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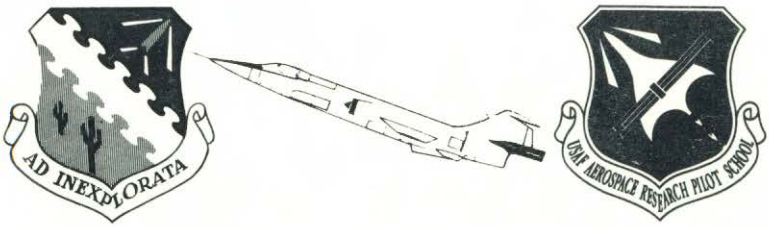
USAF AEROSPACE RESEARCH PILOT SCHOOL

EDWARDS AIR FORCE BASE, CALIFORNIA



THE USAF AEROSPACE RESEARCH PILOT SCHOOL

INTRODUCTION

Flight test training in the Air Force originated as an in-house training activity in Test Operations at Wright Field in about 1943. It then progressed to formal school status with its own staff and aircraft, and in 1951 moved west to Edwards AFB. Events of the late 1950's exposed the need for aerospace pilots trained for work in advanced aircraft and manned space researcb programs. Thus in 1961, the research pilot or "aerospace training" phase was added to the School's curriculum. Since its beginning the Test Pilot School, now called the Aerospace Research Pilot School (ARPS) has been in a constant state of change to keep its course of instruction, test methods, and training vehicles ahead of the anticipated needs of future test programs. The change has been such that those individuals associated with the School just a few years ago would hardly recognize it as it is today.

The purpose of this publication is to enhance the reader's knowledge of the scope and capabilities of the Aerospace Research Pilot School. This is done by explaining the School's present and future mission, by outlining its course of instruction, and by reviewing lightly some of the specialized training, techniques, and equipment unique to the School.

MISSION

The mission of the School is threefold:

1. To train Experimental Test Pilots to supervise and conduct flight tests of research, experimental, or production type aerospace vehicles.

2. To train Aerospace Research Pilots for flight test, engineering design, and/or management in advanced aircraft and manned space research programs.

3. To conduct preliminary training for Manned Orbiting Laboratory (MOL) astronauts.

SELECTION CRITERIA

To enlist the highly capable pilots desired to eventually work in the field of flight test, the School and Air Force maintain an exceptionally rigid selection process. The minimum eligibility requirements are:

EDUCATION: Bachelor's degree in engineering, physical science or mathematics.

AGE: Apply before 32nd birthday and enter the course before 33rd birthday.

ASSIGNMENT: Active duty pilot in the grade of major or below.

FLIGHT EXPERIENCE: A minimum of 500 hours as instructor or first pilot in:

a. Jet or turbo-prop bomber or transport aircraft.

b. Supersonic fighter or trainer aircraft.

c. Helicopters

d. A combination of the above.

NOTE: In lieu of the above, 1000 hours as instructor or pilot in a single engine jet aircraft is acceptable. (See AFR 53-19 for complete details.)

AVERAGE QUALIFICATIONS

While the above are the minimum requirements for consideration, the large number of applicants allows final selection of pilots with much higher qualifications. An examination of the last four graduating classes shows the average backgrounds of the 16 military members of each of the classes to be:

EDUCATION: Ten Bachelor's degrees, five Master's degrees, and one Doctorate per class.

AGE: Average age is 31.

FLIGHT EXPERIENCE: 2,300 hours for the average fighter/trainer pilot (11 pilots per class).

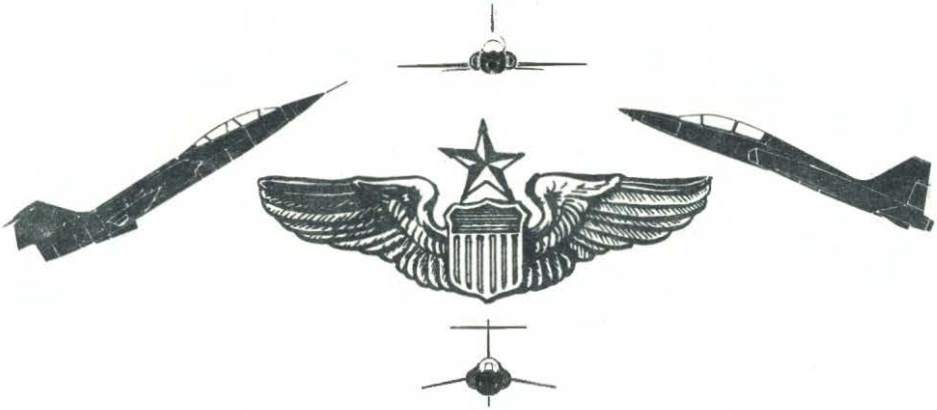
2,800 hours for the average bomber/transport pilot (5 pilots per class).

Diversity of experience is an important (and in today's Air Force, very rare) attribute sought after in a prospective test pilot. The majority of the pilots selected for the School have extensive operational experience in three or more aircraft. In addition, experience and subsequent assignment considerations dictate the desirability of a combat tour in South East Asia prior to assignment to the School. As a result, almost all recent entrants have completed Vietnam tours.

The average class size at ARPS is 22. This consists of 16-18 U.S. military pilots (of which two are usually Marine or Navy pilots), and as many as six other pilots. Recently the "other" pilots category has included civilian contractor pilots, FAA and NASA pilots, and military and/or civilian pilots from allied countries. The School conducts two classes per year, with starting dates in the first week of February and the first week of August.

CURRICULUM

The year long course at ARPS consists of two phases. Phase I is eight months in duration and comprises the experimental test pilot training, while Phase II lasts the remaining four months and encompasses advanced aircraft and space training. At present only the U.S. military pilots stay on for the Phase II research pilot course - all civilian and foreign pilots are graduated at the end of Phase I.



PHASE I - EXPERIMENTAL TEST PILOT COURSE

The eight month Experimental Test Pilot Course is designed to train pilots in the latest methods of testing and evaluating aircraft and related aeronautical equipment. The academics, simulation, and flying training are designed to give the student the theoretical and practical background required to supervise and conduct flight tests of research, experimental, or production type aircraft.

The phase is divided into two major segments, Performance, and Stability and Control, approximately three and five months in duration respectively.

PERFORMANCE

The Performance subphase progressively develops the theory, flight test techniques, and data reduction methods associated with performance flight testing.

ACADEMICS

The Academics are conducted at an undergraduate aeronautical engineering course level and begin with a brief review of calculus, physics, thermodynamics, and aerodynamics, and progress through the detailed theory of aircraft and engine performance. The Appendix gives a breakdown of the entire ARPS curriculum.

Note that the time allotted some of the subjects is extremely short. As an example, the Calculus Review is just two hours long, and in reality consists only of a final exam which covers an entire year's course in calculus. Physics-Thermodynamics is another example, with only six hours to cover all applicable concepts. This brevity in the basic courses is dictated by the ever increasing complexity of flight testing, and the necessarily greater number of subjects to which a new test pilot must be exposed to adequately prepare him to understand and perform his work. The factor which allows pushing the student through the basics at this rapid pace is the student's own high level academic background - most of those accepted for the School carried at least a B+ or better average in related courses at the undergraduate or graduate level.

Figure 1 Aerospace Research Pilot School

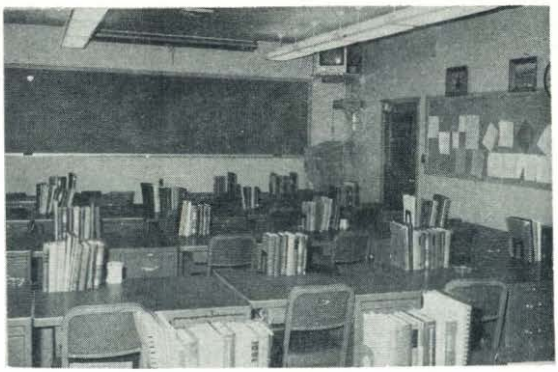


Figure 2 ARPS Classroom

FLYING

Performance flying closely parallels the academic curriculum and teaches the student the basic methods of performance data gathering. Pitot static calibration, takeoff, climb, range, acceleration, turning, and descent performance, are all investigated. To apply his knowledge to a practical exercise, each student flies a limited Category II performance flight test program in either the T-33, T-38, or B-57, and documents his results in a formal written report. Individual oral reports on the progress of the test program give each student the experience to practice this form of reporting.

STABILITY AND CONTROL

The Stability and Control subphase is designed to prepare the student to test and evaluate the handling qualities of an aircraft.

ACADEMICS

Background theory courses in vector analysis, differential equations, operational math, and dynamics prepare him to derive the basic equations of motion of an aircraft. The equations are examined in detail with in-depth studies of each of the important stability parameters. The variables that govern static longitudinal and lateral-directional stability are investigated, and considerable time is spent on the theory behind roll coupling, spin testing, and aeroelastic effects. The expanding role of electronic and hydraulic systems to aid or completely implement the stability and control of modern aircraft has dictated the inclusion of an extensive group of subjects related to linear and non-linear control theory. More than fifty hours are allotted to this area of study.

FLYING

The real uniqueness of the ARPS curriculum is realized when the above mentioned academic courses are coupled with the School's computers, simulators, and aircraft. As an example, to investigate the stability and dynamics of an aircraft, the student first derives the basic aircraft equations of motion and becomes familiar with the variables involved. These equations are then placed on an analog computer where the effects of varying basic frequencies and damping ratios can be observed visually. The School's static aerodynamic simulator is then used to allow the student to vary individual stability parameters to see how they change an aircraft's handling characteristics. With this basic familiarity of the parameters

involved, the student takes to the air in the Cornell Aeronautical Laboratory's B-26 variable stability trainer and the two ARPS NF-106 variable stability aircraft (the NF-106 is covered in detail later). These flying laboratories allow an infinite variance of aircraft handling qualities and control systems, and give the student first hand in flight experience in observing a vast range of flight characteristics that could never collectively be found in individual test or production vehicles. Finally, the student applies his newly gained experience to the planning, conduct, and reporting of a relatively complete stability and control investigation of the F-104 and either the T-33, T-38, or B-57. In addition to the basic longitudinal and lateral-directional stability measurements, the investigation includes an examination of the engine out characteristics of the

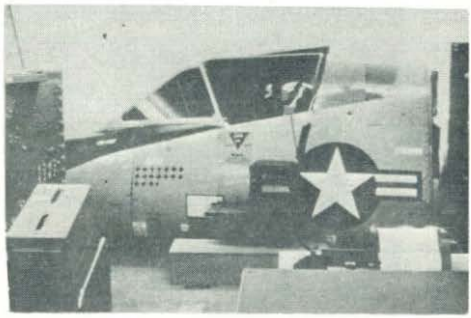


Figure 3 Static Aerodynamic Simulator

Figure 4 Cornell Variable Stability B-26

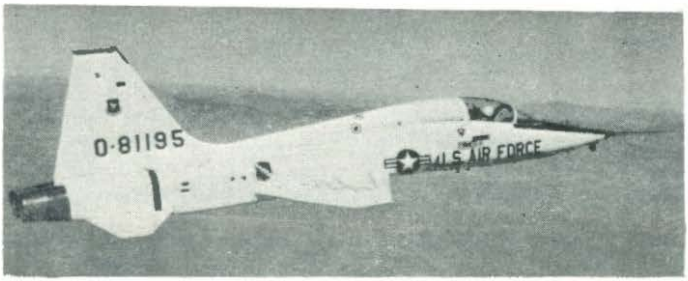


Figure 8 ARPS T-38

B-57, the spin characteristics of the T-33, and the high supersonic Mach number handling characteristics of the F-104 (see the Appendix for a detailed list of training flights).

V/STOL

In addition to the above mentioned topics, the Stability and Control portion of ARPS includes an extensive introduction to the emerging field of vertical and short takeoff and landing technology. Both helicopter and V/STOL theory are coupled with helicopter flight in the H-13 and UH-1F, and V/STOL flight simulation in the Ryan XV-5 simulator. Future plans call for advanced helicopters and V/STOL training aircraft to be added to the curriculum.

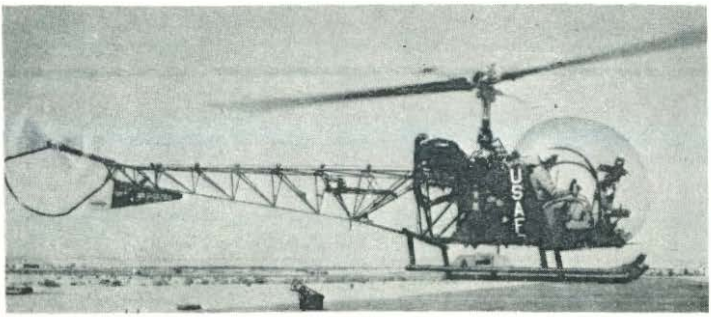


Figure 6 ARPS H-13

Qualitative Testing

Another area which receives heavy emphasis is that of qualitative flight testing. Each student is briefed on the optimal techniques to be employed, and then performs a one flight evaluation of one or more aircraft that he has never flown before. Written and/or oral reports are then presented on his findings. Typical aircraft evaluated include the F-100, F-102, F-4, F-111, TA-4F, A-1E, B-52, KC-135, C-130, C-141, T-28, T-29, OV-1, O-2, U-6, U-10, and UH-1B.

Gliding

In addition to the above missions, the pilots are given a short introductory glider flight program (2 hours) to complement their high performance experience with very high L/D flight. The introduction consists of eight flights in Schweizer 2-32's, 2-33's, and 1-26's at a commercial gliding facility in Tehachapi, California. In addition to gaining a basic familiarity with aircraft of this type, the student also gathers limited glider handling and performance data.

Figure 7 Schweizer 1-26 Glider

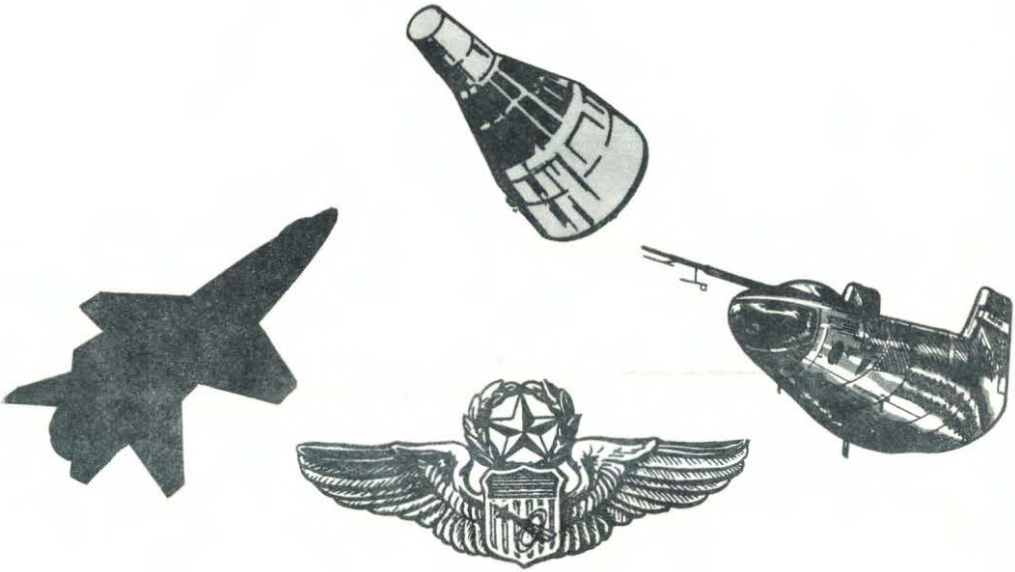
Reports

Probably the most tedious and yet one of the most necessary parts of the curriculum is the written and oral report program. A test pilot who cannot clearly and accurately report his findings is wasting valuable time and effort in flying a test program. Several opportunities are given the student to practice and develop his writing and speaking abilities. In addition, the individual analysis of the test data required to prepare a report is a powerful tool in helping the student develop a critical eye for the effects of flying accuracy on test results.

As the end of the Phase I curriculum approaches, the student begins to gain considerable understanding of the language, theory, techniques, and problems of flight testing. Thus at this time he is given increasing opportunities to learn from various experts in the associated fields of flight test through a series of guest lectures. In addition, each class is given field trips to various test activities and aircraft manfacturers, and one class each year travels on a two week visit to study the flight test centers and schools of our allies in Europe.

The end of the Phase I Experimental Test Pilot Training Course signals the departure of the foreign and civilian students. As graduates of this phase, they have been trained to perform as test pilots, engineers, and managers on atmospheric test programs of research, test, and production type aircraft and V/STOL vehicles. The U.S. military students remain at the School for an additional four months training in the Phase II Aerospace Research Pilot Course.

Figure 8 ARPS F-104C



PHASE II - AEROSPACE RESEARCH PILOT COURSE

The four month Aerospace Research Pilot Course is designed to increase the qualifications of the Phase I graduate to enable him to participate in the flight testing, engineering design, and/or management of advanced aircraft and manned space research programs. The course includes (1) academic instruction in subjects related to advanced aircraft and space vehicle performance and operation, (2) practical test flying in aircraft and simulators exhibiting research aircraft and manned space vehicle flight characteristics, (3) familiarization with the physiological and psychological aspects of high performance and space flight, and (4) field trips to various government and civilian facilities engaged in the development, testing, and employment of present and future advanced aircraft, space vehicles, and related systems and components.

ACADEMICS

Much emphasis is placed on the intensive academic program. The subjects are presented at the graduate level and consist of background

studies in astronomy, digital computers, bioastronautics, space enrivonment, and the supporting mathematics. The mechanics and performance aspects of advanced aircraft and space flight are investigated in courses on rocket propulsion, space flight mechanics, reentry heating, and relativity. Finally, aircraft and space vehicle guidance and control capabilities are studied in space navigation and inertial guidance courses.

SIMULATION

An extensive simulation curriculum is employed to bridge the gap between classroom theory and practical application. The curriculum is keyed to progression in academics and provides:

1. Verification of performance and guidance and control theory by actual practice.

2. Practical experience in energy management and the characteristics of many types of advanced aircraft and space vehicle control systems.

3. A build-up of experience in instrument display selection, control system selection, and other trade-off areas for future pilot contributions to the design phase of new space systems.

4. Development of piloting skills required for space operations which are impractical to perform except in simulation.

The simulation missions range from small part tasks in fixed base devices to full mission simulations including complete propulsion, control, guidance, visual cues, instrument displays, sound, heat, pressure suit facilities, vibration, simulated motion and g levels, etc., of a specified space system in real time. Most major maneuvers of the current and near-future space programs are duplicated by simulation.

The simulation equipment currently in use includes:

1. Static Aerodynamic Simulator - used to simulate any aerodynamic vehicle including those with rocket propulsion and reaction controls at any altitude and velocity from reentry to light aircraft environment. (See Figure 3.)

2. Reaction Control Trainer - an air bearing bedstead flown visually or on instruments which is computer integrated to provide many desired vehicle characteristics and handling qualities.

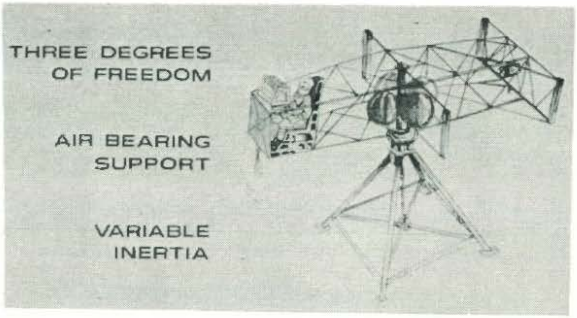


Figure 9 Reaction Control Trainer

3. Static Space Simulator - used to simulate any space mission part task from attitude orientation and control through launch, rendezvous and reentry.

