Proposed Program

for the

USAF EXPERIMENTAL FLIGHT TEST PILOT SCHOOL

1960 - 1965

Study and Recommendations
prepared by the Staff of the
USAF Experimental Flight Test Pilot School
Air Force Flight Test Center
Edwards Air Force Base
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1. INTRODUCTION:

a. This proposed program for the USAF Experimental Flight Test Pilot School was prepared by the School staff at the request of Headquarters ARDC (RDPTS-1). Rapid changes in the projected Weapon System posture of the Air Force and continuing restrictions on the availability of resources demand that careful and realistic planning be conducted in all R & D areas. In particular, the increasing emphasis upon space-oriented systems suggests that changes in the test pilot training program are in order at this time.

b. A study entitled "Future Requirements for Test Pilot Training" was conducted by the School Commandant in December 1959. The estimates of training requirements for the period 1960-1965, as stated in that report, were based on an extrapolation of the experience from the period 1955-1959, and upon ARDC-furnished estimates of future requirements in AFSC 8744. Since that time, the ARDC estimate of future requirements in AFSC 8744 has been revised downward, and the requirements for other students in the School (foreign officers, contractor pilots, non-ARDC assignees, etc.) have been re-evaluated in the light of more recent developments.

c. The December 1959 report mentioned the requirement for specialized training for Space Research Pilots, but did not include a proposal for the curriculum, resources, or capabilities of such a program. Since that time, the School staff has devoted considerable time toward the study and development of a realistic and effective Space Research Pilot Course. Some of the results of that effort are contained in this report in the form of a relatively firm proposal for a Space Research Pilot Course to be conducted within the framework of the present Test Pilot School.

d. In order to adequately reflect the dual training functions in aircraft testing and manned space vehicle testing, it is recommended that the name of the Test Pilot School be changed to "The USAF Aerospace Research Pilot School". It is proposed that two distinct courses be established within the existing framework of the Test Pilot School as follows:

(1) An Experimental Test Pilot Course, similar in format and curriculum to the present Test Pilot training course.

(2) A Space Research Pilot Course, a new program to be offered approximately once per year initially, beginning in June 1961. Candidates for this course are to be selected from among highly qualified, experienced, and motivated graduates of the Experimental Test Pilot Course.

2. CONSIDERATION OF AIR FORCE REQUIREMENTS:

a. Experimental Test Pilot Course: The most recent estimate from Headquarters ARDC shows a Command requirement for approximately twenty (20) graduates of the Experimental Test Pilot Course per year through 1965. Best estimates of the average annual requirements for other organizations, as reflected in Reference d, are as follows:

Command or Organization	Average Annual Requirement
AMC, TAC, SAC, etc.	7
Foreign Students	4
Contractor Pilots or FAA	2
Army Pilots	4

To realize the maximum economy in School operation and still meet Air Force needs, two Experimental Test Pilot Courses per year are proposed. This will produce thirty-two (32) graduates of the Experimental Test Pilot Course annually, five less than the anticipated total requirement. However, it is felt that adjustment of length of tours in testing assignments, or reassignment of Test Pilot School graduates not being utilized in AFSC 8744, will compensate for the reduced number of graduates. Considering ARDC requirements first, the following distribution of the thirty-two (32) graduates is suggested (assuming that all students successfully complete the course):

Command or Organization	Graduates Assigned Annually
ARDC	20
AMC, TAC, SAC, etc.	4
Contractor or FAA	1
Foreign Students	4
Army	3*

*Note: Since Army pilots receive specialized training, they should not be entered in an Air Force Class. Instead, when a requirement is generated for a sufficient number of Army test pilots to fill an entire class, an Army class could be substituted for an Air Force class. It should be emphasized that the figures given above are annual averages, and do not necessarily represent the exact figures for any one year.

b. Space Research Pilot Course: The Air Force has firmly committed itself to the manned spacecraft field with the awarding of the Dynasoar I contract and the establishing of a test force; and a review of future planned systems

indicates that development action on a number of additional programs is forecast to commence in the 1963-1965 time period. Since it is planned to assign test pilots to specific projects as early as possible in the development cycle, the requirement for space oriented pilots is immediate and will increase as development activity increases. While it is impossible at this time to predict the exact numbers of space oriented pilots that will be required, a reasonable estimate is that the annual requirements through 1965 will not exceed six to eight pilots. This estimate is based on the assumption that development action on no more than two new programs will be initiated in any one year and that from two to five pilots will be assigned to each program.

3. COURSE CURRICULUM:

a. Experimental Test Pilot Course:

(1) Course Content: A USAF Experimental Test Pilot must be considerably more than a well-trained, competent pilot. Certainly, he must possess the piloting skill and know-how needed for the actual flight tests; but he must also be capable of handling associated non-flying jobs. Of equal importance to flying skill is an officer's ability to plan and conduct a test program, analyze test data, accurately and clearly report test results, and make sound recommendations. The Experimental Test Pilot Course is designed to thoroughly train the student in test planning, flight testing, test analysis, and report preparation. The course is continuously revised to keep abreast of new developments in aircraft requiring new or improved test techniques and methods. Except for minor problems in acquiring training aids, the academic portion of the curriculum is revised without undue delay. However, there is almost always a lag in providing flight training associated with curriculum revisions because of the time required to effect a change in the School aircraft inventory. The academic and flight training programs are outlined in Appendix B. They are based on the assigned aircraft schedule given in Appendix A.

