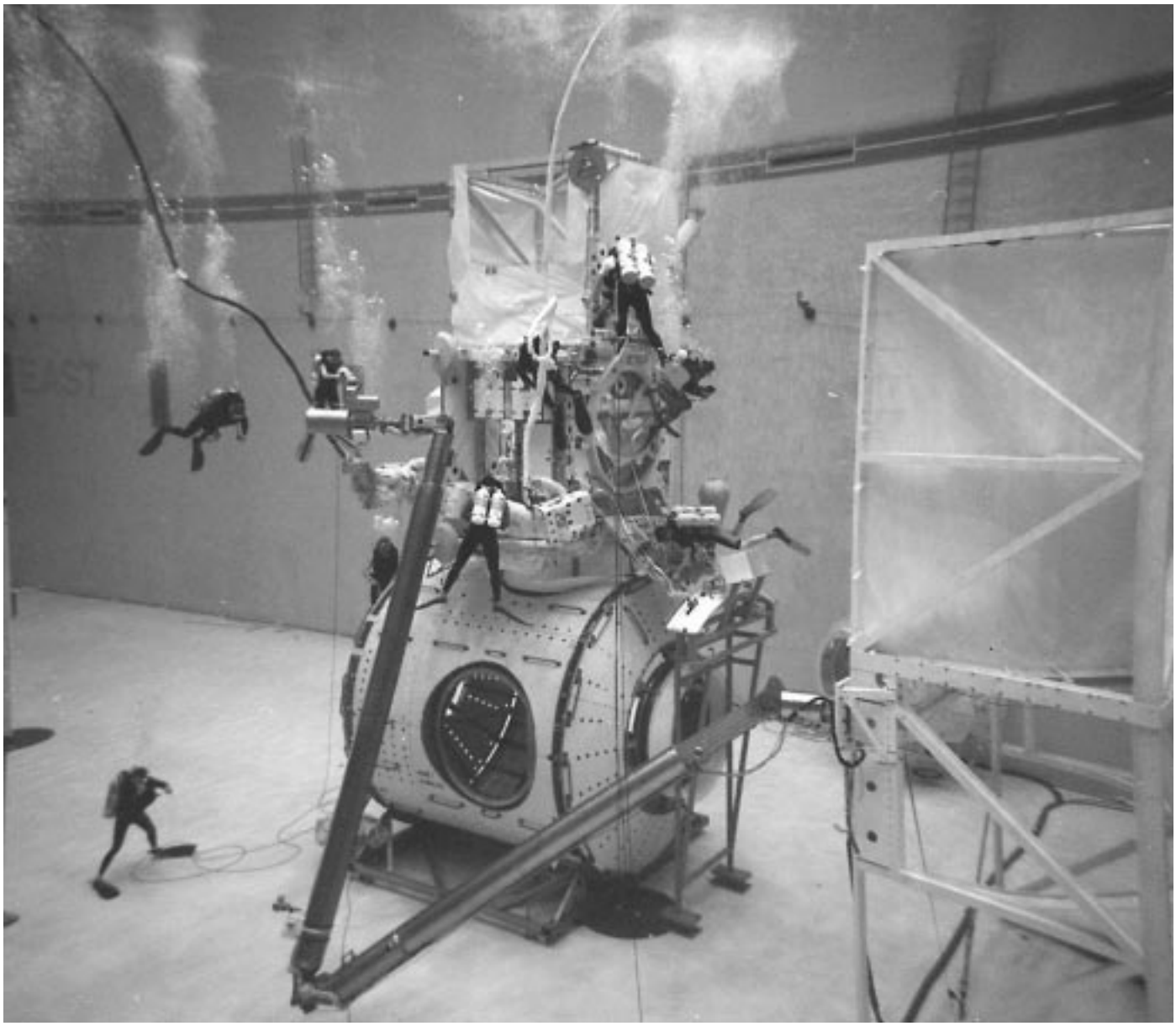
Information Summaries

Astronaut Selection and Training



Divers prepare for astronaut verification tests in the Neutral Buoyancy Laboratory at the Sonny Carter Training Facility. Astronaut Chris Hadfield removes a thermal shroud covering on a heat pipe radiator to verify its design.