Figure 10 Static Space Simulator

4. T-27 Simulator - a moving base simulator with a visual system including earth, stars, and a rendezvous vehicle, plus special effects which include heat, pressure suit facilities, sound, and vibration cues. Wash-out motion is incorporated to induce proper vestibulary cues. Instrumentation, controls, and displays allow simulations which range from light aircraft to complex space missions.

All simulations take place under normal gravity. Motions and attitudes are used to place the gravity vector to best simulate the

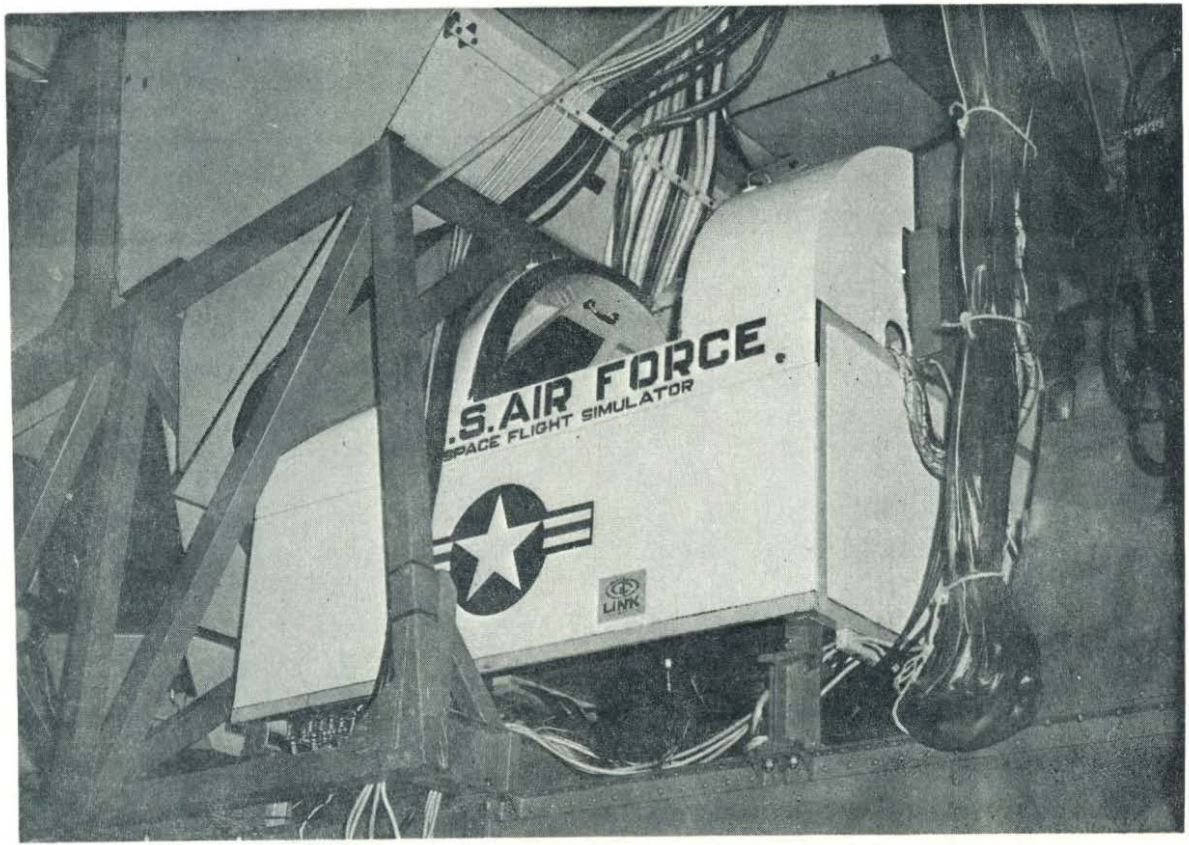


Figure 11 T-27 Space Simulator

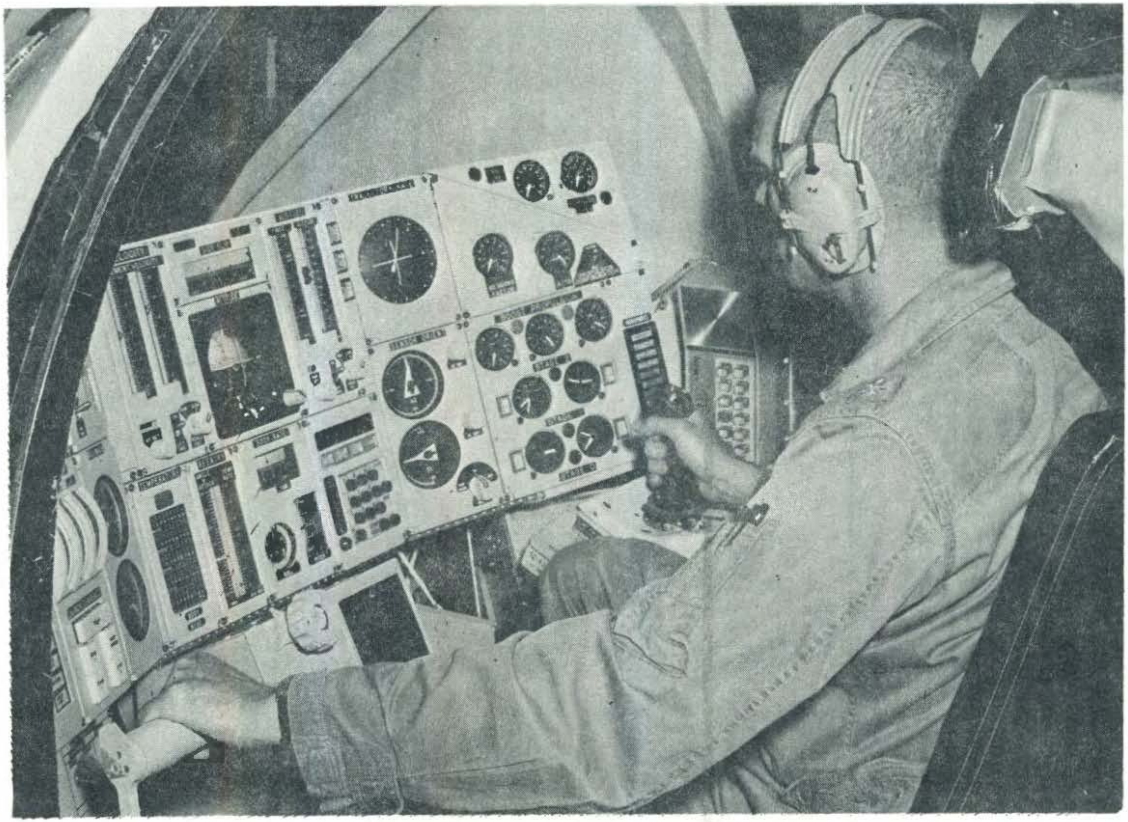


Figure 12 T-27 Cockpit

mission g forces. Actual zero gravity experience is provided in an Air Force Systems Command C-135 flying zero gravity and moon gravity profiles. Heavy g profiles (up to 15 g's) are experienced in the centrifuge at the School of Aerospace Medicine, Brooks AFB, Texas. Actual space program g profiles are flown to include launch, abort, and re-entry.

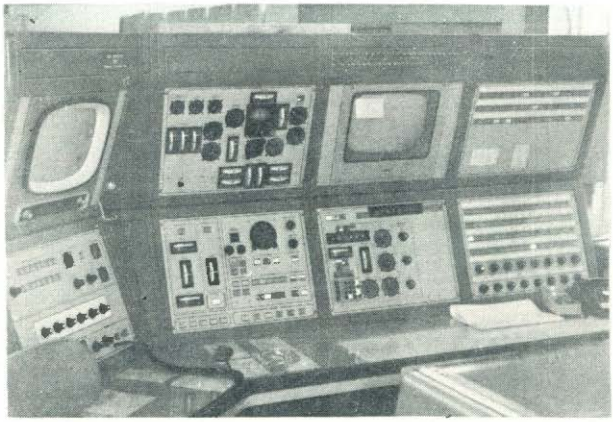
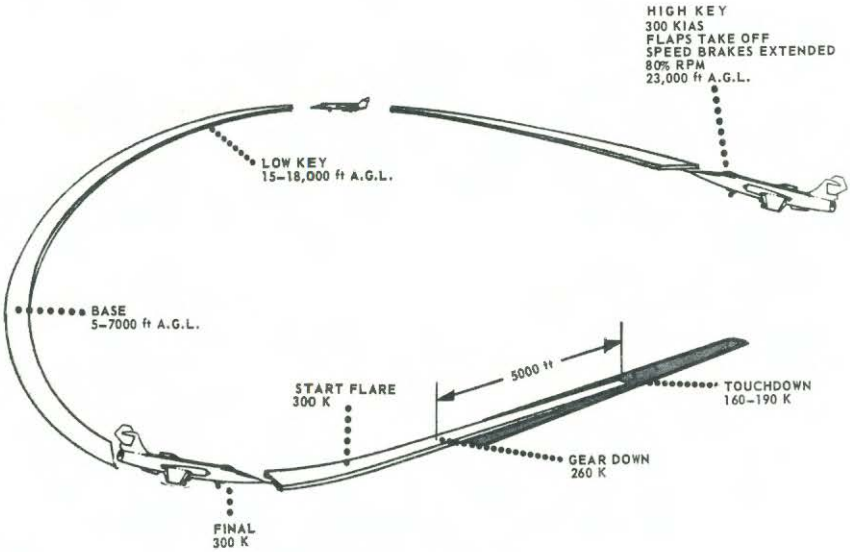


Figure 13 T-27 Instructor's Panel

FLYING

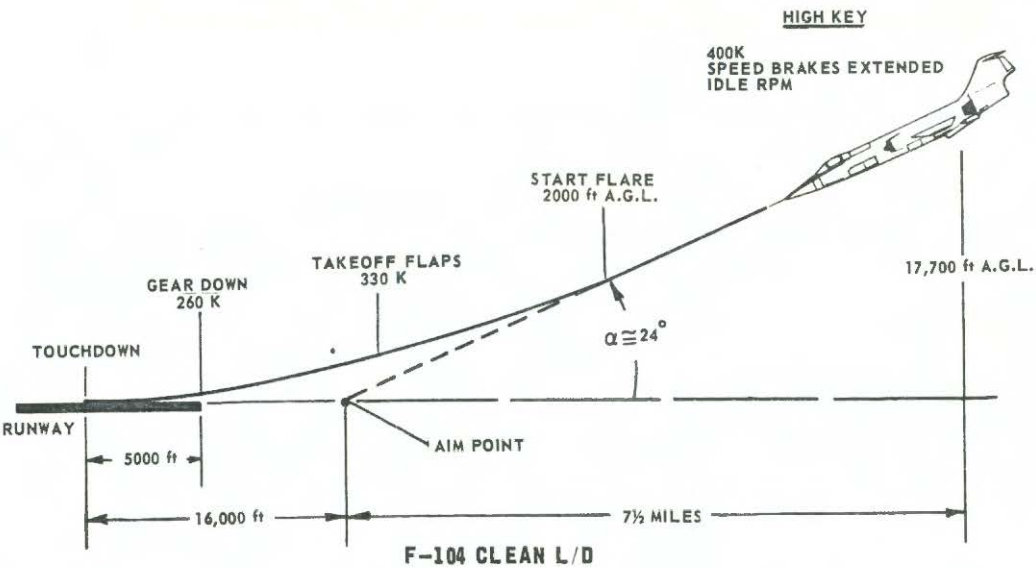
The Phase II flying curriculum fortifies the flight test training of Phase I by providing additional experience in high performance and unusual aircraft. It also provides space and research related flight experience by using special and conventional aircraft in configurations with research vehicle handling qualities in typical research flight profiles. This experience includes exposure to zero gravity, pressure suit survival, rocket propulsion, reaction control handling, energy management, variable stability, and lifting body flight profiles and landing characteristics.

Included in missions flown in the Phase II curriculum are low lift to drag ratio patterns and landings. In a series of 11-13 flights the student examines the handling and performance characteristics of an F-104 in various low L/D configurations designed to simulate X-15 and lifting body type vehicles. Several profiles are flown to include the X-15 landing pattern and high and low speed lifting body landing approaches. Typical patterns are shown in Figures 13 through 15. In addition to becoming familiar with the limited performance characteristics and precise energy management requirements of low L/D vehicles, the student derives practical experience in determining the L/D's of variously configured aircraft, and can predict the critical parameters for vehicle maneuvers and landing patterns. Admittedly only a few graduates of the School will be fortunate enough to fly or test vehicles such as the X-15 or the lifting bodies,



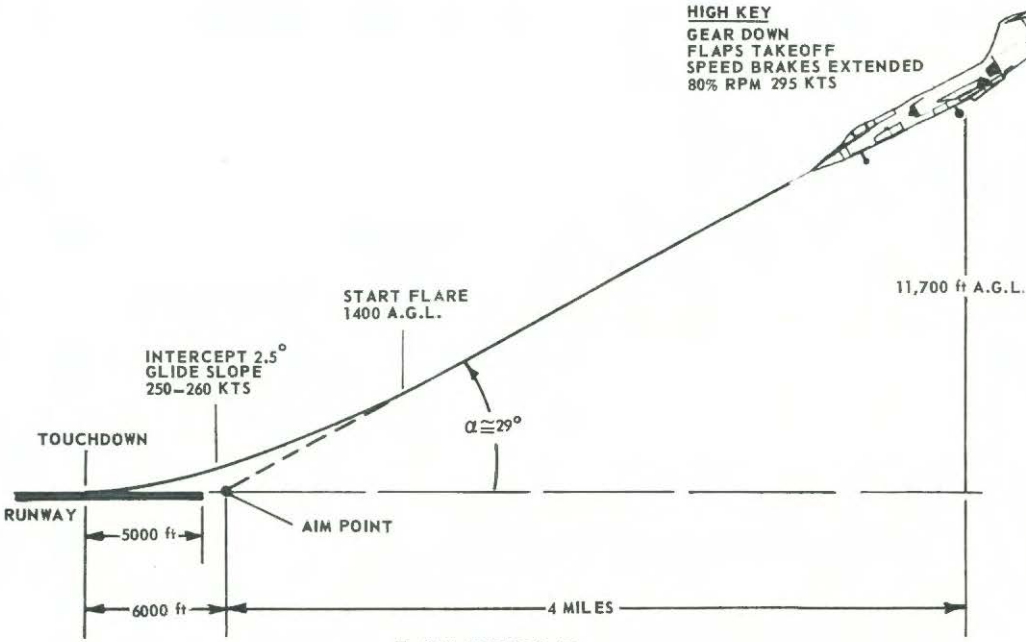
SIMULATED X-15 PATTERN

Figure 14



F-104 CLEAN L/D

Figure 15



F–104 DIRTY L/D

Figure 16

however, a much larger number will be associated with advanced aircraft programs in support, chase, or managerial positions. These considerations in addition to the invaluable benefits of varied experience on a test pilot's capabilities make the low L/D program an extremely useful portion of the curriculum.

Figure 17 F-104 Dirty L/D Configuration - Gear, T/O Flaps & S/B Out, Power 80%

NF-106

The NF-106 variable stability trainer mentioned in the Phase I discussion is designed for extensive application in the space and advanced aircraft oriented Phase II curriculum. The NF-106 is a two seat F-106B that has had major modifications which allow it to be used as a "model follower" inflight simulator of a variety of aircraft or flight vehicles. These modifications include a 144 amplifier analog computer which stores the model to be followed, a stability derivative programmer, a force feel system for the aft cockpit center stick, a front and rear cockpit side arm controller, and an auto pilot that follows three parameters (vertical acceleration, side acceleration, and bank angle under cruise conditions), and automatically flies the NF-106 in such a manner that the model and actual aircraft parameters are equal.

To simulate a desired aircraft, the equations of motion of that aircraft are first programmed into the analog computer. The aft center stick is disconnected from the basic NF-106 and connected to the computer and force feel hydraulic actuator. As pilot control inputs are fed into the computer, the equations of motion are immediately solved and the expected motion of the simulated aircraft appears at the output of the computer. The student's instruments in the rear cockpit are connected to this computer output and therefore indicate the airspeed, altitude, attitude, etc., of the model. A follower loop which monitors the vertical acceleration, side acceleration, and bank angle of the model automatically drives the flight controls of the NF-106 in such a manner that these three parameters are equal

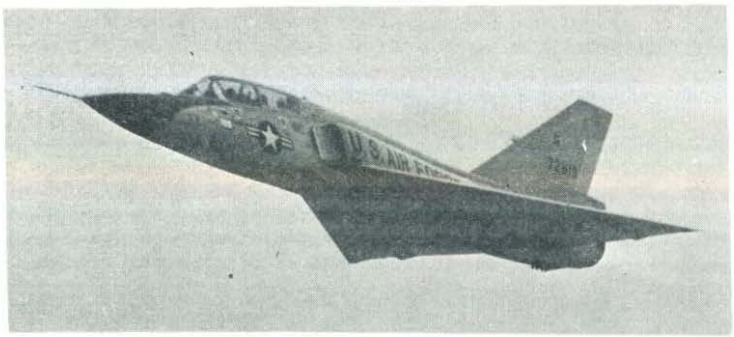


Figure 18 ARPS NF-106

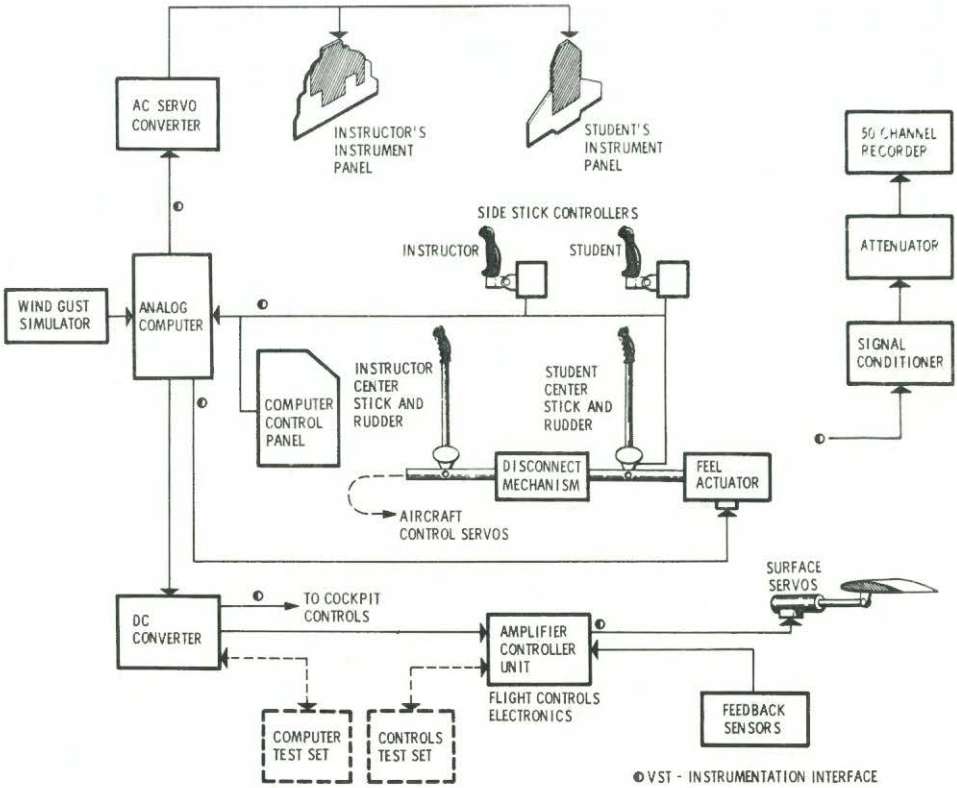


Figure 19 Block Diagram of NF-106 Variable Stability System

in the model and the NF-106. A strain gage compares the force on the aft center stick to the force required as specified by an equation stored in the computer. A hydraulic servo-valve then moves the force feel piston in such a direction as to zero any difference between the required and actual force.