(2) Course Length: The length of the Experimental Test Pilot Course is largely determined by the rate at which a student can absorb the material presented and can accomplish the required flight training, data reduction, and report writing. As aircraft testing has become more complex, the amount of essential training has increased until a minimum of eight months is now required to qualify an officer as an entry level test pilot. This allows four months for training in Performance Flight Testing and four months in Stability and Control Flight Testing.

(3) Desired Number of Students:

(a) Proposed School resources are such that a maximum of two

classes of sixteen students each can be trained annually. To meet the anticipated requirements reflected in Section 2, it will be necessary to assign the maximum number of students to each class. Even if the actual requirements should fall below those anticipated, it is still desireable to fill each class to the maximum because of the selectivity it will afford. As in any school, there is a variance in the quality of the individual graduates. The critical nature, importance, and expense of experimental testing demands that only the best possible test pilots be assigned to this work. Graduating more students than the minimum requirement allows some selectivity in assigning students to ARDC. Any USAF graduates in excess of the ARDC requirement can be assigned to other Commands for use in such organizations as ADC's 4750th Test Squadron and for participation as Command representatives in Category II and III test programs. Past graduates thus assigned have made significant contributions to the Air Force effort.

(b) It is considered desireable to continue to train contractor pilots under the provisions of AFR 50-3. Maintaining a high level of flight testing capability among Air Force contractors is probably as important to the best interests of the Air Force as maintaining a high quality in-house testing capability. The contractor test pilot who is familiar with Air Force testing techniques and methods can contribute materially to the reduction of development costs and improvement of the delivered product. Alternatively, the contractor quota can be made available to the FAA from time to time. One FAA pilot recently graduated from the Test Pilot School, and another is scheduled to begin training in the latter part of 1960. It is probable that additional quotas will be requested by the FAA in the future, and it is considered to be in the national interest for the Air Force to provide this training when available.

(c) Due to the recent upward trend in the number of foreign students assigned for training, a firm quota of two foreign students per class, or four per year, is included in the estimate of graduate requirements. It is recommended that foreign student selection continue to be controlled by Hq USAF, and that, whenever possible, the foreign trainees meet the same entrance requirements established for USAF students.

(d) No significant changes in the procedures or criteria for application and selection of USAF students for the Experimental Test Pilot Course is considered necessary.

b. Space Research Pilot Course:

(1) Course Content:

(a) General: Academic and flying training of a highly specialized

nature, as well as physiological and general space technology orientation, will be necessary to adequately prepare pilots for participation in manned spacecraft programs. This training can be effectively conducted using the methods employed in the present Test Pilot School course; i.e., the student receives instruction in basic and applied space theory and instruction and demonstration of applicable space flight test techniques, plans and flys actual or simulated space flight tests under supervised conditions, reduces the flight test data, and writes a complete flight test report. This method of instruction provides the student with the basic knowledge he needs and also enables him to apply this knowledge to the practical job of acquiring and reporting flight test data.

(b) Flying Training: Manned spacecraft flight imposes a considerable requirement for flying training in addition to that presently provided. The performance of manned spacecraft will far exceed that of current operational aircraft. They will operate in environments, use methods of control, and exhibit stability characteristics which are vastly different from conventional aircraft. To cope with these new conditions, the space research pilot will need as much background experience and as much indoctrination in expected spacecraft characteristics and test methods as it is possible for him to acquire. The flying program outlined in Appendix C provides training in three essential areas:

1 Additional experience in planning and conducting a quantitative flight evaluation.

2 Additional experience in conducting qualitative evaluations of as many different kinds of aircraft representative of spacecraft as are available.

3 Extensive indoctrination and familiarization with manned spacecraft characteristics and test methods.

The latter area will, of course, receive primary emphasis; but the others are considered necessary to produce well-rounded, competent, space research pilots. Due to the lead time required for procurement of a space trainer such as a two place X-15, the first two Space Research Pilot Courses are not planned to include training in these vehicles. However, approximately eighty percent of the flying training deemed desireable will be possible with the aircraft expected to be available at the School for the proposed start of the first class in June 1961.