The 21st century promises the challenge for humans to live and work in space. The achievements of scientists, engineers, technicians, and specialists who will build and operate the Space Station are the legacy of the National Aeronautics and Space Administration's (NASA's) many years of experience in selecting and training astronauts to work on the frontier of space.

History of Astronaut Selection

Man's scope of space exploration has broadened since the first U.S. manned space flight in 1961. But the Nation can never forget the original seven space pilots who focused our vision on the stars. In 1959, NASA asked the U.S. military services to list their members who met specific qualifications. In seeking its first astronauts, NASA required jet aircraft flight experience and engineering training. Height could be no more than 5 feet 11 inches because of limited cabin space available in the Mercury space capsule being designed. After many series of intense physical and psychological screenings, NASA selected seven men from an original field of 500 candidates. They were Air Force Captains L. Gordon Cooper, Jr., Virgil "Gus" Grissom, and Donald K. "Deke" Slayton; Marine Lieutenant Colonel John H. Glenn, Jr., Navy Lieutenant M. Scott Carpenter and Navy Lieutenant Commanders Walter M. Schirra, Jr., and Alan B. Shepard, Jr.

Each man flew in Project Mercury except Slayton, who was grounded for medical reasons. Sixteen years later, Slayton was an American crew member of the Apollo-Soyuz Test Project, the world's first international manned space flight.

Nine pilot astronauts were chosen in September 1962, and fourteen more were selected in October 1963. By then, prime emphasis had shifted away from flight experience and toward superior academic qualifications. In October 1964, applications were invited on the basis of educational background alone. These were the scientist astronauts, so called because the 400-plus applicants who met minimum requirements had a doctorate or equivalent experience in the natural sciences, medicine or engineering. Of these 400 applicants, six were selected in June 1965.

In April 1966, 19 pilot astronauts were named and in August 1967, 11 scientist astronauts were added to the program. When the Air Force Manned Orbiting Laboratory program was canceled in mid-1969, seven astronaut trainees transferred to NASA.

Shuttle Era Astronaut Candidate Recruiting

The first group of astronaut candidates for the space shuttle program was selected in January 1978. In July of that year, the 35 candidates began a rigorous training and evaluation period at NASA's Johnson Space Center (JSC), Houston, Texas, to qualify for subsequent assignment for future space shuttle flight crews. This group of 20 mission scientist astronauts and 15 pilots completed training and went from astronaut candidate status to astronaut (active status) in August 1979. Six of the 35 were women and four were minorities.

Eight groups of pilots and mission specialists have been added since then: 19 in 1980, 17 in 1984, 13 in 1985, 15 in 1987, 23 in 1990, 19 in 1992, 19 in 1995 and 35 in 1996.

Selection and Training for the Future

In the future, the United States with its international partners Japan, Canada, Russia and the European Space Agency, will operate a man-tended space station. From that orbiting depot, humans will continue their journeys to the Moon and Mars. As these plans become reality, the need for qualified space flight professionals will increase.

To respond to these needs, NASA accepts applications for the Astronaut Candidate Program on a continuous basis. Candidates are selected as needed, normally every two years, for pilot and mission specialist categories. Both civilian and military personnel are considered for the program. Civilians may apply at any time. Military personnel must apply through their parent service and be nominated by their service to NASA.

The astronaut candidate selection process was developed to select highly qualified individuals for human space programs. For mission specialists and pilot astronaut candidates, the education and experience requirements are at least a bachelor's degree from an accredited institution in engineering, biological science, physical science, or mathematics.

Astronaut candidate Eileen M. Collins retreats from the water during a water survival training school hosted by the Naval Air Station in Pensacola, Florida.

View of astronaut candidates and payload specialists during a training flight on the KC-135. The trainees experience weightlessness in the hold of the aircraft as it performs parabolic flight maneuvers.