The stability derivative programmer can be used to change the stability derivatives as a function of Mach, airspeed, or altitude. This allows the NF-106 to simulate other aircraft for any portion of their flight profile.

With the follower loop not engaged the NF-106 can be flown on the ground as a fixed base simulator. This feature will be used to allow the student to get ground practice for the mission which he will fly the following day. Motion and acceleration cues will of course be missing during this ground simulation.

The School's two NF-106's are used in a unique series of missions. The Phase II portion of these missions includes investigation and evaluation of the following:

1. NF-104 energy management and stability and control profiles.

2. X-15 high altitude profiles.

3. X-15 high speed profiles.

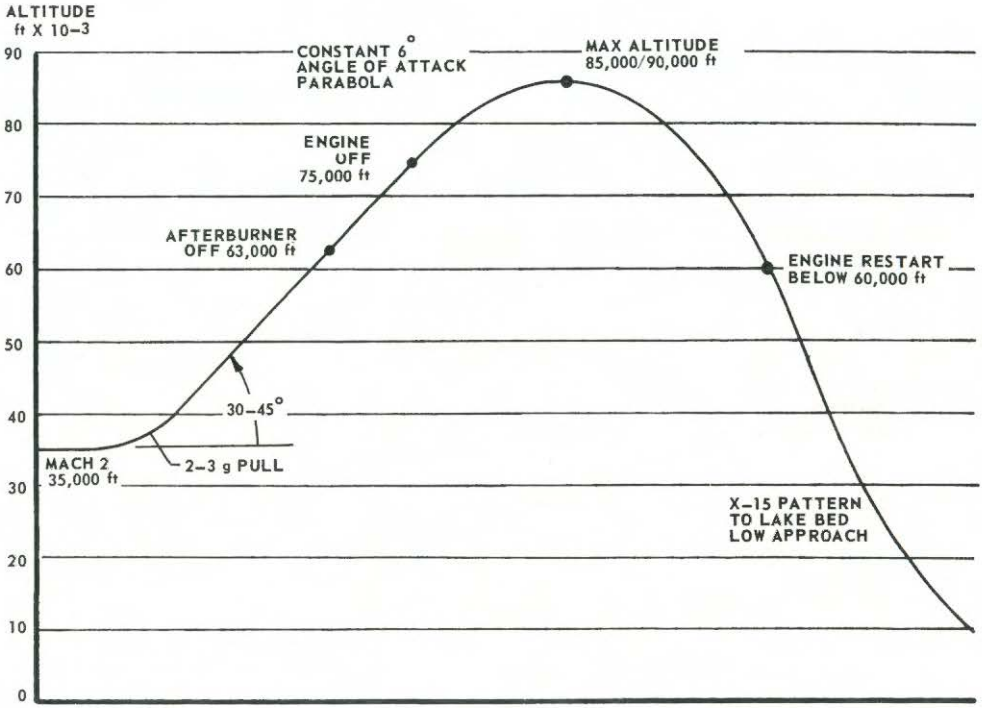
4. X-24A lifting body energy management flights.

5. X-24A lifting body stability and control flights.

The capabilities of the NF-106 will allow the student to experience and evaluate the flight characteristics of the selected vehicle through any portion of its flight profile. For example, the X-15 high altitude mission will take the student from launch at 45,000 feet, .84 Mach and dynamic pressure of 145 psf to a peak altitude of 250,000 feet, a velocity of 4,460 feet per second and a dynamic pressure of .7 psf. The simulation will then continue to a high dynamic pressure reentry condition above 75,000 feet. Although the actual NF-106 will not approach this profile, the student will experience all the handling qualities, instrument readings, and visual and acceleration cues (within the limits of the NF-106) that he would have experienced in an actual X-15 flight. In addition, the simulation can be frozen at any point in the profile to allow the student to perform a detailed examination of the handling qualities at that point. It is anticipated that the learning outcomes of these simulations will be of great value to pilots participating in present or future advanced research and space flight programs.

Zoom Missions

Probably the most eagerly anticipated and rewarding missions in the Phase II curriculum are the zoom familiarization flights. In addition to the great benefits of broadened experience, these missions are designed to expose the student to the demanding requirements of



F-104 ZOOM PROFILE

Figure 20

flight in near outer space conditions. The basic program is flown in the F-104 and consists of seven missions. The first mission is a pressure suit familiarization mission during which the student flies a depressurized F-104 at high altitudes and high Mach numbers to experience the techniques and limitations of flight in a fully inflated suit. The second mission is with an instructor and is a demonstration of the basic zoom profile shown in Figure 20. The mission is flown in a two place F-104D and is limited to a 30° climb angle with a resulting peak altitude between 70 and 80 thousand feet. The remaining five missions are flown solo in an F-104C and consist of basically the same maneuver with climb angles increasing from 30° to a maximum of 45°. Resulting peak altitudes are a function of exactness of technique and meteorological conditions, and average just below 90,000 feet. In addition to the engine shutdown requirements and pitch angle limitations shown in Figure 20, the aircraft is flown at a precise angle of attack of six degrees during the power off profile. Minimum dynamic pressure experienced is no less than 20 psf. The engine is restarted when descending through 60,000 feet, and a precautionary X-15 type pattern is flown to the Rogers lakebed runway. In the seven years this program has been in existence there has never been a case of failure of an engine to restart.

NF-104

For a portion of the class, the end of the F-104 zoom missions signals the end of the School flying curriculum. However, a select few (six in the most recent class) are given the opportunity to fly

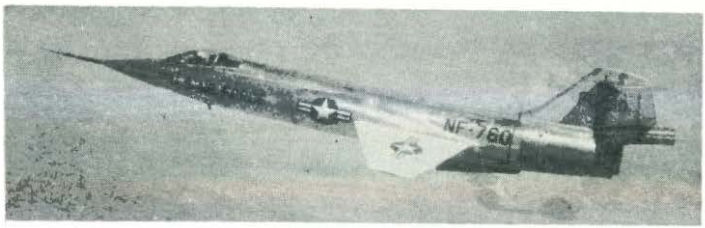
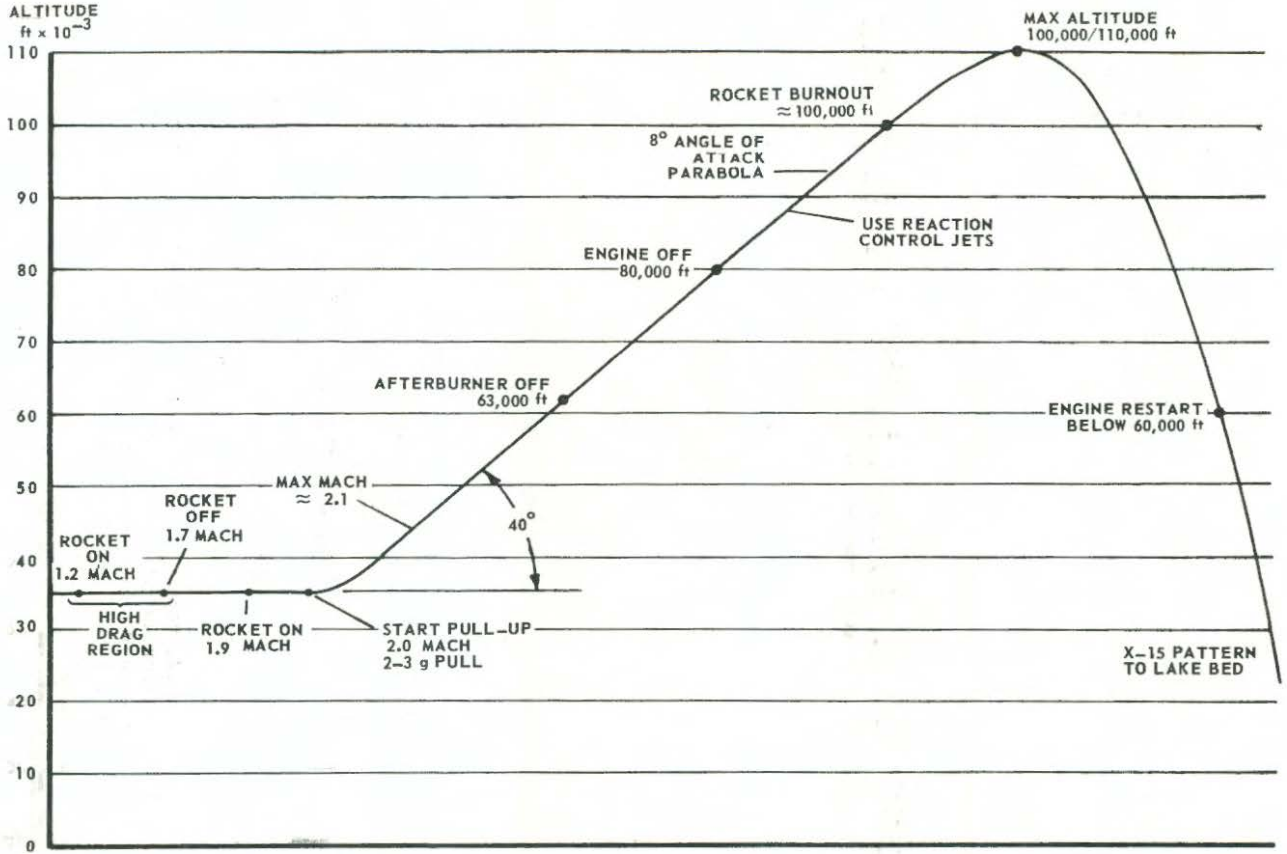


Figure 21 ARPS NF-104

an additional three mission NF-104 zoom program. The NF-104 is an F-104A, modified by the addition of a rocket engine, extra wingspan, a larger tail, reaction control jets in the wing tips and nose, and a reaction jet controller in addition to the center stick. The



NF-104 ZOOM PROFILE

Figure 22

aircraft is designed to fly basically the same zoom profile as the F-104, but with a significantly higher altitude capability. (See Figure 22.) This higher altitude is reached with the aid of a 6,000 pound thrust JP-4/hydrogen peroxide fueled LR-121/AR-2 rocket engine which is used on the run-in and during the climb portion of the mission. Thrust duration is approximately two minutes.

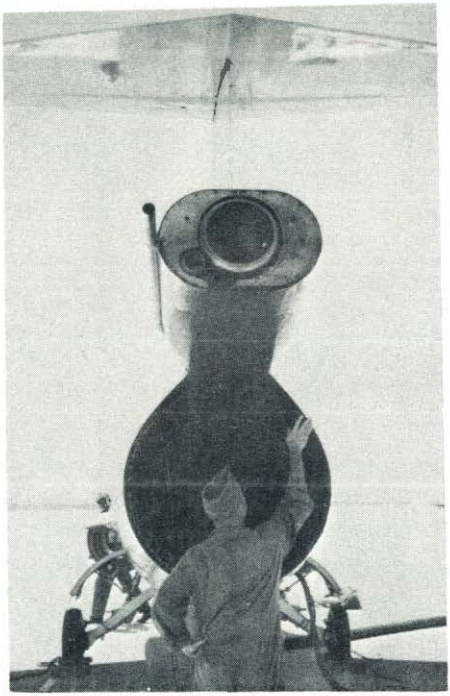


Figure 23 LR-121/AR-2 Rocket Engine

The altitude capability using a mission prescribed climb angle of 40° is between 100 and 110 thousand feet. At these altitudes the dynamic pressure is low enough (15-20 psf) to allow precise aircraft attitude control through the use of hydrogen peroxide reaction control jets. A hand operated reaction control handle allows manual actuation of the jets.

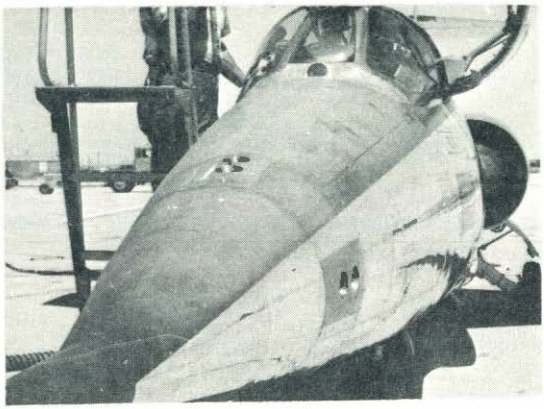
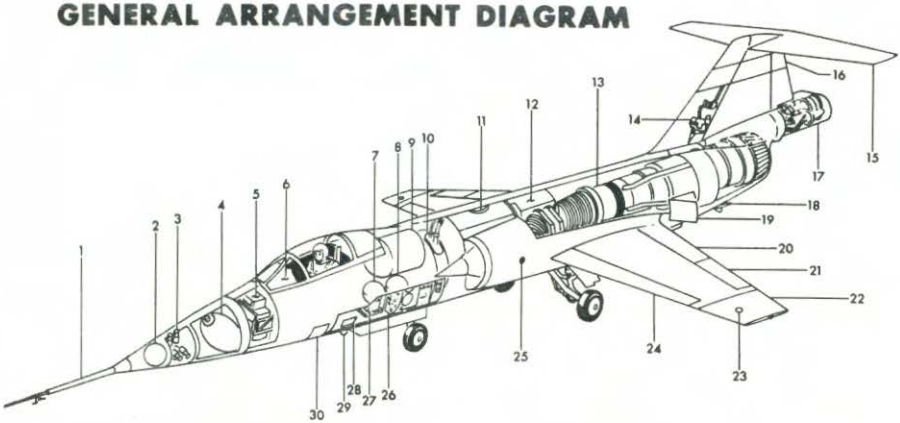


Figure 24 NF-104A Pitch and Yaw
Reaction Control Jets

Figure 25 NF-104A Showing Larger
F-104G Tail Installed

GENERAL ARRANGEMENT DIAGRAM



1 YAPS HEAD BOOM
2 RCS PRESSURIZATION GN_2 TANK
3 RCS PITCH AND YAW MOTORS (EIGHT)
4 RCS H_2O_2 TANK
5 OSCILLOGRAPH
6 ELECTRICALLY HEATED WINDSHIELD
7 COCKPIT PRESSURIZATION GN_2 TANK
8 H_2O_2 PRESSURIZATION GN_2 TANK
9 FORWARD H_2O_2 TANK
10 AFT H_2O_2 TANK
11 FORWARD MAIN JP-4 FUEL TANK
12 AFT MAIN JP-4 FUEL TANK
13 J79-GE-3B TURBOJET ENGINE WITH AFTERBURNER
14 HORIZONTAL STABILIZER POWER CONTROL ASSEMBLY
15 CONTROLLABLE HORIZONTAL STABILIZER
16 RUDDER
17 MODIFIED LR 121-NA-1 ROCKET ENGINE
18 DRAG CHUTE DOOR
19 SPEED BRAKE
20 TRAILING EDGE FLAP
21 AILERON
22 WING TIP EXTENSION
23 RCS ROLL MOTOR (TWO EACH WING TIP)
24 LEADING EDGE FLAP
25 NAVIGATION LIGHTS (SIX)
26 AUTOMATIC OBSERVER (AO) PANEL
27 THIRTY-FOUR-AMPER-HOUR BATTERY
28 UHF RECEIVER/TRANSMITTER
29 APW-11 TRANSMITTER ANTENNA
30 UHF ANTENNA

Figure 26 NF-104 General Arrangement

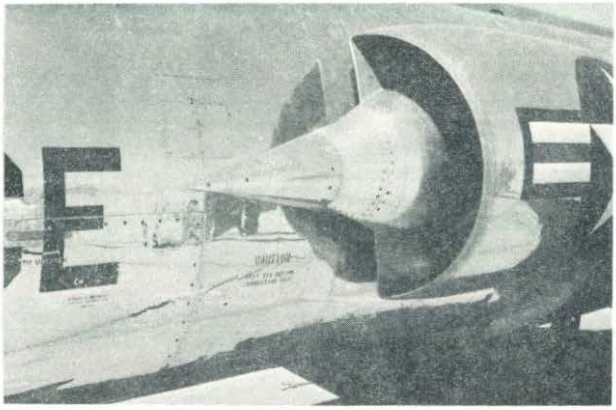


Figure 27 NF-104 Elongated Inlet Cone

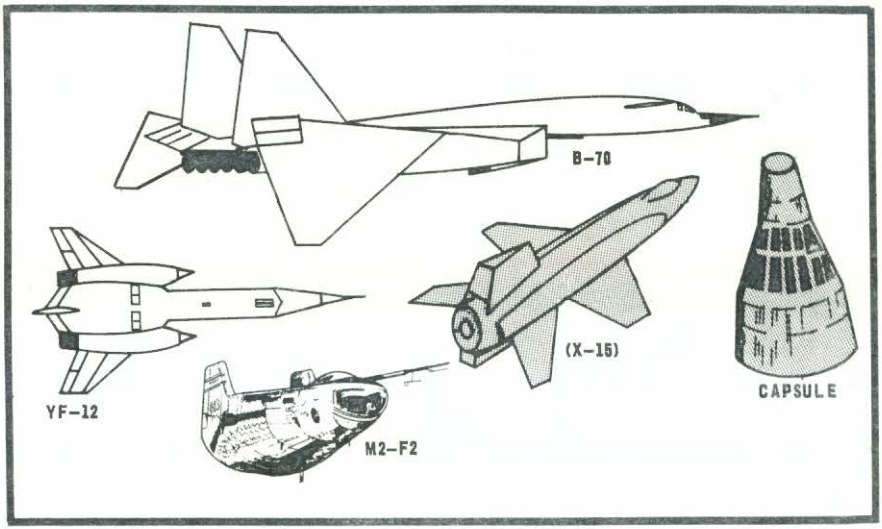
The F-104 and NF-104 zoom missions give the student singularly unique experience in a variety of advanced aircraft and research vehicle oriented disciplines. In addition to familiarity with basic X-15 type flight, re-entry, and landing profiles, the student gains a rare appreciation for the precision, energy management, handling, and meteorological tradeoffs involved in safely reaching the maximum altitude capability of an aircraft. Aircraft response to normal and reaction controls at extreme altitudes is investigated. Zero g conditions are experienced. Pilot capabilities and limitations under full pressure suit operation are demonstrated. Finally, the missions serve as an evaluation of the pilot's ability to react optimally under the demanding conditions of environment and vehicle performance to be found in present and future advanced aircraft research programs.

The end result of the zoom mission program is a pilot who has experienced as closely as economically and operationally practical, many of the conditions and exacting requirements of advanced research oriented flight. This experience when coupled to his test pilot training is an invaluable asset in the actual manning, support, or management of future manned or unmanned flight research and space programs.

Figure 28 ARPS NF-104A

As at the end of Phase I, the students of Phase II are taken on several industry and government agency field trips to broaden their knowledge of the hardware and techniques of advanced aircraft and space operations. One of the major excursions of this series is a week long orientation at the School of Aerospace Medicine, San Antonio, to examine the physiological and psychological aspects of high performance and space flight.