(c) Academic Training: The competence of a research or experimental test pilot is greatly dependent on his engineering knowledge. Ideally, he should be an authority in every field related to his vehicle, which for a manned spacecraft covers a large field of rather formidable subjects. Obviously, this

is neither possible nor practical; but he must be given a thorough indoctrination in the shortest possible time on the subjects related to vehicles he may be expected to test. This indoctrination will cover such general subjects as propulsion, orbital mechanics, trajectories, aerodynamic heating, stability and control, astronomy, hypersonic aerodynamics, and meteorology. To properly approach such subjects, even on an indoctrination basis, it is first necessary to develop some fundamental principles and concepts. For this reason, the academic portion of the course is divided into two parts, one dealing with basic fundamentals and the other with applied theory. Included in the applied theory will be its application to the specific flying training missions outlined in Appendix C. Appendix D is an outline of the academic portion of the proposed course. It includes the academic subjects, a brief on the scope of presentation, and the estimated number of classroom hours required to cover each.

(d) Flight Test Program Planning: The success of a flight test program is largely dependent on how well it is planned and organized. Major emphasis is given to planning in the training program. Approximately 100 hours of student time is devoted to instruction and actual practice in planning flight test programs. This includes determining the test requirements as dictated by applicable specifications, laying out the test program to satisfy these requirements with maximum efficiency, and coordinating with the various facilities (instrumentation, data reduction, maintenance, etc.) whose support is required in conducting the program.

(e) Seminars and Field Trips: In addition to the technical knowledge of how to plan and conduct a flight test program, it is essential that the students know and understand the organization and functions of the various agencies both military and civilian, charged with the responsibilities of testing space research and weapon systems. As project officers in space research or test programs they will be required to coordinate with numerous agencies concerned with the projects, such as the contractor, the Weapons System Project Office, the Test Force, Flight Test Engineering, etc. The efficiency with which they plan, manage, and conduct their portion of a program is dependent on an understanding of the capabilities and responsibilities of all agencies associated with the program. A series of seminars and field trips will be used to provide the students with this understanding and also to provide general technological orientation and to keep them abreast of latest developments in the field. Examples of seminar subjects and facility visits included as a part of the course curriculum are included in Appendix B. The seminars are conducted weekly by authorities in each specific area of interest. Two weeks during each course are used for facility visits. The location of the School is ideal for facility visits inasmuch as numerous representative facilities are located right at Edwards AFB and many others are concentrated in the Southern California area.

(2) Course Length: The proposed course length for the initial two Space Research Pilot Courses is twenty-four weeks. Of this time, four weeks will be required for

medical and physiological screening and pressure suit fitting and checkout. Two weeks are planned for field trips, with the remaining eighteen weeks being devoted to the flying and academic programs previously outlined. Appendix E is a breakdown of the approximate number of hours required for coverage of the planned program. This breakdown does not include outside study time as this varies considerably with the individual. A good rule of thumb, however, is to allow two hours of outside study for each hour of academic classroom material presented. It is estimated that an additional six weeks will be required when the space trainer is included in the program; three weeks for instruction in the trainer systems, precheckout simulator practice and flight program planning, and three weeks to fly the missions and prepare the flight test reports. This additional time is included in the course programmed to start in January 1963.

(3) Desired Number of Students:

(a) The fact that some pilots, by virtue of training, experience, ability, and temperament, make better test pilots than others is well known. A rigid selection process has been used in the past to insure that only those best qualified are used to fill the most critical test pilot positions. The continued application of rigid selection criteria will be even more important for pilots assigned to manned spacecraft programs. Pilots selected to attend the Space Research Pilot Course will be graduates of the Experimental Test Pilot Course. Their potential test pilot ability will have been closely evaluated, and only the most promising will be retained for the advanced training. However, even this extreme selection cannot guarantee that all those retained will prove to be capable of coping with the complexity and vast departures from conventional systems that will be encountered in space research programs. It is, therefore, considered desirable to continue to train slightly more pilots than will be required to satisfy expected requirements. The first two courses are planned for eight students each with the number being increased to ten students starting with the January 1963 course. While these numbers will exceed the expected requirements, there will be no additional facilities required to accommodated them; and the Air Force will be assured of having extremely well qualified pilots available for assignment to space research programs.

(b) Initially, the Space Research Pilot Course should train USAF officers only. At a later date, it may be desirable to include contractor pilots and/or officers from other services or foreign countries in this program.

4. AIRCRAFT REQUIREMENTS:

a. General. The primary criteria used in selecting the aircraft models recommended for inclusion in the School inventory was the capability of the aircraft for satisfying the specific training requirments of the School. For example, the aircraft used in the Space Research Pilot Course must be capable of performing or

demonstrating in-flight regimes characteristic of spacecraft if they are to be of any substantial value to the course. A secondary, but none-the-less important, consideration was the probable availability and retainability of the aircraft. Substitution of other aircraft models with similar capabilities or deletion of one particular model (with the possible exception of the F-104) should not seriously effect the flying training program. However, the quality and scope of the training program is obviously governed by the range of capability of the aircraft inventory. Additionally, the course must of necessity be designed around the particular aircraft that are available in the School inventory. Changes in the inventory require numerous changes in such details as engine charts, calibration curves, test techniques, data reduction methods, etc. These changes must be worked out in advance by the School staff and they obviously cannot be accomplished overnight. Several months time and a considerable amount of manpower, material, and expense are also required to instrument the aircraft. For the foregoing reasons, substitution, deletion, or frequent changes of models should be made only when absolutely necessary. The proposed aircraft inventory schedule for the Aerospace Research Pilot School is given in Appendix A. This schedule provides for:

(1) Continuation of the present Experimental Test Pilot Course on a basis of two classes per year through 1965.