For mission specialist applicants, three years of related, progressively responsible professional experience must follow the degree. An advanced degree is desirable and may be substituted for all or part of the experience requirement (i.e., master's degree = 1 year of work experience, doctoral degree = 3 years of experience).

Pilot astronaut applicants must also meet the following requirements prior to submitting an application:

(1) At least 1,000 hours pilot-in-command time in jet aircraft; flight test experience is highly desirable.

(2) Ability to pass a NASA Class I space physical, which is similar to a military or civilian Class I flight physical, and includes the following specific standards: for vision-distance visual acuity - 20/70 or better uncorrected, correctable to 20/20, each eye. For Blood Pressure-140/90 measured in a sitting position.

(3) Height between 64 and 76 inches.

Mission specialists have similar requirements to pilot astronauts, except that the qualifying physical is a NASA Class II space physical, which is similar to a military of civilian Class II flight physical and includes the following specific standards: for vision-distance visual acuity - 20/200 or better uncorrected, correctable to 20/20, each eye. For Blood pressure-Same as for Pilots. Height requirements for mission specialists are between 58.5 and 76 inches.

The application package may be obtained by writing to the Astronaut Selection Office, Mail Code AHX, Johnson Space Center, Houston, TX 77058-3696.

Applicants who meet the basic qualifications are evaluated by discipline panels. Those selected as finalists are screened during a week-long process of personal interviews, thorough medical evaluations, and orientation. The Astronaut Selection Board's recommendations are based on the applicant's education, training, and experience as well as unique qualifications and skills. Because several hundred applicants fulfill the requirements, the final selection is based largely on personal interviews. Astronauts are expected to be team players and highly skilled generalists with just the right amount of individuality and self-reliance to be effective crew members.

Selected applicants are designated astronaut candidates and assigned to the astronaut office at the Johnson Space Center for a 1 to 2 year training and evaluation program. Civilian candidates who successfully complete the training and evaluation and are selected astronauts are expected to remain with NASA for at least 5 years. Successful military candidates are detailed to NASA for a specified tour of duty.

Salaries for civilian astronaut candidates are based on the Federal Government's General Schedule pay scales for grades GS-11 through GS-14, and are set in accordance with each individual's academic achievements and experience.

SPACE SHUTTLE CREW POSITIONS

Commander/Pilot Astronauts

Pilot astronauts serve as both space shuttle commanders and pilots. During flight, the commander has onboard responsibility for the vehicle, crew, mission success, and safety of flight. The pilot assists the commander in controlling and operating the vehicle and may assist in the deployment and retrieval of satellites using the remote manipulator system (RMS), referred to as the robot arm or mechanical arm.

Mission Specialist Astronauts

Mission specialist astronauts work with the commander and the pilot and have overall responsibility for coordinating shuttle operations in the following areas: Shuttle systems, crew activity planning, consumables usage, and experiment/payload operations. Mission specialists are trained in the details of the Orbiter onboard systems, as well as the operational characteristics, mission requirements/objectives, and supporting equipment/systems for each of the experiments conducted on their

Astronaut Claude Nicollier in water egress training. View is of Nicollier in one-man life raft.

Astronaut Candidate Leroy Chiao participates in a classroom session during his astronaut candidate training period.

assigned missions. Mission specialists perform extravehicular activities (EVAs), or space walks, operate the remote manipulator system, and are responsible for payloads and specific experiment operations.

Payload Specialists

Payload specialists are persons other than NASA astronauts (including foreign nationals) who have specialized onboard duties; they may be added to shuttle crews if activities that have unique requirements are involved and more than the minimum crew size of five is needed.

First consideration for additional crew members is given to qualified NASA mission specialists. When payload specialists are required they are nominated by NASA, the foreign sponsor, or the designated payload sponsor. In the case of NASA or NASA-related payloads, the nominations are based on the recommendations of the appropriate Investigator Working Group (IWG). Although payload specialists are not part of the Astronaut Candidate Program, they must have the appropriate education and training related to the payload or experiment. All applicants must meet certain physical requirements and must pass NASA space physical examinations with varying standards depending on classification.