Graduates of the combined Phase I and Phase II course are uniquely qualified to take part in both atmospheric and space oriented test programs. In addition they are thoroughly prepared to undertake the highly specialized training required for mission performance as astronauts in specific space vehicles.



ASSIGNMENT

Graduates of the Aerospace Research Pilot School have taken part in a great majority of the significant flight test achievements in this and many other countries. Every modern Air Force bomber, fighter, and transport, the X-15, YF-12, and B-70, the lifting bodies (HL-10, M2-F2, and X-24), and the Mercury, Gemini, Apollo, and MOL programs have had graduates of the School in key crew manning and/or management positions.

While 41 of the Nation's astronauts are alumni of ARPS, the majority of the School's military graduates go on to less exotic positions as Research Pilots in the Air Force Systems Command. Typical of their assignments are positions in fighter or bomber test operations at the Air Force Special Weapons Center, Kirtland AFB, the Air Force Missile Development Center, Holloman AFB, the Armament Development Test Center, Eglin AFB, the Aeronautical Systems Division, Wright-Patterson AFB, and Air Force Flight Test Center, Edwards AFB.

MANNED ORBITING LABORATORY TRAINING

All MOL astronauts are graduates of ARPS. In February of 1966, ARPS developed a preliminary MOL crew training plan for the Space Systems Division with specialized background training at the Aerospace Research Pilot School. The program was accepted as a "Preliminary MOL Training Program," and amounted to a 4-6 month post graduate course consisting of subjects directly applicable to MOL.

MOL Group I completed this training in July 1966, MOL Group II in May 1967, and the most recently selected MOL Group III in January 1968.

STAFF QUALIFICATIONS

The staff of the Aerospace Research Pilot School consists of highly qualified Air Force test pilots, scientists, and engineers. Although none are specialists in every field associated with flight test, the over-all composition of the staff insures that each of these areas of interest is covered by at least one instructor with expert qualifications. In addition to experience in bomber, fighter, transport, and VSTOL test operations, the staff as a whole has had considerable combat, scientific research, and educational experience. Total flying time per staff member averages over 3,500 hours, and among the 28 working instructors, there are twenty Master's degrees and two PhD's in related scientific disciplines.

FUTURE PLANS

The general design which dictates the Aerospace Research Pilot School's future direction is to maintain a dynamically progressive curriculum which will stay ahead of the anticipated needs of future atmospheric and space test programs. This requires continually changing courses of instruction, development of new test methods, and flight test training in the latest state-of-the-art vehicles.

The School's academic flight test curriculum is progressively updated by selecting test pilot staff members with recent scientific and/or graduate school experience. An extensive series of guest lectures by experts from leading universities, civilian aerospace corporations, and government test facilities augments the modernization of the curriculum as well as providing an insight into new methods of flight testing. Major new equipment under study includes a variable stability helicopter, a practical and reliable V/STOL training aircraft, a powered lifting body trainer, and a universal aircraft simulator.

Proper direction in the selection of these new vehicles, the timely changes to the curriculum, and the development of new test methods are insured through close and continuing contacts between the Aerospace Research Pilot School and the many branches of the aerospace profession.

APPENDIX

SUMMARY OF ARPS

AIRCRAFT and CURRICULUM

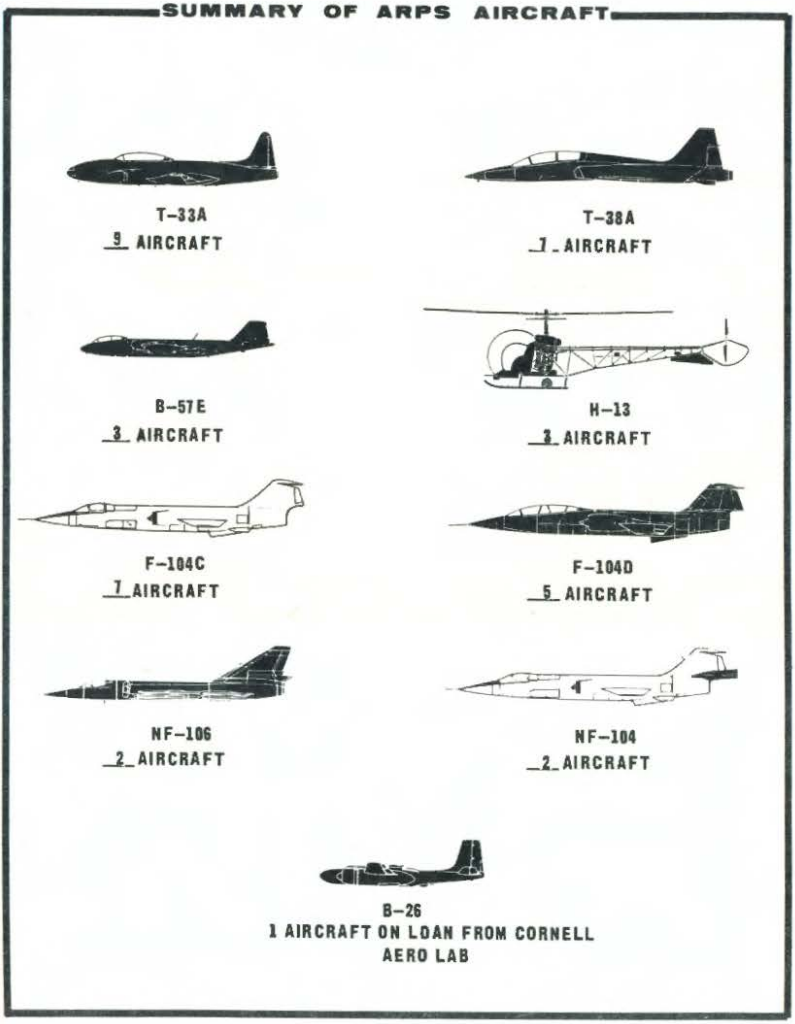

SUMMARY OF ARPS AIRCRAFT
T-33A
9 AIRCRAFT
T-38A
7 AIRCRAFT
B-57E
3 AIRCRAFT
H-13
3 AIRCRAFT
F-104C
7 AIRCRAFT
F-104D
5 AIRCRAFT
NF-106
2 AIRCRAFT
NF-104
2 AIRCRAFT
B-26
1 AIRCRAFT ON LOAN FROM CORNELL
AERO LAB

Figure 29

PHASE I ACADEMIC CURRICULUM

EXPERIMENTAL TEST PILOT PHASE

The academic curriculum in the Experimental Test Pilot Phase of the Aerospace Research Pilot School is contained in the following nine categories:

1)	Flight Test Theory	122 hours
2)	Background Theory Courses:	204 hours
	(Aerodynamics, Physics, Mathematics, Propulsion and Control Systems)	
3)	Flight Test Techniques	40 hours
4)	VSTOL Characteristics	32 hours
5)	Briefings:	51 hours
	(Airplane familiarization, instrumentation, and local area briefings)	
6)	Qualitative Evaluations and Handling Qualities of Airplanes	6 hours
7)	Simulation	8 hours
8)	Report Writing Instruction	9 hours
9)	Category Testing and Military Specifications	3 hours
	TOTAL*	475 hours

Course Duration - 36 weeks

*Does not include hours for examinations, seminars, oral reports, field trips, or physical training.

CURRICULUM CATEGORY BREAKDOWN

I. FLIGHT TEST THEORY

Course	Hours
Pitot-Static System	6
Standard Atmosphere Properties	2
Energy Concepts	6
Correction of Data to Standard Day	2
Takeoff and Landing Theory	4
Fuel and Weight Determination	1
Turning Theory	2
Cruise Theory	12
Stability and Control Introduction	5
Longitudinal Stability Theory	14
Spin Theory	12
Engine Out Theory	4
Maneuvering Flight Theory	11
Lateral-Directional Stability	14
Dynamics	13
Roll Coupling	6
Systems Analysis	8
TOTAL	122

II. BACKGROUND THEORY COURSES
(Aerodynamics, Physics, Mathematics, and Control Systems, etc.)

Course	Hours
Physics - Thermodynamics Review	6
Aerodynamics Introduction	8
Subsonic Aerodynamics	14
Supersonic Aerodynamics	13
Airbreathing Propulsion (Engines)	16
Vectors	8
Equations of Motion	14
Operational Math, Differential Equations	14
Analog Computers	16
Linear Control Systems	25
Root Locus	10
Aeroelasticity	9
Probability	9
Non Linear Control Systems	17
Hypersonic Aerodynamics	16
Digital Computers	5
Computer Data Reduction	4
TOTAL	204

CURRICULUM CATEGORY BREAKDOWN CONT'D

III. FLIGHT TEST TECHNIQUES

Course	Hours
Flight Test Techniques General Briefing	2
Data Reduction	1
Tower Flyby FTT	1
Pacer FTT	1
Smoke Trail FTT	1
Helicopter FTT	2
Sawtooth Climb Ftt	1
Check Climb - Level Acceleration FTT	2
Turning Performance FTT	1
Speed Power FTT	2
Range FTT	2
Stall FTT	2
Performance Final FTT	1
Longitudinal Stability FTT	2
Spin FTT	2
Engine Out FTT	2
Maneuvering Flight FTT	2
Lateral Directional FTT	3
Stability Final FTT	1
Soaring FTT	1
Qualitative FTT	3
Non Steady Testing FTT	1
Formation FTT	1
Supersonic Formation FTT	1
Chase FTT	1
Dynamics FTT	1
TOTAL	40

IV. VSTOL CHARACTERISTICS

Course	Hours
Helicopter Fundamentals	10
VSTOL	22
TOTAL	32

CURRICULUM CATEGORY BREAKDOWN CONT'D

V. BRIEFINGS
(Airplane familiarization, instrumentation, & local area briefings)

Course	Hours
ARPS Introduction	8
Local Area	3
T-33 Checkout Briefing	2
Special Instrumentation	1
T-38 Checkout Briefing	3
Stability & Control Instrumentation	2
Instrumentation Tour	1
Calibration Books	1
F-104 Checkout Briefing	12
F-104 Instrumentation	1
B-52 Fam Briefing	1
F-106 Fam Briefing	2
F-111 Fam Briefing	1
Test Center Briefings	4
Ejection Seat	5
Survival	4
TOTAL	51

VI. QUALITATIVE EVALUATIONS AND HANDLING QUALITIES OF AIRPLANES

Course	Hours
B-26 Variable Stability (Cornell Aero Labs)	4
Qualitative Flight Testing	2
TOTAL	6

VII. SIMULATION

Course	Hours
Dynamics Simulator	2
Helicopter Simulator	2
Control Systems Evaluation	4
TOTAL	8

CURRICULUM CATEGORY BREAKDOWN CONT'D

VIII. REPORT WRITING INSTRUCTION

Course	Hours
Initial Report Writing Briefing	1
Pitot-Static Report Briefing	1
Category II Report Briefing	2
Category II Report Debriefing	1
Oral Report Briefing	1
Engine Out & Spin Report Briefings	2
Qualitative Report Briefing	1
TOTAL	9

IX. CATEGORY TESTING & MILITARY SPECIFICATIONS

Course	Hours
MIL-C-5011A	1
Category Testing	2
TOTAL	3

PHASE I FLYING CURRICULUM

TEST	TYPE A/C	FLYING HOURS
Checkout	T-33	6.0
Checkout	T-38	5.0
Tower Flyby	T-33	1.5
Pace	B-57/T-33	1.5
Pacer Data	T-33	1.5
Smoke Trail	T-38/T-33	1.2
Smoke Data	T-38	1.2
Sawtooth Climb Demo	T-33	1.5
Sawtooth Climb Data	T-33/B-57	1.5
Check Climb Demo	T-38	1.2
Check Climb Data	T-33/T-38/B-57	1.4
Level Acceleration Demo	T-38	1.3
Level Acceleration Data	T-38	1.2
Level Acceleration Data	T-33/B-57	1.5
Turning Performance Demo	T-33	1.5
Turning Performance Data	T-38	1.2
Turning Performance Data	T-33/B-57	1.5
Performance Evaluation	F-111	2.5
Speed Power Demo	T-33	1.5
Speed Power Data	T-38/B-57	1.5
Range Data	T-33/T-38/B-57	2.5
Stall Demo	B-57	1.5
Stall Practice	T-33	1.5
Performance Flight Test Techniques Practice	T-38	1.2
Performance Flight Test Techniques Final	T-38	1.2
Stability Preliminary	T-33/T-38/B-57	1.3
Longitudinal Static Stability Demo	T-38	1.2
Longitudinal Static Stability Qualitative	T-33/T-38	1.4
Longitudinal Static Stability Data	T-33/T-38/B-57	1.5
V/STOL Familiarization	H-13/UH-1	14.0
Maneuvering Flight Demo	T-38	1.2
Maneuvering Flight Qualitative	T-33/T-38	1.3
Maneuvering Flight Data	T-33/T-38/B-57	1.3
Spin Demo	T-33	1.3
Spin Data	T-33	1.5
Spin Chase	T-33/T-38	1.5
Engine Out Demo/Data	B-57	1.8
Sideslip and Aileron Roll Demo	T-33	1.5
Sideslip and Aileron Roll Qualitative	T-33/T-38	1.4
Sideslip Data	T-33/T-38/B-57	1.5
Aileron Roll Data	T-33/T-38/B-57	1.3
Dynamics Demo	B-57	1.7
Dynamics Qual	T-33/T-38	1.3
Dynamics Data	T-33/T-38/B-57	1.5
Variable Stability	B-26	5.0
Variable/Point Stability	F-106	2.5

PHASE I FLYING CURRICULUM CONT'D

TEST	TYPE A/C	FLYING HOURS
Qualitative Testing Practice	T-38	1.2
Qualitative Testing Demo	F-104	1.0
Preliminary Evaluation Test	Various	1.8
Performance/Handling Evaluation	B-52	3.0
Flight Test Technique Practice	T-38	1.2
Flight Test Technique Final	T-38	1.2
Checkout	F-104	7.0
Formation and Chase	F-104	4.5
Stability and Control Evaluation	F-104	6.0
High L/D Training	Schweizer	2.0
	TOTAL	121.1

In addition to the curriculum flying, students log time in the rear seat as observer or assistant in data gathering missions, and fulfill the requirements of AFM 60-1.

PHASE II ACADEMIC CURRICULUM

RESEARCH PILOT PHASE

The academic curriculum in the Research Pilot Phase of the Aerospace Research Pilot School is as shown:

Course Title	Classroom Hours
Flight Mechanics	51
Rocket Propulsion	24
Inertial Guidance	22
Electrical Engineering	15
Digital Computers	7
Astronomy	7
Celestial Navigation	4
Relativity	3
Seminars	9
Simulation Briefings	11
Flying Briefings	9
Telemetry, F/M, & Systems Test	8
TOTAL*	170

Course Duration - 16 weeks

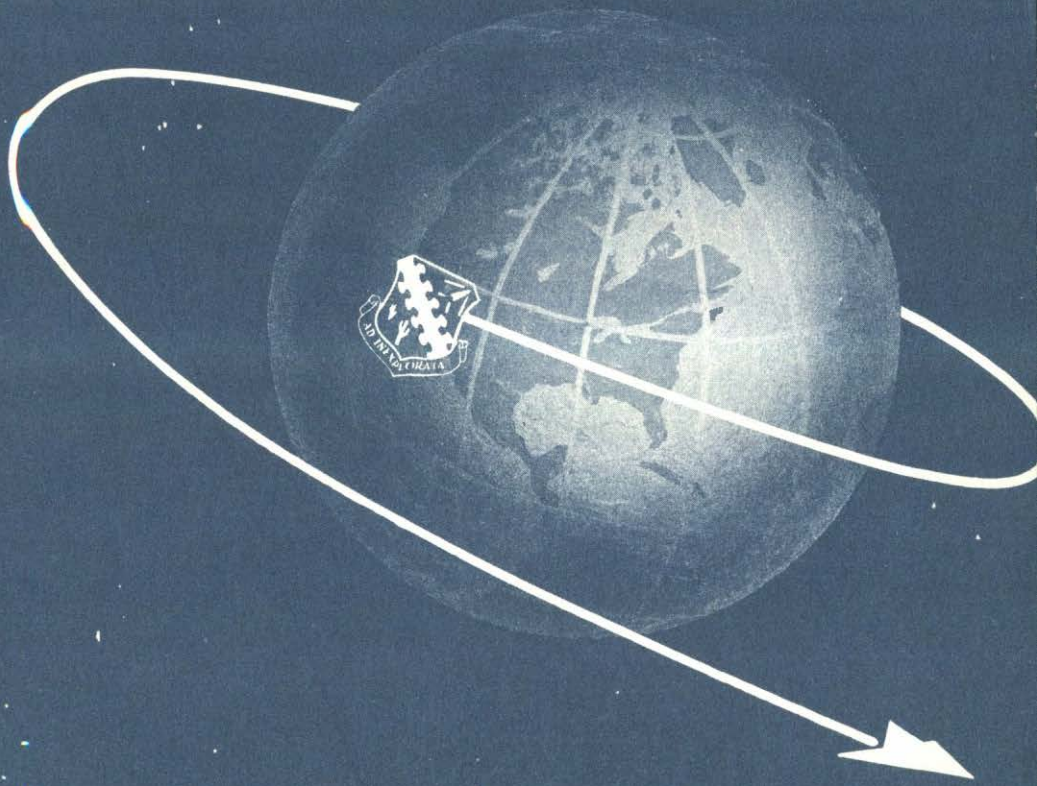
*Does not include field trips and physical training.

PHASE II FLYING CURRICULUM

TEST	TYPE A/C	FLYING HOURS
Low L/D Approaches and Landings	F-104	8.0
L/D Determinations	F-104	4.0
Stability and Control	F-111	4.0
Lifting Body Simulation	F-106	3.0
Low/High Range Profile	F-104	1.4
Zooms	F-104	4.0
Chase	F-104	5.0
Zooms	NF-104	1.5
	TOTAL	30.9

In addition to the curriculum flying, students log time in the rear seat as observer or assistant in data gathering missions, and fulfill the requirements of AFM 60-1.

THE UNITED STATES AIR FORCE AEROSPACE RESEARCH PILOT SCHOOL

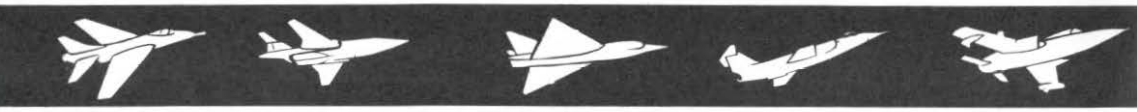


foreword . . .

The tremendous strides made in the development of aerospace vehicles require test pilots with training as advanced and sophisticated as the vehicles they must evaluate. Although orbital mechanics and the estimation of aircraft performance and control characteristics are among the subjects taught in many aeronautical or astronautical engineering courses, these courses rarely include up-to-date methods of flight testing.

To fill the need for pilots with a sound understanding of the technical problems involved in evaluating modern aerospace vehicles, the USAF Aerospace Research Pilot School offers two courses of instruction, the Experimental Test Pilot Course and the Aerospace Research Pilot Course. These courses produce men who are adept at engineering evaluation as well as flight test techniques.

table of contents . . .