(2) Conduct of one Space Research Pilot Course per year through 1965.

(3) Maintenance of the present helicopter flight test training capability.

(4) Revision of the flying programs to keep pace with new developments.

(5) Sufficient overlap of release and acquisition dates to permit orderly integration of new models into the training program.

The specific missions planned for each aircraft model are indicated in the flying training outlines in Appendixes B and C.

b. Aircraft Used in the Experimental Test Pilot Course:

(1) T-33: The six T-33's presently assigned provide the backbone of the Experimental Test Pilot Course. Because of their reliability and the familiarity of almost all pilots with the T-33, they are used to the maximum extent possible in both performance and stability. Approximately thirty percent of the student's training is accomplished in T-33's; and they provide the major portion of AFR 60-2 requirements for pilots assigned to the School. No additional T-33's can be used since all tests that can be accomplished in the T-33 are being flown in that aircraft. To maintain the total number of assigned aircraft as small as possible, two T-33's will be released when the four T-38's are assigned, leaving a total of four T-33's at the School through 1965.

(2) TF-102: Ordinarily the School prefers not to have one aircraft of a type because of the lack of flexibility. An exception has been made in the case of the TF-102 so that at least one delta wing airplane will be available for both performance and stability training. The TF-102 will be used primarily for tests where flying characteristics differ markedly from those of aircraft with conventional wing and tail. As activity in the Space Research Pilot Course increases, it is planned to replace the TF-102 with an additional F-104. The increased flexibility this will afford will be more important at that time than retention of the delta wing capability.

(3) T-28: The use of obsolete T-28's for training test pilots has in the past been questioned by individuals unfamiliar with test pilot training. Actually, the T-28 is an excellent airplane for teaching fundamentals of instrument calibration and performance testing. It gives the student an opportunity to master basic techniques before attempting more exacting tests in higher performance aircraft. The high in-commission rate and low operating costs of the T-28 have resulted, over the past eight years, in more test pilot training per Air Force dollar than any other type of aircraft in the School inventory. The T-28's will be phased out of the USAF inventory in the near future, and the reciprocating engine performance flight training formerly given in these aircraft will be accomplished in U-3A's. The training given in T-28's which does not specifically require a reciprocating engine aircraft will be given in T-38's. To avoid interrupting the training cycle, the T-28's should be retained until the T-38's and U-3A's are delivered to the School.

(4) T-38: The T-38 adds considerable flexibility to the training program. Its flight envelope makes it suitable for almost all tests flown in the Performance Phase of the Experimental Test Pilot Course and extends the performance evaluation into the supersonic speed range. All of the training presently given in T-28's, with the exception of reciprocating engine performance, will be given in T-38's.

(5) B-57: The three B-57's are used entirely for training in stability and control testing. They are particularly well suited for asymmetric power, but are used for stalls, aircraft dynamics, and several stability and control tests as well. They are equipped with the most modern, complete, and flexible instrumentation installation of any aircraft assigned to the School; and they are relied on heavily. It would be desirable to have two additional multi-engine aircraft; but in order to hold the number of assigned aircraft to the lowest possible total, the B-57's are given priority maintenance consideration, and thereby fulfill School requirements for this type. The B-57's will be required through 1965.

(6) F-104B and C: The two F-104's will be used exclusively for the Space Research Pilot Course while the course is being given. Between Space Research Pilot Courses, the available F-104 time will be divided approximately equally between performance and stability phases of the Experimental Flight Test Pilot Course. Flight training in specific energy flight test techniques will be possible with the F-104's, where formerly this relatively new concept in flight testing could only be discussed in the classroom.

(7) F-86: The two remaining F-86's assigned to the School will be phased out of the USAF aircraft inventory as soon as replacement aircraft are delivered to the School. With the exception of spin testing, the training given in these aircraft will be accomplished in the F-104's and T-38's.

(8) H-43: Prior to the start of Class 60-B in April 1960, the School curriculum did not include flight training in helicopter testing. Because Class 60-B is composed primarily of Army pilots, a strong capability in both the academic and flight phases of helicopter training has been established. It is desirable that this capability be retained after the termination of the Army class. In the first place, a continuing capability in this area would provide for high quality instruction of helicopter pilots assigned as students in the future. Secondly, it is desirable for all students who will be future test pilots to have a limited orientation in helicopter testing techniques. The training will be particularly beneficial to pilots who will later be working with V/STOL aircraft test programs. The H-43 was not selected for its suitability as a training helicopter. Instead, most consideration in the choice was given to maintenance problems. Maintainability is extremely important when only one aircraft of a type is assigned; and indications are that the H-43 will be the primary USAF helicopter for the next few years.