ASTRONAUT CANDIDATE TRAINING

Astronaut candidates receive training at JSC near Houston, Texas. They attend classes on shuttle systems, in basic science and technology: mathematics, geology, meteorology, guidance and navigation, oceanography, orbital dynamics, astronomy, physics, and materials processing are among the subjects. Candidates also receive training in land and sea survival training, scuba diving, and space suits.

As part of the Astronaut Candidate training program, Astronaut Candidates are required to complete military water survival prior to beginning their flying syllabus, and become SCUBA qualified to prepare them for the extravehicular activity training. Consequently, all Astronaut Candidates will be required to pass a swimming test during their first month of training. They must swim 3 lengths of a 25M pool in a flight suit and tennis shoes. The strokes allowed are freestyle, breast, and sidestroke. There is no time limit. They must also tread water continuously for 10 minutes.

Candidates are also exposed to the problems associated with high (hyperbaric) and low (hypobaric) atmospheric pressures in the altitude chambers and learn to deal with emergencies associated with these conditions.

In addition, astronaut candidates are given exposure to the microgravity of space flight. A modified KC-135 jet aircraft produces periods of weightlessness for 20 seconds. During this brief period, astronauts experience the feeling of microgravity. The aircraft then returns to the original altitude and the sequence is repeated up to 40 times in a day.

Pilot astronauts maintain flying proficiency by flying 15 hours per month in NASA's fleet of 2-seat T-38 jets; they

Astronaut Bernard A. Harris, Jr., prepares to make use of a Sky Genie device used in emergency egress training. The device would aid in emergency egress operations aboard a troubled space shuttle.

STS-44 Commander Frederick D. Gregory (left) and Pilot Terence T. Henricks are at their appointed positions on the forward flight deck of the Fixed Base (FB) Shuttle Mission Simulator (SMS) in JSC's Mission Simulation and Training Facility, Bldg 5.

build up jet aircraft hours and also practice Orbiter landings in the Shuttle Training Aircraft, a modified corporate jet aircraft. Mission specialist astronauts fly a minimum of 4 hours per month.

ASTRONAUT FORMAL TRAINING

The astronauts begin their formal space transportation system training program during their year of candidacy by reading manuals and by taking computer-based training lessons on the various Orbiter systems ranging from propulsion to environmental control.

The next step in the training process is the single systems trainer (SST). Each astronaut is accompanied by an instructor who helps in the learning process about the operations of each Orbiter subsystem using checklists similar to those found on a mission. The checklists contain information on normal system operations and corrective actions for malfunctions. The astronauts are trained in the SSTs to operate each system, to recognize malfunctions, and to perform corrective actions.

Following the SST portion of the training program, the astronauts begin training in the complex Shuttle Mission Simulators (SMSs). The SMS provides training in all areas of shuttle vehicle operations and in all systems tasks associated with the major flight phases: prelaunch, ascent, orbit operations, entry and landing. The orbit training includes payload operation, payload deployment and retrieval, maneuvers, and rendezvous. Two additional simulators, a fixed base and a motion base, are used to train the astronauts.

The fixed base crew station is used for both specific mission/payload training and launch descent and landing training. It is the only trainer with complete fore and aft consoles, including an RMS console. A digital image generation system provides visual cues for out-the-window scenes of the entire mission, e.g., the Earth, stars, payloads and the landing runway. Missions can be simulated literally from launch to landing.

The motion base crew station is used to train pilots and commanders in the mission phases of launch, descent, and landing. Motion cues are provided by the 6-degrees-of-freedom motion system which also allows the flight deck to be rotated 90 degrees to simulate lift-off and ascent.

Astronauts begin their training in the SMS using generic training software until they are assigned to a particular mission, approximately 10 months before flight. Once they are assigned to a flight, astronauts train on a flight simulator with actual flight-specific training software.

During this last 11 weeks, the astronauts also train with the flight controllers in the Mission Control Center (MCC). The SMS and MCC are linked by computer in the same way the Orbiter and MCC are linked during an actual mission. The astronauts and flight controllers learn to work as a team, solving problems and working nominal and contingency mission timelines. Total hours in the SMS for the astronauts, after flight assignment, is about 300 hours.