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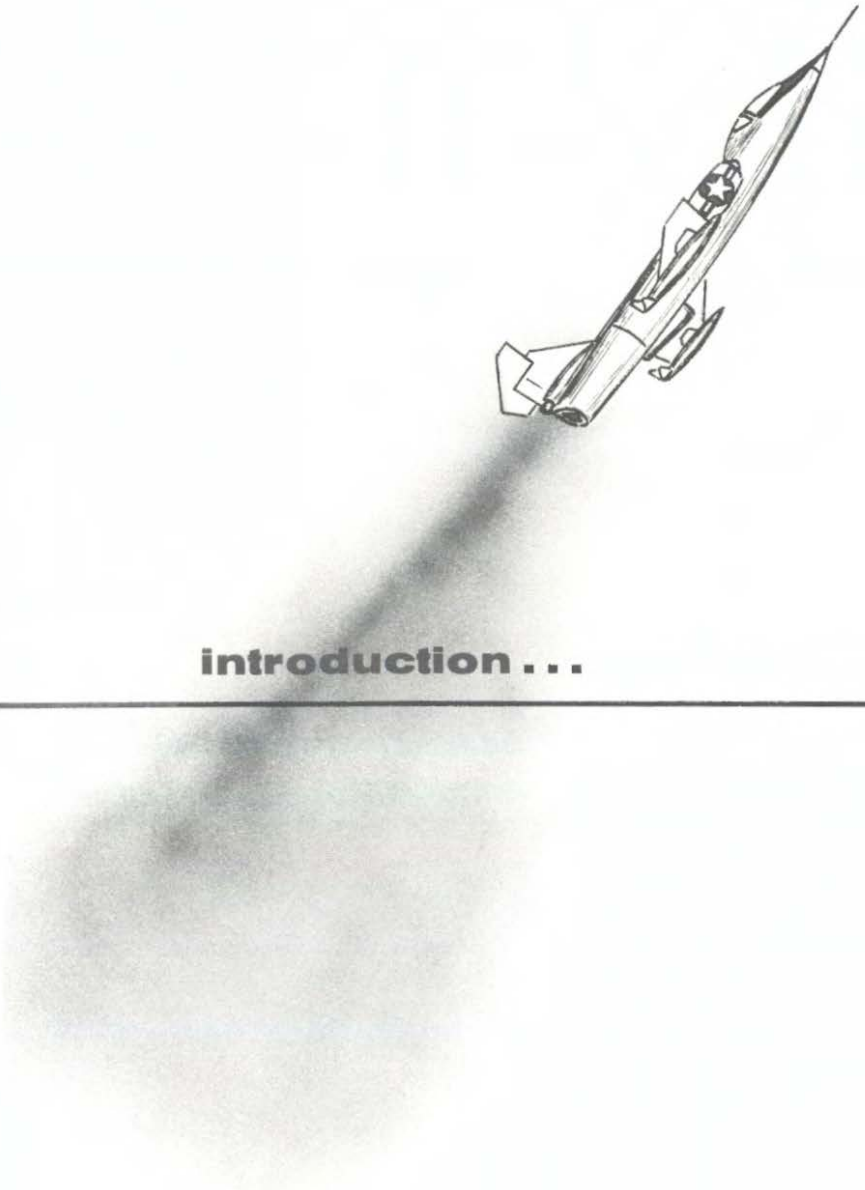

introduction . . .

This brochure has been prepared to acquaint you with the USAF Aerospace Research Pilot School. It is one of five schools in the free world that presents a formal course for experimental test pilot training and, in addition, is the only free world school that offers a formal course for space research pilot training.

The School was initiated in 1943 by the Air Material Command at Wright-Patterson AFB, Ohio, and has since developed into one of the outstanding service schools in the world. The change in School aircraft inventory from T-6's in 1943 to rocket augmented F-104's in 1963 further emphasizes the tremendous advances made by the School in the short period of 20 years.

The School is now a USAF school which is supervised and operated by the Air Force Systems Command. Its location at the Air Force Flight Test Center, Edwards Air Force Base, California, adds to its effectiveness by giving the students and instrnctors first hand knowledge of current and practical flight test information.

On the following pages you will find a discussion of the USAF Aerospace Research Pilot School's mission, organization, facilities, and curriculum. Information about recreational and other facilities available at or near Edwards AFB is also included.

The mission The mission of the USAF Aerospace Research Pilot School is to train selected pilots to monitor and conduct flight tests of research, experimental, or production type aerospace vehicles. These tests are made to determine flight characteristics, performance, stability, and functional utility and to obtain technical information on the serviceability and functioning of installed equipment and components. To discharge this mission responsibility, the School conducts two courses.

The future? *The School's aerospace mission is dynamic; changes in objectives, curriculum content, and training methods will certainly accelerate as man probes beyond the limits of the atmosphere and the boundaries of today's technology. What form these changes will take can not now be accurately predicted — even the planners who must translate tomorrow's vehicle possibilities into today's training have only a glimpse of the School's future.*

1. THE EXPERIMENTAL TEST PILOT COURSE . . .

. . . of approximately 8 months duration, is designed to train pilots in the latest methods of testing and evaluating aircraft and related aeronautical equipment. Although most students are Air Force pilots, this training is extended to pilots of other services and agencies of the United States, services of allied nations, and test pilot employees of USAF contractors.

2. THE AEROSPACE RESEARCH PILOT COURSE . . .

. . . trains pilots and project officers for manned space research programs. This "postgraduate" course, of approximately 7 months duration, is offered to a limited number of selected graduates of the Experimental Test Pilot course or an equivalent course.

CURRICULUM

EXPERIMENTAL
TEST PILOT
COURSE

Performance

Stability & Control

The Test Pilot Course is divided into two sixteen-week phases, a Performance Phase and a Stability and Control Phase, each of which involves approximately 240 hours of formal academic instruction and 100 hours of flying. The instruction is comparable to that in the last two years of an engineering school but more specialized in nature. Students find the classroom instruction quite interesting because they have an opportunity to actually apply the theoretical concepts during practical test flights.

In the Performance Phase the student is taught the fundamentals of performance flight testing. Instruction starts with a brief review of calculus, physics, and aerothermodynamics, and progresses through theory of aircraft performance, flight test techniques, data reduction methods, and supersonic aerodynamics to the special project report and final examination. Performance flying includes such tests as calibration, sawtooth and optimum energy climbs, and level flight performance.

The Stability and Control Phase prepares the student for tests that determine whether an aircraft meets the minimum standards for flying qualities consistent with safety and acceptable control as set forth in military specifications. All aspects of longitudinal, lateral, and directional stability, including stalls, trim changes, and landing tests, are covered. Lateral-directional stability tests performed are aileron rolls, adverse yaw, asymmetric power, sideslips, and lateral dynamics. In short, he is taught to evaluate the handling qualities of an aircraft, reduce and analyze the data obtained, and prepare an engineering report on the results of his evaluation.

CURRICULUM

AEROSPACE RESEARCH PILOT COURSE

Academics

Simulation

Flying

Bioastronautics

This course provides the most advanced technological training ever offered in a USAF school. The curriculum is divided into four general training areas which are:

Academic Instruction, which includes a variety of technical subjects, such as computer theory, orbital and flight mechanics, aerothermodynamics, guidance and control, astronomy, chemical, nuclear and exotic propulsion, and project management.

Flying Training, which includes energy management, re-entry corridor simulation, rocket power and ballistic control operation in modified F-104's, and variable stability and low L/D training in F-106 aircraft.

Simulator Training, which includes actual ballistic control operation on a ballistic control simulator, simnlation of launch, operations in space and re-entry in a moving base, 6 degrees of freedom simulator, and closed loop centrifuge training on the Johnsville NADC centrifuge.

Bioastronautics Training, which is provided by the School of Aerospace Medicine with emphasis on psychophysiological factors of space flight.

In addition to the above, field trips to organizations engaged in developing and testing space systems provide students and instructors with the latest information available.

organization

The School's organization
clearly reflects its training mission.
In support of the two training divisions,
the Training Research and Development Division
acts as project office for the design,
development, and procurement
of special training devices
including simulators and
modified aircraft.

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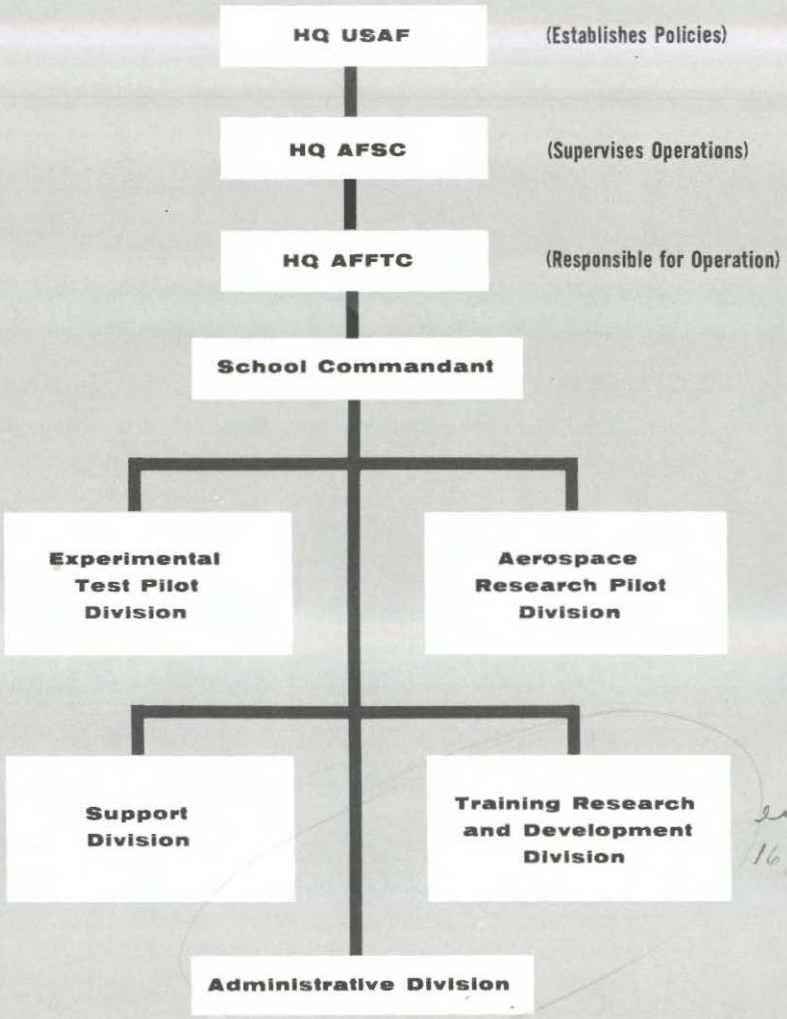

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facilities

- Housing facilities at Edwards AFB are excellent: The base has over 2,000 family housing units varying in size from 2-4 bedrooms with 1-2 bathrooms. The units are unfurnished; however, certain items of furniture are available. Each home is equipped with a stove, refrigerator, washer, forced air heating and evaporative cooling. The School arranges for student housing and waiting periods rarely exceed two weeks, with housing allocated on a first come first served basis.

- The base has a complete 45 bed hospital which offers pediatric, obstetric, surgical and limited dependent dental care.

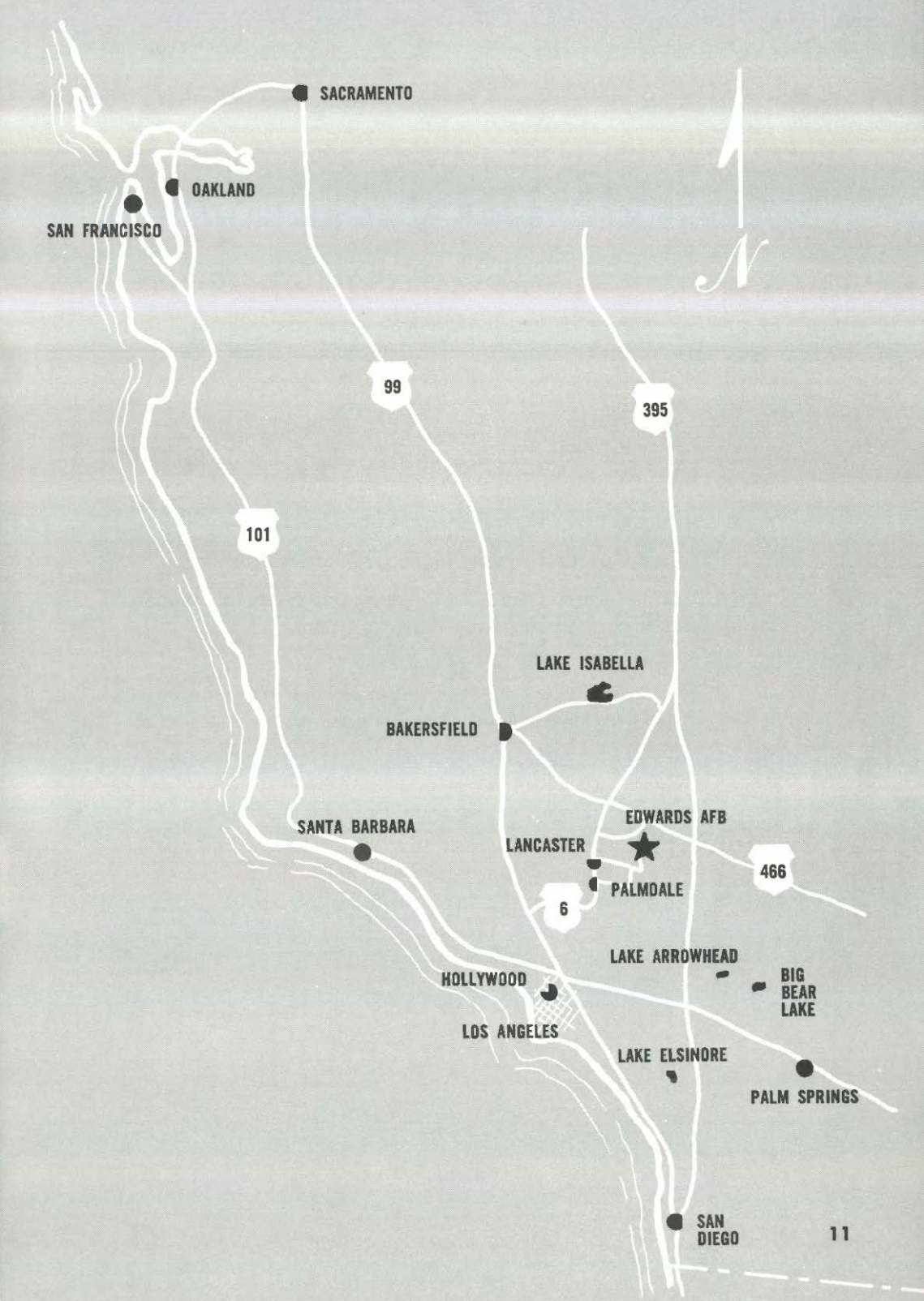
- On-base dependent schooling includes two Elementary schools and fully accredited Junior High and High Schools.

recreation

The School schedules and requires that each student spend four hours each week in self-supervised physical training at the golf course or at the Base Gymnasium which has a steam room, handball and basketball courts, and an exercise room.

Additional base-operated facilities include hobby shops and tbe nearby Lake Isabella Recreation Area where military persounel can enjoy camping, fishing, and boating at nominal costs. Local club facilities include an active Officers' Club, Rod and Gun Club, Aero Club and Skin Diving Club.

Edwards AFB is located within driving distance of a number of cities and recreation areas. These include Los Angeles, 95 miles; Bakersfield, 85 miles; San Diego, 225 miles; San Francisco 400 miles. The Pacific Ocean and many mountain areas such as Big Bear Lake, Big Pine Ski area, and Lake Arrowbead are within a 150 mile radius.


SACRAMENTO
OAKLAND
SAN FRANCISCO
N
99
395
101
LAKE ISABELLA
BAKERSFIELD
EDWARDS AFB
SANTA BARBARA
LANCASTER
466
PALMDALE
6
LAKE ARROWHEAD
HOLLYWOOD
BIG BEAR LAKE
LOS ANGELES
LAKE ELSINORE
PALM SPRINGS
SAN DIEGO

eligibility....

Minimum requirements for entrance into the courses offered by the USAF Aerospace Research Pilot School have been established by Headquarters USAF. Prospective students, to be eligible, **must . .**

for the

EXPERIMENTAL TEST PILOT COURSE

- Be serving on active duty in the grade of Major or below.
- Hold a currently effective aeronautical rating of pilot, and be currently on flying status as a pilot.
- Be qualified in jet aircraft and have a minimum of 1500 hours total flying time. It is desirable that this time be diversified and include experience in recent types of aircraft.
- Possess a bachelor's degree or equivalent in engineering, a physical science, or mathematics.
- Not have been selected or alerted for overseas duty at the time of application.

for the

AEROSPACE RESEARCH PILOT COURSE

- Be serving on active duty in the grade of Lieutenant Colonel or below.
- Hold a currently effective aeronautical rating of pilot and be currently on flying status as a pilot.
- Have a minimum of 2000 hours total flying time including experience in jet aircraft. Flight test experience is desirable.
- Possess a degree or equivalent in engineering, a physical science, or mathematics.
- Be a graduate of the Experimental Test Pilot Course, Navy Test Pilot School, or the Royal Air Force's Empire Test Pilot School.
- Be certified as medically qualified based upon successful completion of special medical and psychophysiological testing procedures.

selection....

Initial screening of applications for both courses is performed by the Aerospace Research Pilot School Selection Board. The applications of officers nominated for attendance are forwarded to Headquarters USAF for final selection.

Since a great deal of selectivity must be exercised in assigning personnel for training at the Aerospace Research Pilot School, AFR 53-19 requires the first indorsement of an application for the . . .

Aerospace Research Pilot Course to contain an evaluation of:

1. The applicant's skill and experience as a test pilot.
2. His judgement.
3. His ability to analyze test data, report test results, and make sonnd recommendations, and . . .
4. His interest in research and experimental test work.

Experimental Test Pilot Course to contain an evaluation of:

1. The applicant's skill and experience as a pilot.

2. His ability to perform precision flying according to predetermined flight plans.

3. His judgement and ability to analyze problems, and . . .

4. His incentive for receiving test pilot training.

assignment..

Graduates of the Experimental Test Pilot Course will be selected to fill vacancies in AFSC 1344, Experimental Flight Test Officer. Most such positions are at Air Force Systems Command Centers; however, vacancies occur in other commands, primarily Air Defense Command.

Graduates of the Aerospace Research Pilot Course will be assigned to positions in space development or flight test programs whicb will utilize their special training.

Assignments are determined first by Air Force requirements and second by the individual graduate's preference.

Interested persons are referred to AFR 53-19 for procedure and format

If additional information is required, write to . . .

COMMANDANT
USAF Aerospace Research Pilot School
Attn: FTTB
Air Force Flight Test Center
Edwards Air Force Base, California

TP3

USAF AEROSPACE RESEARCH PILOT SCHOOL

EDWARDS AIR FORCE BASE, CALIFORNIA

The

USAF AEROSPACE RESEARCH PILOT SCHOOL

INTRODUCTION

Flight test training in the Air Force originated as an in-house training activity in Test Operations at Wright Field in about 1943. It than progressed to formal school status with its own staff and aircraft, and in 1951 moved west to Edwards AFB. Events of the late 1950's exposed the need for aerospace pilots trained for work in advanced aircraft and manned space research programs. Thus in 1961, the research pilot or "aerospace training" phase was added to the School's curriculum. Since its beginning the Test Pilot School, now called the Aerospace Research Pilot School (ARPS) has been in a constant state of change to keep its course of instruction, test methods, and training vehicles ahead of the anticipated needs of future test programs. The change has been such that those individuals associated with the School just a few years ago would hardly recognize it as it is today.