(9) U-3A: The U-3A was selected as a replacement for the T-28 primarily for reasons of economy. Maintenance and operating costs are considerably less than those for a T-29, for example. The U-3A, like the T-28, can be used for teaching fundamentals before progressing into more difficult tests in higher performance aircraft.

c. Aircraft Used in the Space Research Pilot Course:

(1) F-104B and C: The F-104 aircraft are the "workhorses" of the proposed flying training program. In fact, without the F-104's or aircraft with nearly identical performance there can be no Space Research Pilot Course. Approximately twenty-one hours of demonstration and flight test time per student are planned for this aircraft. Its performance envelope and aerodynamic characteristics make possible simulation of a wider range of spacecraft operations than can be accomplished with any other currently operational aircraft. The aerodynamic characteristics, in particular, are uniquely representative of lifting re-entry vehicles in their normal landing configurations. Lift-drag ratios from approximately 2.0 to 5.0 can be maintained by merely varying the aircraft configurations; i.e., clean, speed brakes, or gear and flaps. This range affords close simulation of the approach and landing characteristics of all currently planned investigations of zero "g" and the energy management considerations that will be encountered in re-entry vehicles. The performance capability of the aircraft facilitates limited investigations of zero "g" and the energy management considerations that will be encountered in re-entry vehicles. Zero "g" conditions can be maintained for periods of approximately one minute.

Energy management problems can be evaluated over a range of altitude and speed combinations in excess of 80,000 feet and Mach 2.0. A relatively minor modification of one F-104 aircraft will provide a limited capability for indoctrination in and evaluation of reaction controls and vehicle attitude control for re-entry. The NASA facility at Edwards has modified an F-104A to provide 3-axis reaction control and is currently performing flight evaluations of the system. The performance capability of the aircraft enables operation for approximately one minute in a flight regime where greater than 90% of the aircraft attitude control is provided by the reaction controls. Cost of this modification is between 50 and 80 thousand dollars, depending on system sophistication.

(2) T-38: By instrumenting one of the four T-38 aircraft for stability and control measurements, each student in the Space Research Pilot Course can be afforded the opportunity to plan and fly a complete stability test program. This will enable them to refine their flight test techniques and provide additional experience in planning and flying a flight test program. Even though the students will have flown this aircraft in the performance phase of the Experimental Test Pilot Course, they will not have conducted any prior stability investigations on the aircraft. The performance envelope of the T-38, while not comparable to that of the F-104, is adequate for providing the additional experience and practice that is considered desirable in this area.

(3) Variable Stability Aircraft: The training possible with a variable stability aircraft is beneficial in two specific ways: First, the stability characteristics of spacecraft during launch and re-entry phases of operation as well as their operation in the atmosphere can be easily and safely demonstrated. Second, a wide range of stability and general handling qualities can be easily provided for the student to evaluate. Each different combination of stability characteristics the student encounters provides essentially the same experience he would get from evaluating a new or different vehicle. Since the capability of a test pilot to analyze and evaluate, particularly from a qualitative viewpoint, the acceptability of a vehicle's level of stability and its control system is greatly dependent on his experience with a wide variety of aircraft, the training possible with this vehicle will be invaluable.

(4) Space Trainer: Manned spacecraft flight will involve numerous pilot functions not encountered in conventional aircraft, but with which the pilot must be thoroughly familiar if maximum return from spacecraft test missions is to be assured. Among these functions are:

(a) Vehicle control during launch and boost operation characterized by low normal acceleration and high longitudinal acceleration.

(b) Vehicle control in the space environment at zero "g" using ballistic controls.

(c) Energy managment through flight profile control to achieve desired altitude, speed, and range combinations.

(d) Re-entry attitude control and transition from ballistic to aerodynamic control.

(e) Power-off low L/D landing.

Simulation of a limited portion of these functions with presently operational or modified aircraft is possible, as indicated above in the discussion of the F-104 and variable stability aircraft. However, it is highly desirable to provide experience and training in these functions that are beyond the capability of operational or modified aircraft. While the cost of a training vehicle with near space flight capability, such as a two-place X-15 would be considerably greater than for any other aircraft previously used in test pilot training, the benefits derived from such a vehicle should more than compensate for this cost. A pilot with training and experience in the unique functions he will encounter in space flight will be capable of contributing substantially more to the conduct of a space research program than he would otherwise. When the cost of procuring and operating a space trainer is considered against the cost of a single space research mission, the relative value of the space trainer becomes more evident. If the training a pilot thus received assured just one additional successful mission per project, the space trainer would have more than paid for itself.