In parallel with the SMS training there are several other part-task trainers that are used to prepare astronauts for shuttle missions. These trainers are in varying degrees of fidelity and each serve a particular purpose.

The Sonny Carter Training Facility, or Neutral Buoyancy Laboratory (NBL), provides controlled neutral buoyancy operations in the facility water tank to simulate the zero-g or weightless condition which is experienced by the spacecraft and crew during space flight. It is an essential tool for the design, testing and development of the space station and future NASA programs. For the astronaut, the facility provides important pre-flight training in becoming familiar with planned crew activities and with the dynamics of body motion under weightless conditions.

Several full-scale mockups and trainers are also used to train astronauts. The full fuselage trainer is a full-sized plywood

High angle view of Building 9 Training Facilities including the Space Shuttle Full Fuselage Trainer and the Remote Manipulator System (RMS) mock-up. Also visible is a mock-up of the Hubble Space Telescope for use in training with the RMS.

Astronauts Norman E. Thagard and Bonnie J. Dunbar leave the Mir Space Station Simulator at the Gagarin Cosmonaut Training Center (Star City), near Moscow, Russia.

Orbiter mockup with nonfunctional mid-deck and flight deck, and full-scale payload bay. It is used for onboard systems orientation and habitability training. Astronauts practice meal preparation, equipment stowage, trash management, use of cameras, and experiment familiarization. This trainer is also used for emergency egress training after shuttle landings.

The crew compartment trainer is a mockup of the forward section of the Orbiter crew station, without a payload bay, that can be tilted vertically. It is used to train for on-orbit habitability procedures and also emergency pad egress and bailout operations. The crew stations of both trainers are similar.

The manipulator development facility is a full-scale mockup of the payload bay with full-scale hydraulically operated RMS, the mechanical arm on the Orbiter which is used to move payloads in and out of the payload bay. Mission specialists use this trainer to practice deploying and reberthing of payloads into the Orbiter.

Pilots training for a specific mission receive more intensive instruction in Orbiter approach and landing in Shuttle Training Aircraft (STA), which are four Gulfstream II business jets modified to perform like the Orbiter during landing. Because the Orbiter approaches landings at such a steep angle (17-20 degrees) and high speed (over 300 miles per hour), the STA approaches with its engines in reverse thrust and main landing gear down to increase drag and duplicate the unique glide characteristics of the Orbiter. Assigned pilots receive about 100 hours of STA training prior to a flight, which is equivalent to 600 shuttle approaches. In between training sessions, the crew members continue to keep themselves up-to-date on the status of the space craft and payloads for their assigned mission. In addition, the astronauts study flight rules and flight data file procedures, and participate in mission-related technical meetings. They also participate in test and checkout activities at the NASA Kennedy Space Center in Florida, the launch site for the space shuttle.

The months of preparation pay off and the mission is a success; the actual mission will have far fewer contingencies than were practiced for. The accuracy of the simulations and training is remarkable. Astronauts often comment that only the noise and vibration of launch and the experience of weightlessness are missing from the practice sessions; everything else in training accurately duplicates the space experience.

Astronauts who participate in the Russian Space Station Mir program receive Russian language training before transferring to the Yuri Gagarin Cosmonaut Training Center for approximately 13 months. Four weeks prior to the shuttle launch that will deliver them to Mir, the astronaut returns to JSC to train and integrate as part of the shuttle crew during the final phase. Russian language courses continue at the Gagarin Training Center until the astronaut reaches the level required to begin technical training.

The Russian technical training includes theoretical training on the Russian vehicles design and systems, EVA training, scientific investigations and experiments, and biomedical training.

The astronauts' mission continues even after the Orbiter has returned. The crew will spend several days in medical testing and debriefing, recounting their experiences for the benefit of future crews to assist in future training and to add to the space flight knowledge base.

Members of the media also receive a detailed post-flight briefing by the crew. Then, the studies and training that may eventually lead to another space flight are resumed.