The purpose of this publication is to enhance the reader's knowledge of the scope and capabilities of the Aerospace Research Pilot School. This is done by explaining the School's present and future mission by outlining its course of instruction, and by reviewing lightly some of the specialized training, techniques, and equipment unique to the School.

MISSION

The mission of the School is:

1. To train Experimental Test Pilots to supervise and conduct flight tests of research, experimental, or production type aerospace vehicles.

2. To train Aerospace Research Pilots for flight test, engineering design, and/or management in advanced aircraft and manned space research programs.

SELECTION CRITERIA

To enlist the highly capable pilots desired to eventually work in the field of flight test, the School and Air Force maintain an exceptionally rigid selection process. The minimum eligibility requirements are:

EDUCATION: Bachelor's degree in engineering, physical science or mathematics.

AGE: Enter the course before 33rd birthday.

ASSIGNMENT: Active duty pilot in the grade of major or below.

FLIGHT EXPERIENCE: A minimum of 1000 hours total flying time and at least one year as an aircraft commander in:

a. Jet or turbo-prop bomber or transport aircraft.

b. Jet fighter or trainer aircraft.

c. Helicopters (with at least 200 hours in jet aircraft other than pilot training).

d. A combination of the above.

NOTE: See AFR 53-19 for complete details.

AVERAGE QUALIFICATIONS

While the above are the minimum requirements for consideration, the large number of applicants allows final selection of pilots with much higher qualifications. As examination of recent graduating classes shows the average backgrounds of the U.S. military members of each of the classes to be:

EDUCATION: Eleven Bachelor's degrees and six Master's degrees.

AGE: Average age is 30 years.

FLIGHT EXPERIENCE: 2,100 hours for the average fighter/trainer pilot (11 pilots per class).

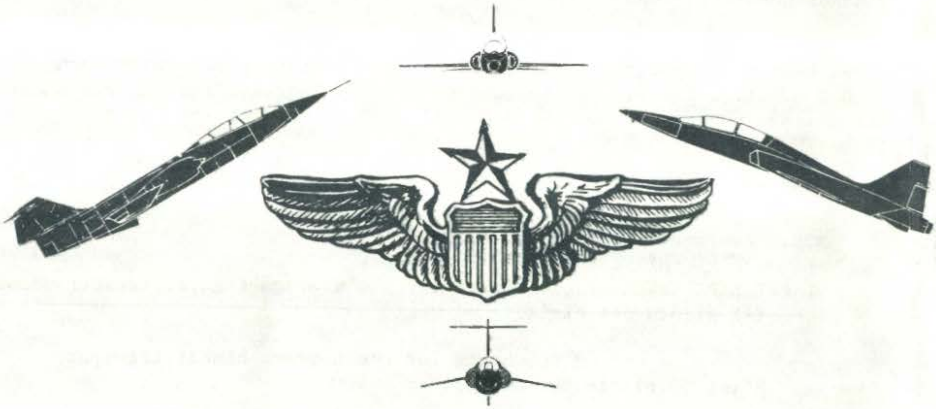
3,000 hours for the average bomber/transport pilot (6 pilots per class).

Diversity of experience is an important (and in today's Air Force, very rare) attribute sought after in a prospective test pilot. The majority of the pilots selected for the School have extensive operational experience in three or more aircraft. In addition, experience and subsequent assignment considerations dictate the desirability of a combat tour in Southeast Asia prior to assignment to the School. As a result, almost all recent entrants have completed Vietnam tours.

The average class size at ARPS is 22. This consists of 16-18 U.S. military pilots (of which two are usually Marine or Navy pilots), and as many as six other pilots. Recently the "other" pilots category has included civilian contractor pilots, FAA and NASA pilots, and military and/or civilian pilots from allied countries. The School conducts two classes per year, with starting dates in the first week of February and the first week of August.

CURRICULUM

The year long course at ARPS consists of two phases. Phase I is eight months in duration and comprises the experimental test pilot training, while Phase II lasts three and one half months and encompasses advanced aircraft and space training. Normally only the U.S. military pilots stay on for the Phase II research pilot course - civilian and foreign pilots are graduated at the end of Phase I.



PHASE I - EXPERIMENTAL TEST PILOT COURSE

The eight month Experimental Test Pilot Course is designed to train pilots in the latest methods of testing and evaluating aircraft and related aeronautical equipment. The academics, simulation, and flying training are designed to give the student the theoretical and practical background required to supervise and conduct flight tests of research, experimental, or production type aircraft.

The phase is divided into two major segments, Performance, and Stability and Control, approximately three and five months in duration respectively.

PERFORMANCE

The Performance subphase progressively develops the theory, flight test techniques, and data reduction methods associated with performance flight testing.

ACADEMICS

The Academics are conducted at an undergraduate aeronautical engineering course level and begin with a brief review of calculus, physics, thermodynamics, and aerodynamics, and progress through the detailed theory of aircraft and engine performance. The Appendix gives a breakdown of the entire ARPS curriculum.

Note that the time allotted some of the subjecta is extremely short. As an example, the Calculus Review is just two hours long, and in reality consists only of a final exam which covers an entire year's course in calculus. Physics Thermodynamics is another example of using a comprehensive examination to insure adequate student knowledge for the basic sciences. This brevity in the basic courses is dictated by the ever increasing complexity of flight testing, and the necessarily greater number of subjects to which a new test pilot must be exposed to adequately prepare him to understand and perform his work. The factor which allows pushing the student through the basics at this rapid pace is the student's own high level academic background - most of those accepted for the School carried at least a B+ or better average in related courses at the undergraduate or graduate level.

FIGURE 1 AEROSPACE RESEARCH PILOT SCHOOL

FIGURE 2 ARPS CLASSROOM

FLYING

Performance flying closely parallels the academic curriculum and teaches the student the basic methods of performance data gathering. Pitot static calibration, takeoff, climb, range, acceleration, turning, and descent performance, are all investigated. To apply his knowledge to a practical exercise, each student flies a limited Category II performance flight test program in either the T-33, T-38, or B-57, and documents his results in a formal written report.

STABILITY AND CONTROL

The Stability and Control subphase is designed to prepare the student to test and evaluate the handling qualities of an aircraft.

ACADEMICS

Background theory courses in vector analysis, differential equations, operational math, and dynamics prepare him to derive the basic equations of motion of an aircraft. The equations are examined in detail with in-depth studies of each of the important stability parameters. The variables that govern static longitudinal and lateral-directional stability are investigated, and considerable time is spent on the theory behind roll coupling, spin testing, and aeroelastic effects. The expanding role of electronic and hydraulic systems to aid or completely implement the stability and control of modern aircraft has dictated the inclusion of an extensive group of subjects related to linear and non-linear control theory. More than fifty hours are allotted to this area of study. V/STOL theory is presented to familiarize the student with the attributes and state-of-the-art for such aircraft.

FLYING

The real uniqueness of the ARPS curriculum is realized when the above mentioned academic courses are coupled with the School's computers, simulators, and aircraft. As an example, to investigate the stability and dynamics of an aircraft, the student first derives the basic aircraft equations of motion and becomes familiar with the variables involved. These equations are then placed on an analog computer where the effects of varying basic frequencies and damping ratios can be observed visually. The School's static aerodynamic simulator is then used to allow the student to vary individual stability parameters to see how they change an aircraft's handling characteristics. With this basic familiarity of the

parameters involved, the student takes to the air in the Cornell Aeronautical Laboratory's B-26 variable stability trainer and the two ARPS NF-106 variable stability aircraft (the NF-106 is covered in detail later.) These flying laboratories allow an infinite variance of aircraft handling qualities and control systems, and give the student first hand in flight experience in observing a vast range of flight characteristics that could never collectively be found in individual test or production vehicles. Finally, the student applies his newly gained experience to the planning, conduct, and reporting of a relatively complete stability and control investigation of the F-104 and either the T-33, T-38, or B-57. In addition to the basic longitudinal and lateral-directional stability measurements, the investigation includes an examination of the engine out characteristics of the B-57, the spin

FIGURE 3 STATIC AERODYNAMIC SIMULATOR

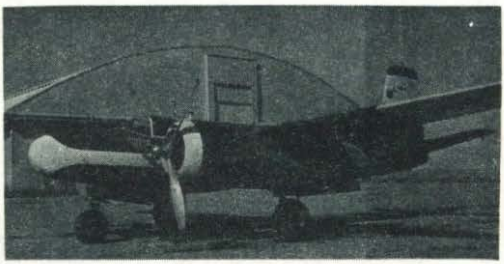


FIGURE 4 CORNELL VARIABLE STABILITY B-26

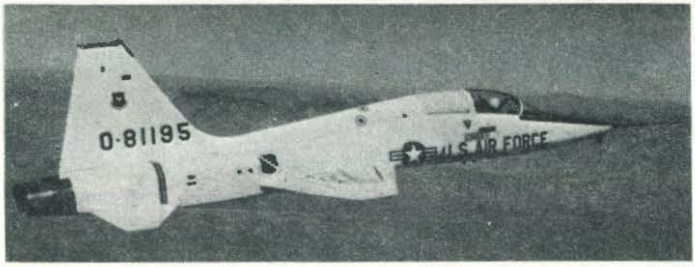


FIGURE 5 APRS T-38

characteristics of the T-33, and the high supersonic Mach number handling characteristics of the F-104. (see the Appendix for a detailed list of training flights).

Qualitative Testing

Another area which receives heavy emphasis is that of qualitative flight testing. Each student is briefed on the optimal techniques to be employed, and then performs a one flight evaluation of one or more aircraft that he has never flown before. Written and/or oral reports are then presented on his findings. Typical aircraft evaluated include the F-100, F-102, F-4, F-111, TA-4F, A-1E, B-52, KC-135, C-130, C-141, T-28, T-29, OV-1, O-2, U-6, U-10, and UH-1B.

Soaring

In addition to the above missions, the pilots are given a short introductory soaring flight program (2 hours) to complement their high performance experience with very high L/D flight. The introduction consists of eight flights in Schweizer 2-32's, 2-33's, and 1-26's at a commercial flight facility. In addition to gaining a basic familiarity with aircraft of this type, the student also gathers limited soaring handling and performance data.

FIGURE 6 SCHWEIZER 1-26 SAILPLANE

TEST PLANS AND REPORTS

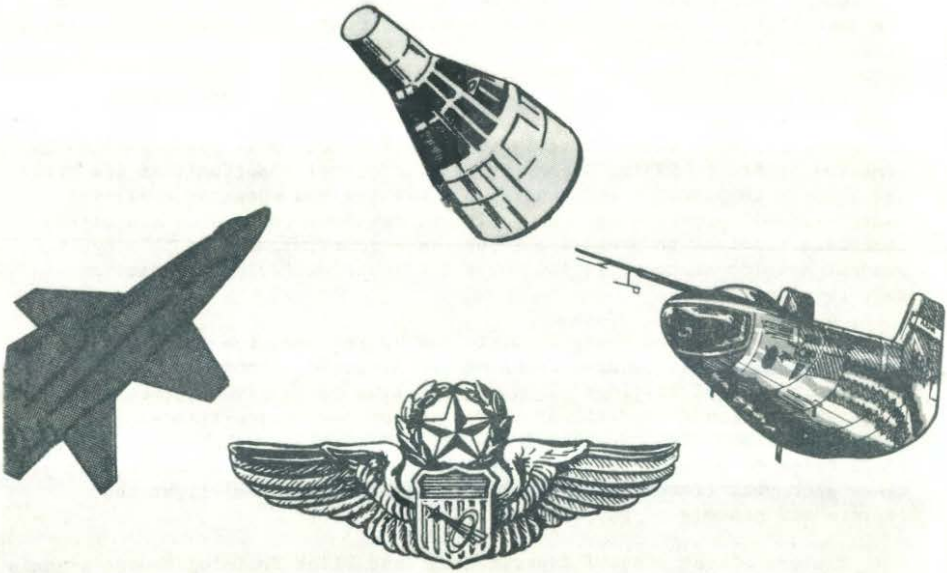
The student writes a test plan for each flight test in the stability and control subphase. This training shows the need to thoroughly define the objectives, techniques, limitations, and desired results of each test before the flight is flown.

Probably the most tedious and yet one of the most necessary parts of the curriculum is the written and oral report program. A test pilot who cannot clearly and accurately report his findings is wasting valuable time and effort in flying a test program. Several opportunities are given the student to practice and develop his writing and speaking abilities under critical supervision. In addition, the individual analysis of the test data required to prepare a report is a powerful tool in helping the student develop an appreciation for the effects of flying accuracy on test results.

As the end of the Phase I curriculum approaches, the student begins to gain considerable understanding of the language, theory, techniques, and problems of flight testing. Thus at this time he is given increasing opportunities to learn from various experts in the associated fields of flight test through a series of guest lectures. In addition, each class, is given field trips to various test activities and aircraft manufacturers, and one class each year travels on a two week visit to study the flight test centers and schools of our allies in Europe.

The end of the Phase I Experimental Test Pilot Training course signals the departure of the foreign and civilian students. As graduates of this phase, they have been trained to perform as test pilots, engineers, and Managers on atmospheric test programs of research, test, and production type aircraft and V/STOL vehicles. The U.S. military students remain at the School for an additional 3 1/2 months training in the Phase II Aerospace Research Pilot Course.

FIGURE 7 ARPS F-104C



PHASE II - AEROSPACE RESEARCH PILOT COURSE

The three and one half month Aerospace Research Pilot Course is designed to increase the qualifications of the Phase I graduate to enable him to participate in the flight testing, engineering design, and/or management of advanced aircraft and manned space research programs. The course includes (1) academic instruction in subjects related to advanced aircraft and space vehicle performance and operation, (2) practical test flying in aircraft and simulators exhibiting research aircraft and manned space vehicle flight characteristics, (3) familiarization with the physiological and psychological aspects of high performance and space flight, and (4) field trips to various government and civilian facilities engaged in the development, testing, and employment of present and future advanced aircraft, space vehicles, and related systems and components.

ACADEMICS

Much emphasis is placed on the intensive academic program. The subjects are presented at the graduate level and consist of background studies in astronomy, digital computers, bioastronautics, space environment, and the supporting mathematics. The mechanics and performance aspects of advanced aircraft and space flight are investigated in courses on rocket propulsion, space flight mechanics, and reentry heating. Aircraft and space vehicle guidance and control capabilities are studied in space navigation and inertial guidance courses.

A systems management course is presented to show the test pilot's position and responsibilities in the overall research and development program.

SIMULATION

An extensive simulation curriculum is employed to bridge the gap between classroom theory and practical application. The curriculum is keyed to progression in academics and provides:

1. Verification of performance and guidance and control theory by actual practice.

2. Practical experience in energy manangement and the characteristics of many types of advanced aircraft and space vehicle control systems.

3. A build-up of experience in instrument display selection, control system selection, and other trade-off areas for future pilot contributions to the design phase of new aerospace systems.

4. Development of piloting skills required for aerospace operations which are impractical to perform except in simulation.

The simulation equipment currently in use includes:

1. Static Aerodynamic Simulator - used to simulate any aerodynamic vehicle including those with rocket propulsion and reaction controls at any altitude and velocity from reentry to light aircraft environment. (See Figure 3.)

2. Control Systems Trainer - used to provide experience in use of proportional, rate, and impulse control systems. Pilots perform various tracking tests with a variety of hand controllers while using many different types of visual displays.

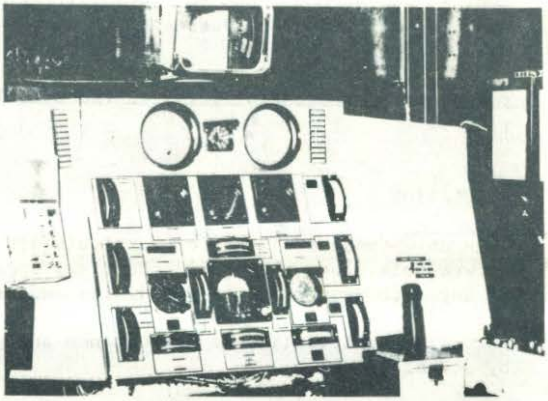
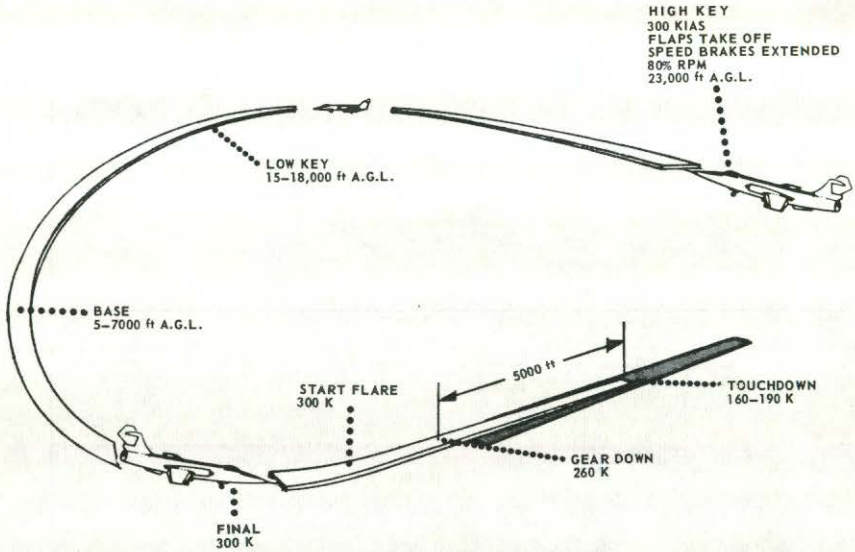


FIGURE 8 CONTROL SYSTEMS TRAINER

Actual zero gravity experience is provided in an Air Force Systems Command C-135 flying zero gravity and moon gravity profiles. Heavy g profiles (up to 15 g's) are experienced in the centrifuge at the School of Aerospace Medicine, Brooks AFB, Texas. Actual space program g profiles are flown to include launch, abort, and re-entry.

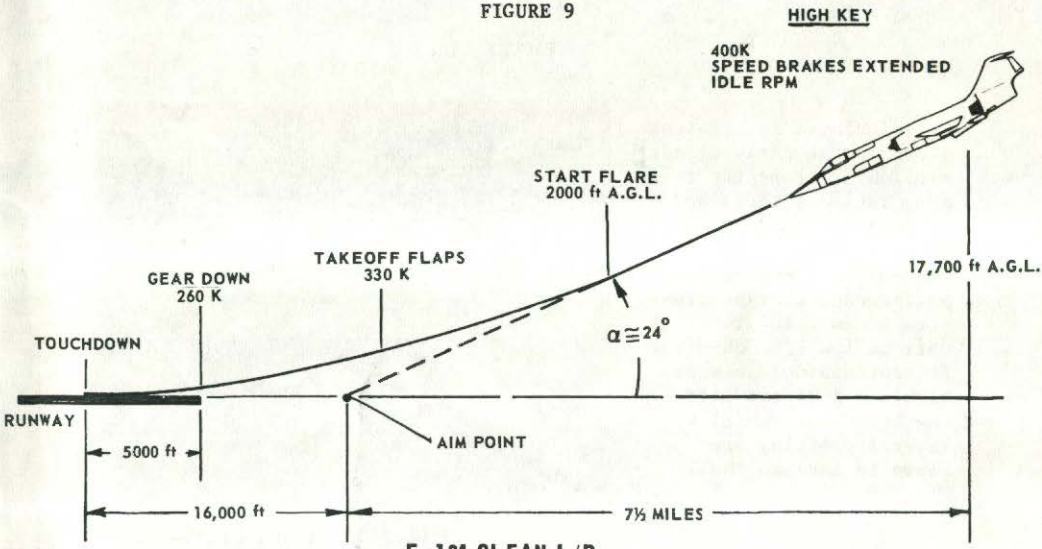
FLYING

The Phase II flying curriculum fortifies the flight test training of Phase I by providing additional experience in high performance and unusual aircraft. It also provides space and research related flight experience by using special and conventional aircraft in configurations with research vehicle handling qualities in typical research flight profiles. This experience includes exposure to zero gravity, pressure suit enviornment, rocket propulsion, reaction control handling, energy management, variable stability, and lifting body flight profiles and landing characteristics.