5. TRAINING CAPABILITIES:

a. There is no limit to the maximum training capability of the Test Pilot School, if adequate resources are made available. However, current available resources have been planned to support an absolute maximum of three classes per year of sixteen students each, utilizing the existing course format. With minor changes, these same resources can be applied to the annual training of two Experimental Test Pilot classes of up to sixteen students each, plus one class per year in the proposed Space Research Pilot Course.

b. A reduction in the number of students per class or the number of classes per year does not result in a proportional reduction in the required resources; and the training cost per student therefore rises rapidly as the number of students decreases. In view of this economic factor, and the anticipated requirements for graduates, it is considered desirable that the School be operated at or hear its maximum proposed training capability.

c. An obvious, but very important, factor affecting the training capability of the School is the competence of assigned instructor personnel. These instructors are responsible for both academic and flying training and, therefore, must be

highly proficient in both areas. With the broadened scope of material that will accompany the start of the proposed Space Research Pilot Course, an even more selective process than has been employed in the past must be used in choosing instructors. Initially, it will be necessary to select from existing personnel sources, and only a limited amount of specialized preparation can be afforded the instructor personnel. Future replacements, however, should be products of a well-organized selection and preparation process. Essential elements of this preparation should be a high level of formal education in astronautics and related fields and experience in experimental flight testing. The competence of the instructor personnel will not have much influence on the number of students that can be trained, but will strongly influence the quality of the graduates and, in turn, the capability of the course in achieving its intended objective.

6. SUMMARY OF IMPORTANT CONCLUSIONS:

a. A Space Research Pilot Course is needed to prepare pilots for participation in manned spacecraft testing.

b. Minor changes in the present resources of the Test Pilot School will permit establishment of a Space Research Pilot Course within the existing framework of the School.

c. Requirements for graduates of the Experimental Test Pilot Course (including ARDC requirements in AFSC 1344, foreign pilots, contractor pilots, etc.) can probably be satisfied by two classes per year of sixteen students each.

7. SUMMARY OF RECOMMENDATIONS: It is recommended that:

a. The name of the USAF Experimental Flight Test Pilot School be changed to "The USAF Aerospace Research Test Pilot School", in order to adequately reflect the dual training capability in aircraft testing and manned space vehicle testing.

b. A Space Research Pilot Course be established within the framework of the present Test Pilot School, each class to consist of six to eight carefully selected USAF officers.

c. The Experimental Test Pilot Course be continued, utilizing the present format, but the number of classes be reduced to approximately two per year of sixteen students each.

d. Limited training quotas for contractor and FAA pilots continue to be provided in the Experimental Test Pilot Course as required.

e. Quotas for the training of four foreign students per year in the Experimental Test Pilot Course be provided.

f. USAF graduates of the Experimental Test Pilot Sourse in excess of ARDC requirements be assigned to other Commands for duty in maintenance flight test, operational evaluation, and Command participation teams in Category II-III testing.

g. The proposed aircraft inventory schedule be supported so that proposed class starting dates can be met.

REFERENCES:

a. Hq USAF letter(AFPMP-1-C-2c) dated 13 Nov 59, Subject: "Training Requirements in AFSC 8744", with ARDC indorsement.

b. Hq USAF letter (AFPMP-11) dated 13 Nov 59, Subject: "USAF Experimental Flight Test Pilot School", with ARDC indorsement.

c. Hq ARDC letter (RDPTS-1) dated 18 May 60, Subject: "Program for USAF Experimental Flight Test Pilot School".

d. "Future Requirements for Test Pilot Training: 1960-1965", a study prepared by the USAF Experimental Flight Test Pilot School dated 29 Dec 59.

e. "Test Pilot School Aircraft Inventory Requirements: 1960-1965", a study prepared by the staff of the USAF Experimental Flight Test Pilot School dated 10 Jun 60.

f. AFR 53-19, "USAF Flight Test School" dated 9 June 1955.

g. USAF Training Prospectus, Page 0-86-2/3, "USAF Flight Test School".