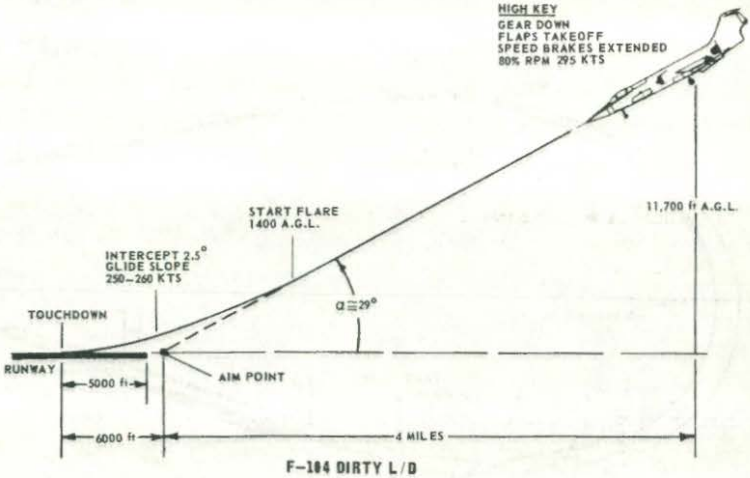
SIMULATED X–15 PATTERN

FIGURE 9



F–104 CLEAN L/D

FIGURE 10



F-104 DIRTY L/D

FIGURE 11

Included in missions flown in the Phase II curriculum are low lift to drag ratio patterns and landings. In a series of flights the student examines the handling and performance characteristics of an F-104 in various low L/D configurations designed to simulate X-15 and lifting body type vehicles. Several profiles are flown to include the

FIGURE 12 F-104 DIRTY L/D CONFIGURATION - GEAR, T/O FLAPS, S/B OUT, AND POWER 80%

X-15 landing pattern and high and low speed lifting body approaches. Typical patterns are shown in Figures 9 through 11. In addition to becoming familiar with the limited performance characteristics and precise energy management requirements of low L/D vehicles, the student derives practical experience in determining the L/D's of variously configured aircraft, and can predict the critical parameters for vehicle maneuvers and landing patterns. Admittedly only a few graduates of the School will be fortunate enough to fly or test vehicles such as the X-15 or the lifting bodies, however, a much larger number will be associated with advanced aircraft programs in support, chase, or managerial positions. These considerations in addition to the invaluable benefits of varied experience on a test pilot's capabilities make the low L/D program an extremely useful portion of the curriculum.

NF-106

The NF-106 variable stability trainer mentioned in the Phase I discussion is designed for extensive application in the space and advanced aircraft oriented Phase II curriculum. The NF-106 is a two seat F-106B that has had major modifications which allow it to be used as a "model follower" inflight simulator of a variety of aircraft or flight vehicles. These modifications include a 144 amplifier analog computer which stores the model to be followed, a stability derivative programmer, a force feel system for the aft cockpit center stick, a front and rear cockpit side arm controller, and an auto pilot that follows three parameters (vertical acceleration, side acceleration, and bank angle under cruise conditions), and automatically flies the NF-106 in such a manner that the model and actual aircraft parameters are equal.

FIGURE 13 ARPS NF-106B

To simulate a desired aircraft, the equations of motion of that aircraft are first programmed into the analog computer. The aft center stick is disconnected from the basic NF-106 and connected to the computer and force feel hydraulic actuator. As pilot control inputs are fed into the computer, the equations of motion are immediately solved and the expected motion of the simulated aircraft appears at the output of the computer. The student's instruments in the rear cockpit are connected to this computer output and therefore indicate the airspeed, altitude, attitude, etc., of the model. A follower loop which monitors the vertical

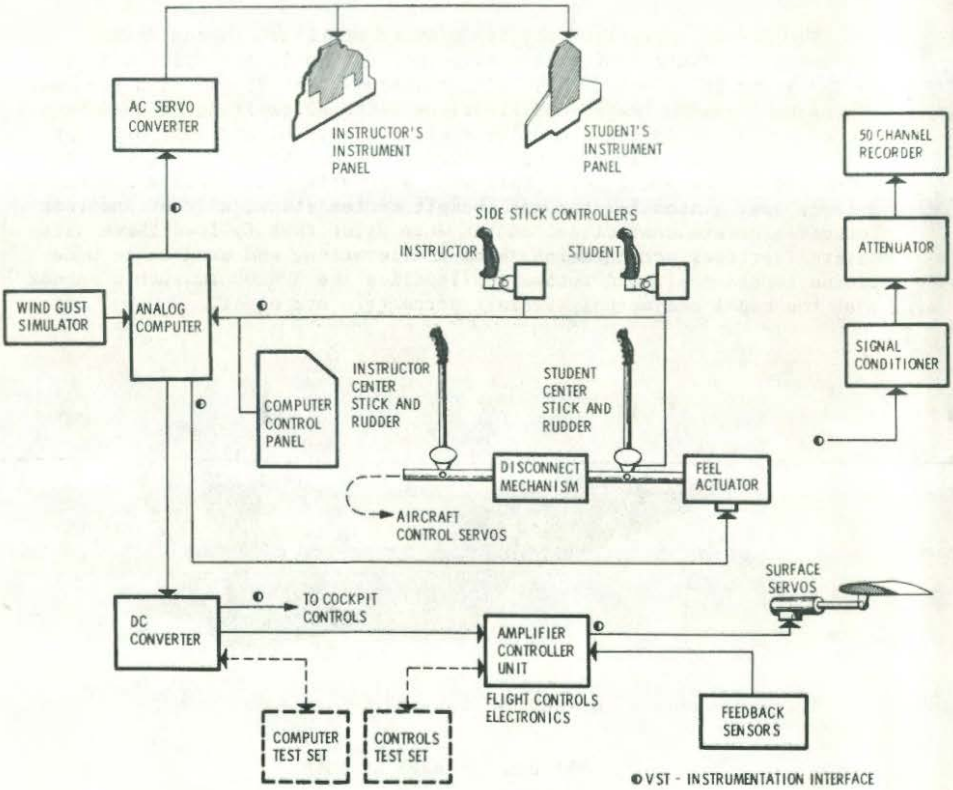


FIGURE 14 BLOCK DIAGRAM OF NF-106 VARIABLE STABILITY SYSTEM

acceleration, side acceleration, and bank angle of the model automatically drives the flight controls of the NF-106 in such a manner that these three parameters are equal in the model and the NF-106. A strain gage compares the force on the aft center stick to the force required as specified by an equation stored in the computer. A hydraulic servo-valve then moves the force feel piston in such a direction as to zero any difference between the required and actual force.

The stability derivative programmer can be used to change the stability derivatives as a function of Mach, airspeed, or altitude. This allows the NF-106 to simulate other aircraft for any portion of their flight profile.

With the follower loop not engaged the NF-106 can be flown on the ground as a fixed base simulator. This feature will be used to allow the student to get ground practice for the mission which he will fly the following day. Motion and acceleration cues will of course be missing during this ground simulation.

It is anticipated that the learning outcomes of these simulations will be of great value to pilots participating in present or future advanced research and space flight programs.

F-104 Side Stick Control System

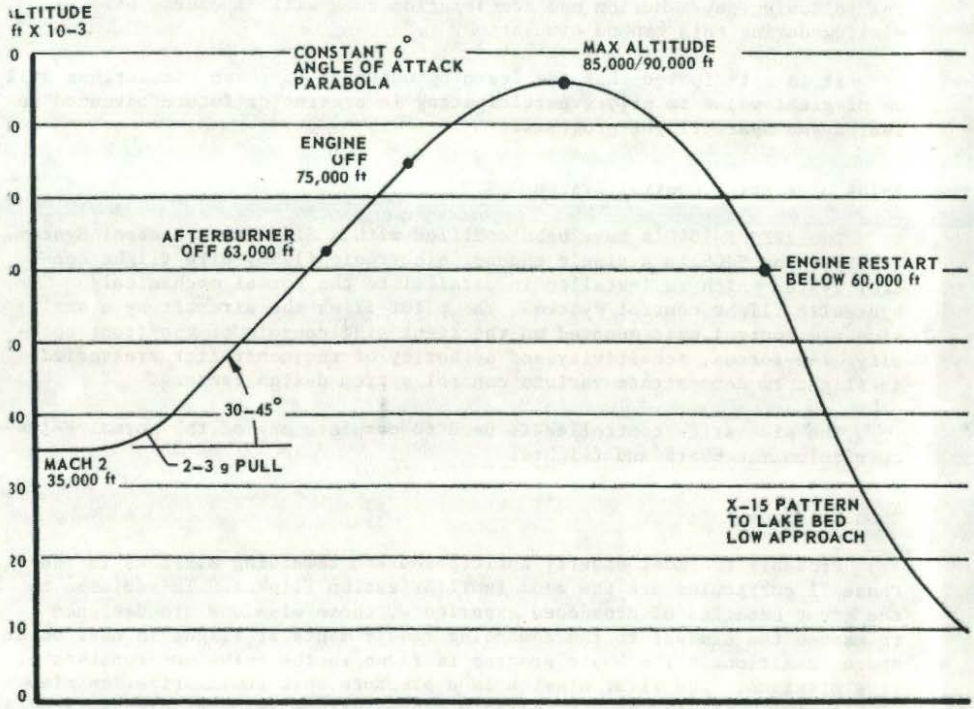
Two ARPS F-104D's have been modified with a Side Stick Control System (SSCS). The SSCS is a single channel electronic fly-by-wire flight control system which is installed in parallel to the normal mechanical/hydraulic flight control system. The pilot flies the aircraft by a small side arm control unit mounted on the right side console of the front cockpit. The forces, sensitivity and authority of the controller are varied in flight to demonstrate various control system design factors.

The side stick controller is used to complete any of the normal F-104 curriculum maneuvers and flights.

Zoom Missions

Probably the most eagerly anticipated and rewarding missions in the Phase II curriculum are the zoom familiarization flights. In addition to the great benefits of broadened experience, these missions are designed to expose the student to the demanding requirements of flight in near outer space conditions. The basic program is flown in the F-104 and consists of five missions. The first mission is a pressure suit familiarization mission during which the student flies a depressurized F-104 at high altitudes and high Mach numbers to experience the techniques and limitations of flight in a fully inflated suit. The second mission is with an instructor and is a demonstration of the basic zoom profile shown in Figure 15. The mission is flown in a two place F-104D and is limited to a 30° climb angle with a

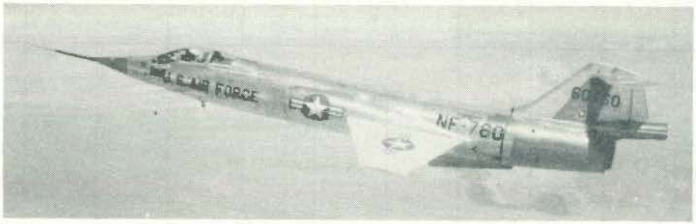
resulting peak altitude between 70 and 80 thousand feet. The remaining three missions are flown solo in an F-104C and consist of basically the same maneuver with climb angles increasing from 30° to a maximum of 45°. Resulting peak altitudes are a function of exactness of technique and meteorological conditions, and average just below 90,000 feet. In addition to the engine shutdown requirements and pitch angle limitations shown in Figure 15, the aircraft is flown at a precise angle of attack of six degrees during the power off profile. Minimum dynamic pressure experienced is no less than 20 psf. The engine is restarted when descending through 60,000 feet, and a precautionary X-15 type pattern is flown to the Rogers lakebed runway. In the seven years this program has been in existence there has never been a case of failure of an engine to restart.



F-104 ZOOM PROFILE

FIGURE 15

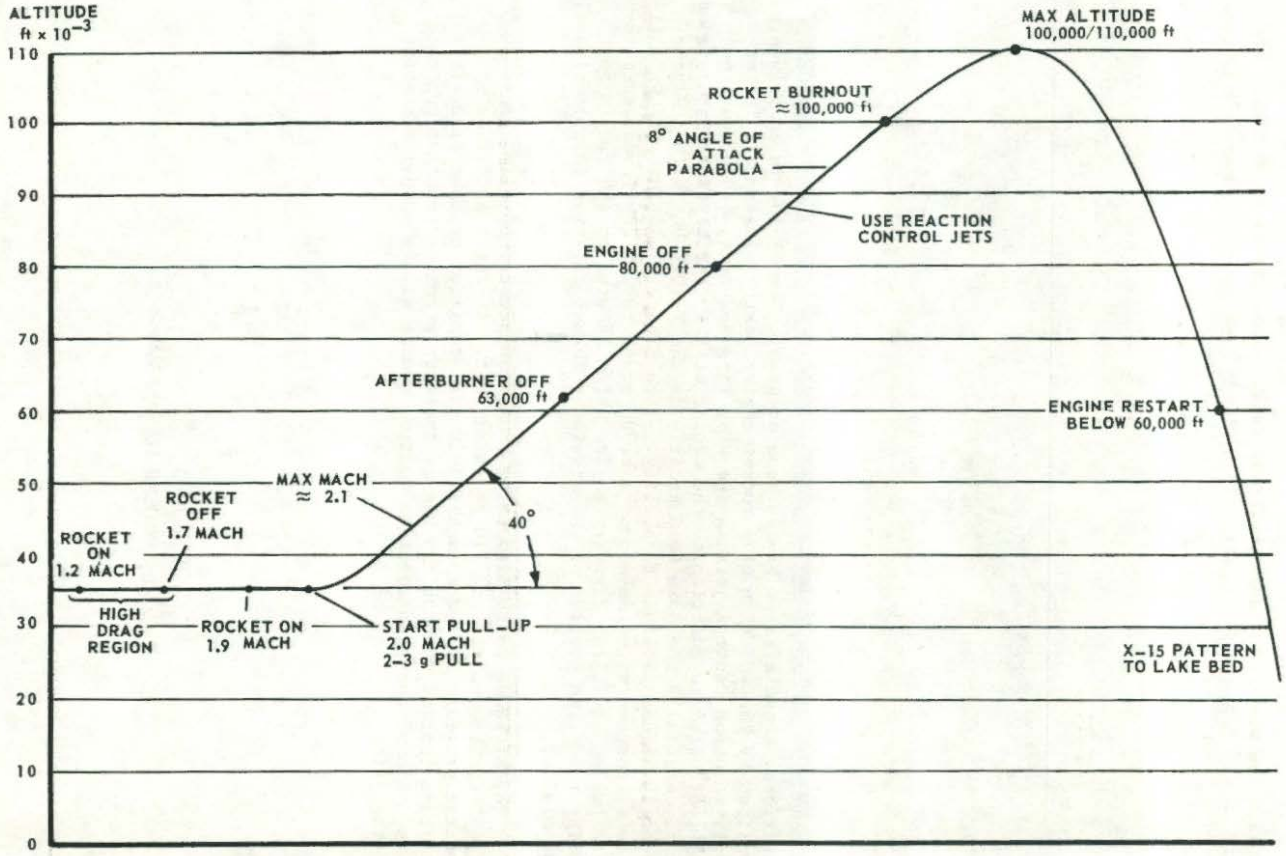
For a portion of the class, the end of the F-104 zoom missions signals the end of the School flying curriculum. However, a select few (six in the most recent class) are given the opportunity to fly an



additional three mission NF-104 zoom program. The NF-104 is an F-104A, modified by the addition of a rocket engine, extra wingspan, a larger tail, reaction control jets in the wing tips and nose, and a reaction jet controller in addition to the center stick. The aircraft is designed to fly basically the same zoom profile as the F-104, but with a significantly higher altitude capability. (See Figure 17.) This higher altitude is reached with the aid of a 6,000 pound thrust JP-4/hydrogen peroxide fueled LR-121/AR-2 rocket engine which is used on the run-in and during the climb portion of the mission. Thrust duration is approximately two minutes.

The altitude capability using a mission prescribed climb angle of 40° is between 100 and 110 thousand feet. At these altitudes the dynamic pressure is low enough (15-20 psf) to allow precise aircraft attitude control through the use of hydrogen peroxide reaction control jets. A hand operated reaction control handle allows manual actuation of the jets.

FIGURE 16 ARPS NF-104



NF-104 ZOOM PROFILE

FIGURE 17

FIGURE 18 LR-121/AR-2 ROCKET ENGINE

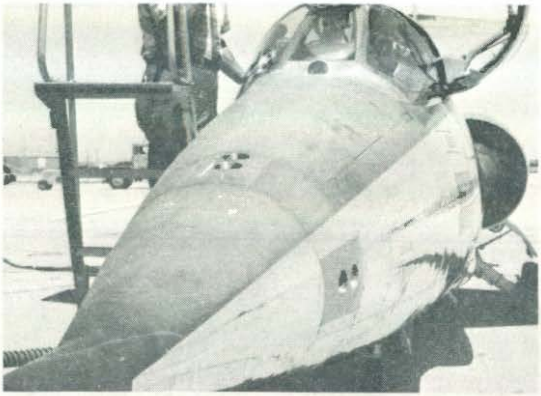
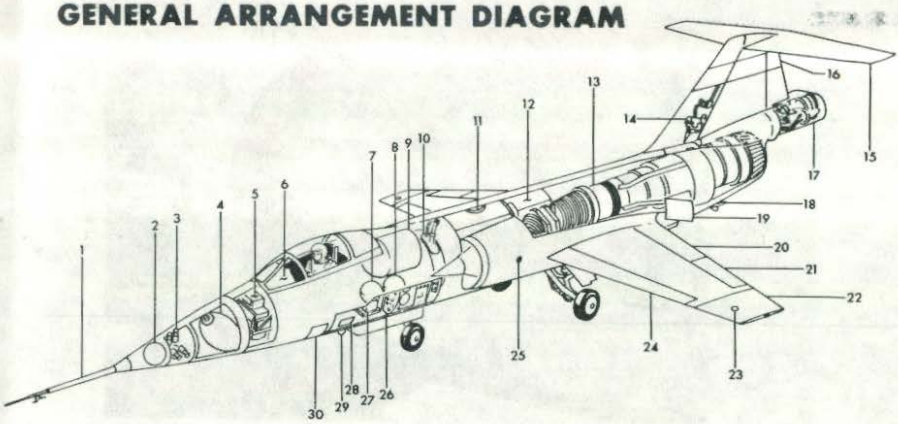


FIGURE 19 NF-104 PITCH AND YAW
REACTION CONTROL JETS

FIGURE 20 NF-104 SHOWING LARGER
F-104G TAIL INSTALLED

GENERAL ARRANGEMENT DIAGRAM



1 YAPS HEAD BOOM
2 RCS PRESSURIZATION GN_2 TANK
3 RCS PITCH AND YAW MOTORS (EIGHT)
4 RCS H_2O_2 TANK
5 OSCILLOGRAPH
6 ELECTRICALLY HEATED WINDSHIELD
7 COCKPIT PRESSURIZATION GN_2 TANK
8 H_2O_2 PRESSURIZATION GN_2 TANK
9 FORWARD H_2O_2 TANK
10 AFT H_2O_2 TANK
11 FORWARD MAIN JP-4 FUEL TANK
12 AFT MAIN JP-4 FUEL TANK
13 J79-GE-3B TURBOJET ENGINE WITH AFTERBURNER
14 HORIZONTAL STABILIZER POWER CONTROL ASSEMBLY
15 CONTROLLABLE HORIZONTAL STABILIZER
16 RUDDER
17 MODIFIED LR 121-NA-1 ROCKET ENGINE
18 DRAG CHUTE DOOR
19 SPEED BRAKE
20 TRAILING EDGE FLAP
21 AILERON
22 WING TIP EXTENSION
23 RCS ROLL MOTOR (TWO EACH WING TIP)
24 LEADING EDGE FLAP
25 NAVIGATION LIGHTS (SIX)
26 AUTOMATIC OBSERVER (AO) PANEL
27 THIRTY-FOUR-AMPER-HOUR BATTERY
28 UHF RECEIVER/TRANSMITTER
29 APW-11 TRANSMITTER ANTENNA
30 UHF ANTENNA

FIGURE 21 NF-104 GENERAL ARRANGEMENT

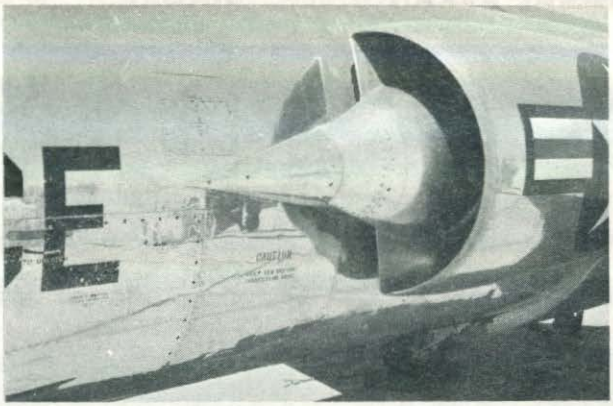


FIGURE 22 NF-104 ELONGATED INLET CONE

The F-104 and NF-104 zoom missions give the student singularly unique experience in a variety of advanced aircraft and research vehicle oriented disciplines. In addition to familiarity with basic X-15 type flight, re-entry, and landing profiles, the student gains a rare appreciation for the precision, energy management, handling, and meteorological tradeoffs involved in safely reaching the maximum altitude capability of an aircraft. Aircraft response to normal and reaction controls at extreme altitudes is investigated. Zero g conditions are experienced. Pilot capabilities and limitations under full pressure suit operation are demonstrated. Finally, the missions serve as an evaluation of the pilot's ability to react optimally under the demanding conditions of environment and vehicle performance to be found in present and future advanced aircraft research programs.

The end result of the zoom mission program is a pilot who has experienced as closely as economically and operationally practical, many of the conditions and exacting requirements of advanced research oriented flight. This experience when coupled to his test pilot training is an invaluable asset in the actual manning, support, or management of future manned or unmanned flight research and space programs.

FIGURE 23 NF-104 "ON ANGLE"

As at the end of Phase I, the students of Phase II are taken on several industry and government agency field trips to broaden their knowledge of the hardware and techniques of advanced aircraft and space operations. One of the major excursions of this series is a week long orientation at the School of Aerospace Medicine, San Antonio, to examine the physiological and psychological aspects of high performance and space flight.

Graduates of the combined Phase I and Phase II course are uniquely qualified to take part in both atmospheric and space oriented test programs. In addition they are thoroughly prepared to undertake the highly specialized training required for mission performance as astronauts in specific space vehicles.

ASSIGNMENT

Graduates of the Aerospace Research Pilot School have taken part in a great majority of the significant flight test achievements in this and many other countries. Every modern Air Force bomber, fighter, and transport, the X-15, YF-12, and B-70, the lifting bodies (HL-10, M2-F2, and X-24), and the Mercury, Gemini, Apollo, and MOL programs have had graduates of the School in key crew manning and/or management positions.

While 41 of the Nation's astronauts are alumni of ARPS, the majority of the School's military graduates go on to less exotic positions as Research Pilots in the Air Force Systems Command. Typical of their assignments are positions in fighter or bomber test operations at the Air Force Special Weapons Center, Kirtland AFB, the Armament Development Test Center, Eglin AFB, the Aeronautical Systems Division, Wright-Patterson AFB, and Air Force Flight Test Center, Edwards AFB.

STAFF QUALIFICATIONS

The staff of the Aerospace Research Pilot School consists of highly qualified Air Force test pilots, scientists, and engineers. Although none are specialists in every field associated with flight test, the over-all composition of the staff insures that each of these areas of interest is covered by at least one instructor with expert qualifications. In addition to experience in bomber, fighter, transport, and VSTOL test operations, the staff as a whole has had considerable combat, scientific research, and educational experience. Total flying time per staff member averages over 3,500 hours and among the 28 working instructors, there are twenty Master's degrees and two PhD's in related scientific disciplines.

FUTURE PLANS

The general design which dictates the Aerospace Research Pilot School's future direction is to maintain a dynamically progressive curriculum which will stay ahead of the anticipated needs of future atmospheric and space test programs. This requires continually changing courses of instruction, development of new test methods, and flight test training in the latest state-of-the-art vehicles.

The School's academic flight test curriculum is progressively updated by selecting test pilot staff members with recent scientific and/or graduate school experience. An extensive series of guest lectures by experts from leading universities, civilian aerospace corporations, and government test facilities augments the modernization of the curriculum as well as providing an insight into new methods of flight testing. Major new equipment under study includes the addition of A-7D aircraft and a Universal Aircraft Total Flight Simulator which will be a six degree of freedom moving base simulation with an electrically generated visual display.

Proper direction in the selection of these new vehicles, the timely changes to the curriculum, and the development of new test methods are insured through close and continuing contacts between the Aerospace Research Pilot School and the many branches of the aerospace profession.

APPENDIX

SUMMARY OF ARPS

AIRCRAFT and CURRICULUM

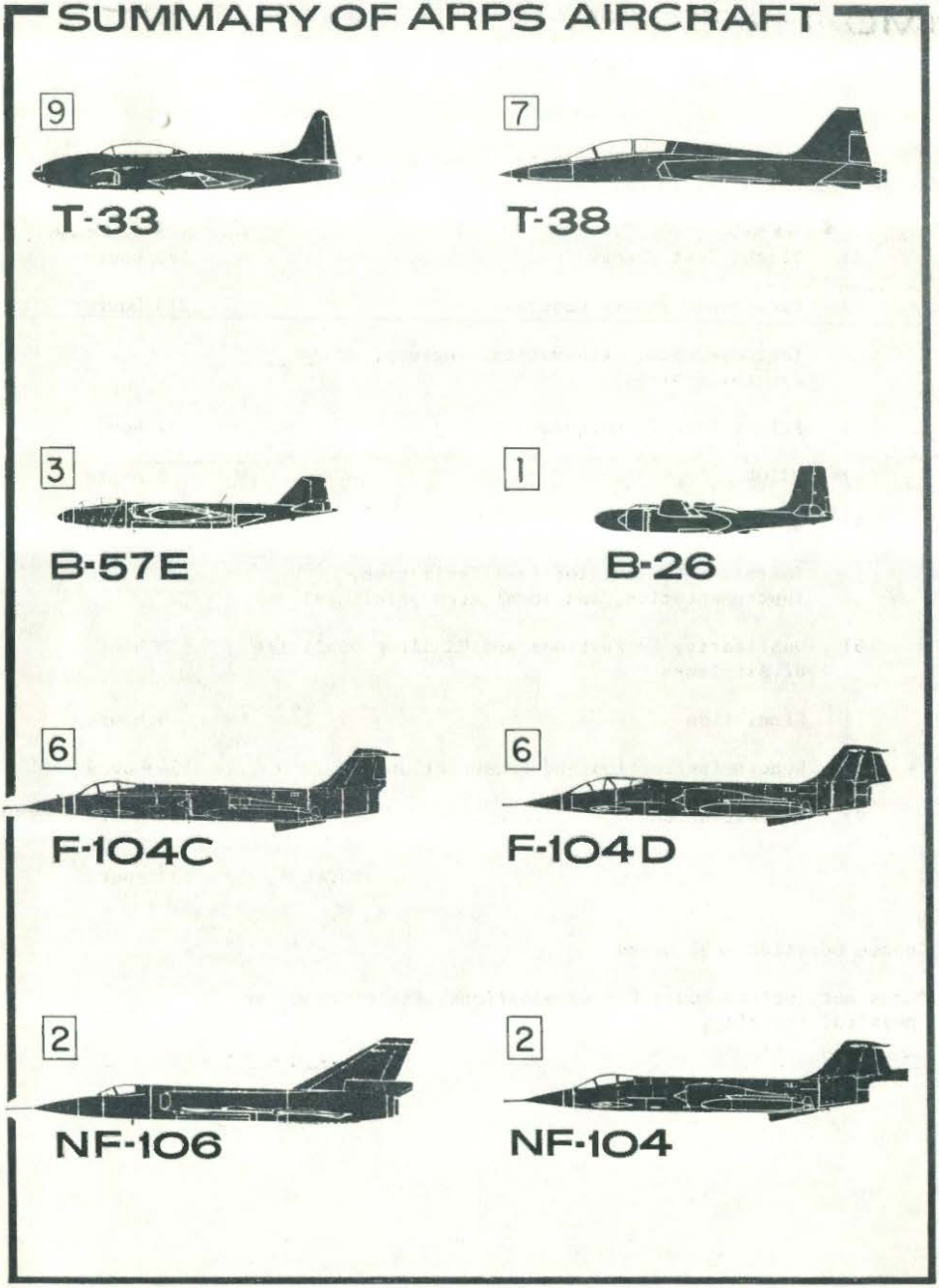

SUMMARY OF ARPS AIRCRAFT
9
T-33
7
T-38
3
B-57E
1
B-26
6
F-104C
6
F-104D
2
NF-106
2
NF-104

FIGURE 24

ACADEMIC CURRICULUM - PHASE I

EXPERIMENTAL TEST PILOT PHASE

The academic curriculum in the Phase I of the Aerospace Research Pilot School is contained in the following nine categories:

1)	Flight Test Theory	123 hours
2)	Background Theory Courses:	223 hours
	(Aerodynamics, Mathematics, Engines, and Control Systems)	
3)	Flight Test Techniques	31 hours
4)	VSTOL	8 hours
5)	Briefings:	59 hours
	(Airplane & Simulator familiarization, instrumentation, and local area briefings)	
6)	Qualitative Evaluations and Handling Qualities of Airplanes	8 hours
7)	Simulation	9 hours
8)	Report Instruction and Presentation	54 hours
9)	Miscellaneous	38 hours
	TOTAL *	553 hours

Course Duration - 36 weeks

*Does not include hours for examinations, field trips, or physical training.

underlined, upper + lower case (for all, I through IX)

I. FLIGHT TEST THEORY

Course	Hours
Pitot-Static System	7
Standard Atmosphere Properties	2
Energy Concepts	8
Correction of Data to Standard Day	2
Takeoff and Landing Theory	4
Turning Theory	2
Cruise Performance	10
Stability and Control Introduction	4
Longitudinal Static Stability Theory	15
Spin Theory	13
Engine-Out Theory	4
Maneuvering Flight Theory	11
Lateral-Directional Stability	15
Dynamics Theory	17
Roll Coupling	5
Handling Qualities	2
MIL-C-5011A/Pilot Rating Scale	1
Systems Management Introduction	1
TOTAL	123

II. BACKGROUND THEORY COURSES

(Aerodynamics, Mathematics, Engines, and Control Systems)

Course:	Hours
Calculus Exam	1
Physics-Thermodynamics Exam	1
Aerodynamics Introduction	9
Subsonic Aerodynamics	10
Supersonic Aerodynamics	13
Airbreathing Propulsion	18
Digital Calculator	6
Computer Data Reduction	4
Vectors and Matrices	14
Equations of Motion	15
Operational Math, Differential Equations	15
Analog Computers	17
Linear Control Systems Root Locus	31

II. BACKGROUND THEORY COURSES (Continued)

Course	Hours
Aeroelasticity	9
Probability	6
Non-Linear Control Systems	18
Soaring	3
Digital Computer Theory	6
Instrumentation	13
Electrical Engineering	14
TOTAL	223

III. FLIGHT TEST TECHNIQUES

Course	Hours
Flight Test Techniques General Briefing	1
Tower Fly-by FTT	
Pacer FTT	2
Smoke Trail FTT	
Sawtooth Climb FTT	
Check Climb - FTT	1
Level Acceleration FTT	1
Turning Performance FTT	1
Speed Power FTT	3
Range FTT	2
Stall FTT	1
Performance Final FTT	1
Longitudinal Static Stability FTT	2
Spin FTT	2
Engine-Out FTT	1
Maneuvering Flight FTT	2
Lateral-Directional FTT	4
Dynamics FTT	1
Stability & Control Final FTT	1
Non-Steady State Testing FTT	1
Chase and Formation FTT	3
Soaring FTT	1
TOTAL	31

IV. VSTOL CHARACTERISTICS

Course	Hours
VSTOL	8
TOTAL	8

V. BRIEFINGS

(Airplane and simulation familiarization, instrumentation, and local area briefings)

Course	Hours
ARPS Introduction	8
Local Area Briefing	2
T-33 Checkout Briefing	2
B-57 Briefing	3
T-38 Checkout Briefing	3
B-52 Briefing	1
Helicopter Briefing	2
F-106 Briefing	2
Stability & Control Instrumentation Briefing	7
F-104 Checkout Briefing	12
Ejection Seat Training	3
Survival Training	4
Test Center Briefings	10
TOTAL	59

VI. QUALITATIVE EVALUATIONS AND HANDLING QUALITIES OF AIRPLANES

Course	Hours
B-26 Variable Stability (Cornell Aero Labs)	4
Qualitative Flight Testing	4
TOTAL	8

VII. SIMULATION

Course	Hours
Dynamics Simulator	1
Control Systems Simulation	4
Simulation Briefing	4
TOTAL	9

VIII. REPORTS

Course	Hours
Initial Report Writing Briefing	1
Pitot-Static Report Briefing	1
Category II Report Briefing	2
Engine-Out & Spin Report Briefing	1
Category II Report Debriefing	1
Qualitative Report Briefing	1
Oral Report Briefing	1
Student Individual Orals (1 Each)	32
Stability & Control Final Presentations	6
Qualitative Flight Orals	8
TOTAL	54

IX. MISCELLANEOUS

Commander's Call	8
Flying Safety Meetings	14
Performance Data Reviews	6
Military Training	10
TOTAL	38

upper + lower case, underlined

FLYING CURRICULUM - PHASE I

EXPERIMENTAL TEST PILOT PHASE

upper + lower case, not underlined

TEST	TYPE A/C	FLYING HOURS
Checkout	T-33	6.6
Checkout	T-38	4.4
Tower Fly-By	T-33	1.5
Pace	B-57/T-33	1.5
Pacer Data	T-33	1.5
Smoke Trail	T-38/T-33	1.2
Smoke Data	T-38	1.2
Sawtooth Climb Demo	T-33	1.5
Sawtooth Climb Data	T-33/B-57	1.5
Check Climb Demo	T-38	1.2
Check Climb Data	T-33/T-38/B-57	1.4
Level Acceleration Demo	T-38	1.2
Level Acceleration Data	T-33/T-38/B-57	1.4
Turning Performance/Speed Power Demo	T-33	2.2
Turning Performance Qualitative	T-33/T-38/B-57	1.4
Speed Power Data	T-33/T-38/B-57	1.7
Range Data	T-33/T-38/B-57	3.1
Stall Demo	B-57	1.5
Stall Data	T-33	1.5
Performance Flight Test Techniques Practice	T-38	1.2
Performance Flight Test Techniques Final	T-38	1.2
Stability Preliminary	T-33/T-38/B-57	1.4
Longitudinal Static Stability Demo	T-38	1.2
Longitudinal Static Stability Qualitative	T-33/T-38	1.3
Longitudinal Static Stability Data	T-33/T-38/B-57	2.3
Maneuvering Flight Demo	T-38	1.2
Maneuvering Flight Qualitative	T-33/T-38	1.3
Maneuvering Flight Data	T-33/T-38/B-57	2.3
Spin Demo	T-33	1.5
Spin Data	T-33	1.3
Spin Chase	T-38	1.3
Engine-Out Demo/Data	B-57	1.8
Sideslip and Aileron Roll Demo	T-33	1.5
Sideslip and Aileron Roll Qualitative	T-33/T-38	1.3
Sideslip and Aileron Roll Data	T-33/T-38/B-57	2.3

FLYING CURRICULUM - PHASE I (Continued)

TEST	TYPE A/C	FLYING HOURS
Dynamics Demo	B-57	1.7
Dynamics Qual	T-33/T-38	1.3
Dynamics Data	T-33/T-38/B-57	1.4
Variable Stability	B-26	6.0
Variable/Point Stability	F-106	1.5
Qualitative Testing Practice	T-38	1.2
Qualitative Testing Demo	F-104	1.0
Qualitative Flight	NF-106	1.0
Preliminary Evaluation Test	Various	1.8
Performance/Handling Evaluation	B-52	3.0
Performance/Handling Evaluation	UH-1	2.0
Flight Test Technique Practice	T-38	1.2
Flight Test Technique Final	T-38	1.2
Checkout	F-104	7.0
Formation and Chase	F-104	5.0
Stability and Control Evaluation	F-104	7.0
Sidestick Controller Evaluation	F-104	2.4
High L/D Training	Schweizer	2.0
	TOTAL	114.6

In addition to the required front seat and solo curriculum flying hours listed above, students will log time in the rear seat acting as observer or assistant in data gathering missions. Additional T-33 flying is accomplished to fulfill AFM 60-1 requirements.

(same, follow Phase I)

ACADEMIC CURRICULUM - PHASE II

AEROSPACE RESEARCH PILOT PHASE

COURSE TITLE	Hours
Flight Mechanics (2-body)	10
Flight Mechanics	23
Flight Mechanics Reentry	13
Rocket Propulsion	18
Guidance	20
Astronomy	10
Seminars	5
Flying Briefings	12
Systems Management	13
Hypersonic Aero	19
TOTAL	143

SIMULATION	Hours
Briefings	6
F-104 Zoom Practice	2
NF-104 Zoom Practice	1
Control Systems Trainer	7
TOTAL	16

FLYING CURRICULUM - PHASE II

AEROSPACE RESEARCH PILOT PHASE

TEST	TYPE A/C	FLYING HOURS
Performance/Handling Evaluation (No Rocket)	NF-104	1.2
Low L/D Approaches and Landing	F-104	7.0
L/D Determinations	F-104	3.0
Lifting Body Simulation	NF-106	1.5
Pressure Suit Familiarization	F-104	1.0
Zooms	F-104	2.4
Zoom Chase	F-104	4.0
Zooms	NF-104	1.2*
Sidestick Controller	F-104	1.0
TOTAL		22.3

*Due to limited number of NF-104 rocket sorties available, only those students whose post graduate assignments dictate a need for this training fly these missions.

In addition to the required front seat or solo curriculum flying, students log time in the rear seat as observer or assistant in data gathering missions. Additional T-33 flying is accomplished to fulfill AFM 60-1 requirements.