APPENDIX A

AIRCRAFT SCHEDULE

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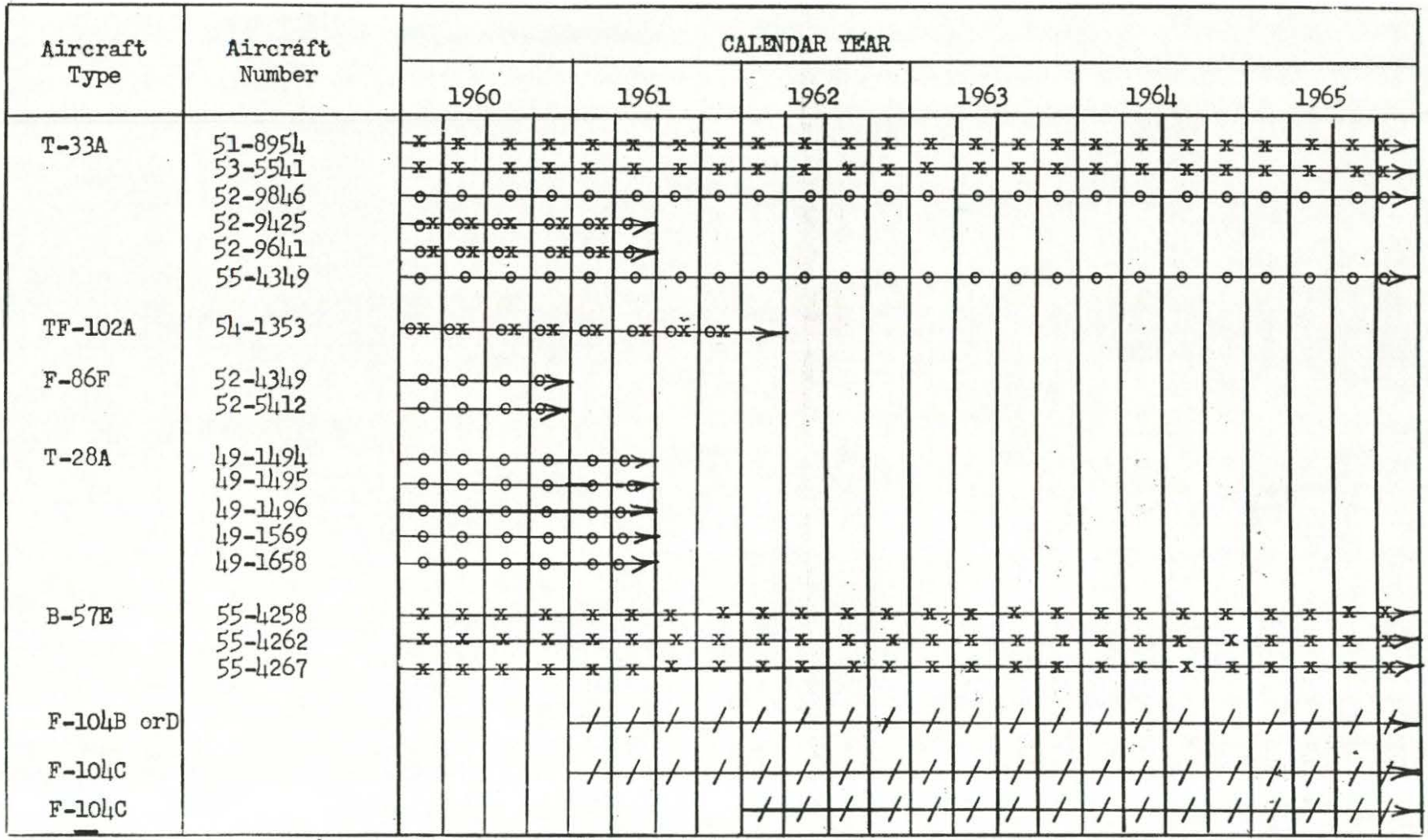
AIRCRAFT SCHEDULE



Legend:		
	o o o o	Primarily Performance
	x x x x	Primarily Stability
	/ / / /	Primarily Space
	x o x o	Multiple Purpose

APPENDIX A

AIRCRAFT SCHEDULE

Aircraft Type	Aircraft Number	Calendar Year																							
		1960				1961				1962				1963				1964				1965			
T-38	59-1594					o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	58-1197						o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	58-1195							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	58-1194								o/	o/	o/	o/	o/	o/	o/	o/	o/	o/	o/	o/	o/	o/	o/	o/	o
H-43B	Unknown					ox	ox	ox	ox	ox	ox	ox	ox	ox	ox	ox	ox	ox	ox	ox	ox	ox	ox	ox	o
U-3A	Unknown							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Unknown							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Space Trainer*	(X-15)									/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Space Trainer*	(X-15)									/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Total		17	17	17	17	19	21	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17

*The number of space trainers required is based on the assumption that each trainer can be flown nine times during each class to provide a class of six students with three training flights each. Space trainers are not included in aircraft totals.

APPENDIX B

COURSE OUTLINE AND AIRCRAFT REQUIREMENTS

FOR

USAF EXPERIMENTAL TEST PILOT COURSE

APPENDIX B

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APPENDIX B

AIRCRAFT UTILIZATION DATA

IN COMMISSION RATE:

AIRCRAFT TYPE	IN COMMISSION RATE
T-33(1)	66%
B-57(1)	41%
TF-102(1)	42%
T-38(2)	50%
F-104(2)	50%
H-43(2)	60%
U-3A(2)	75%

MONTHLY FLYING TIME AVAILABLE FROM EACH TYPE OF AIRCRAFT

TYPE	TIME PER DAY(3)	TIME PER MONTH(4) PER AIRCRAFT (100% in Comm)	ACTUAL TIME(5) PER AIRCRAFT PER MONTH
T-33	4:00	64:00	42:00
B-57	2:30	40:00	16:30
TF-102	2:30	40:00	17:00
T-38	2:30	40:00	20:00
F-104	2:30	40:00	20:00
H-43	2:30	40:00	24:00
U-3A	4:30	72:00	54:00

Notes:

(1) In commission rate based on School maintenance records.

(2) In commission rate based on best available information and estimates.

(3) Maximum time which can be flown daily as determined by academic schedule.

(4) Based on sixteen flying days per month. Field trips, weather, etc., limit flying to approximately this number of days per month.

(5) Time available from each aircraft per month after all factors have been considered.

APPENDIX B

AIRCRAFT AND FLYING TIME REQUIREMENTS*

TYPE OF AIRCRAFT	NUMBER AIRCRAFT REQUIRED	FLYING TIME REQUIRED EACH FOUR MONTHS
T-33	4	680:40
B-57	3	201:20
T-38	4	312:00
TF-102	1	80:00
F-104	2**	168:00
H-43	1	92:00
U-3A	2	444:50

*Aircraft and flying time requirements were computed for the case where a Performance and Stability Phase of the Experimental Test Pilot Course occur simultaneously. This combination generates the largest requirement for both aircraft and flying time.

**One of the F-104's must be either an F-104B or F-104D and the other an F-104C. A two place F-104 is required for dual instruction; and the F-104C is required for maximum performance in speed and altitude.

APPENDIX B

BREAKDOWN OF T-33 FLYING HOUR REQUIREMENTS

PHASE	TYPE OF FLIGHT	HOURS PER STUDENT	TOTALS
Performance	Checkout	1:00	
	Tower Flyby	1:00	
	Level Acceleration	5:00	
	W/δ	5:00	
	Check Climb	1:00	
	Special Projects	0:35	
	Repeated Flights	1:00	
	60-2	5:00	
	Time required/student this phase	19:35	
	Students (16) X Time per student		313:20
Stability	Longitudinal Stability	4:45	
	Sideslips	1:50	
	Spins	1:45	
	Attitude Flying Techniques	1:30	
	Special Projects	1:30	
	Repeated Flights	1:00	
	60-2	5:00	
	Pilot Rating Scales	1:00	
	Time required/student this phase	17:20	
	Students (16) X Time per student		277:20
Instructor 60-2, etc.	Instructors (9) X 10:00	90:00	90:00
	Total T-33 time required each month		680:40

NUMBER OF T-33 AIRCRAFT REQUIRED

Number of aircraft required equals $\frac{\text{Total time required each four months}}{\text{4 X time available/Aircraft per month}}$

equals $\frac{680}{4 \times (42)}$ equals 4.05 equals 4

APPENDIX B

BREAKDOWN OF B-57 FLYING HOUR REQUIREMENTS

PHASE	TYPE OF FLIGHT	HOURS PER STUDENT	TOTALS
Stability	Trim Changes	1:00	
	Asymmetric Power	1:45	
	Dynamics	1:30	
	Qualitative Flights	0:20	
	Special Projects	0:45	
	Stalls	4:00	
	Repeated Flights	1:00	
	Time required/student this phase	10:20	
	Students (16) X time per student		165:20
Instructors 60-2, etc	Instructors (9) X 4:00		36:00
	Total B-57 time required each four months		**201:20**

NUMBER OF B-57 AIRCRAFT REQUIRED

Number of aircraft required equals $\frac{\text{Total time required each four months}}{4 \text{ X time available/Aircraft per month}}$

equals $\frac{201}{4 \text{ X } (16.5)}$ equals 3.04 equals 3

APPENDIX B

BREAKDOWN OF TF-102 FLYING HOUR REQUIREMENT

PHASE	TYPE OF FLIGHT	HOURS PER STUDENT	TOTAL
Performance	Turning Performance	1:30	
	Special Projects	0:35	
	Time required/student this phase	2:05	
	Students (16) X time per student		33:20
Stability	Qualitative Flights	0:40	
	Time required/student this phase	0:40	
	Students (16) X time per student		10:40
Instructors 60-2, etc.	Instructors (9) x 4:00		36:00
	Total TF-102 time required each four months		80:00

NUMBER OF TF-102 AIRCRAFT REQUIRED

Number of aircraft required equals $\frac{\text{Total time required each four months}}{\text{4 X time available/aircraft per month}}$

equals $\frac{80}{4 \text{ X } (17:00)}$ equals 1.18 equals 1

APPENDIX B

BREAKDOWN OF T-38 FLYING HOUR REQUIREMENT

PHASE	TYPE OF FLIGHT	HOURS PER STUDENT	TOTAL
Performance	Checkout	4:00	
	Pacer Test	2:00	
	Cruise Control	2:30	
	Takeoff and landing performance	2:00	
	Time required/student this phase	10:30	
	Students (16) X time per student		168:00
Stability	Maneuvering Flight	3:15	
	Aileron rolls	3:00	
	Special Projects	0:30	
	Time required/student this phase	6:45	
	Students (16) X time per student		108:00
Instructors 60-2, etc.	Instructors (9) X 4:00		36:00
	Total T-38 time required each four months		312:00

NUMBER OF T-38 AIRCRAFT REQUIRED

Number of aircraft required equals $\frac{\text{Total time required each four months}}{\text{4 X time available/aircraft per month}}$

equals $\frac{312}{4 \times (20)}$ equals 3.9 equals 4

APPENDIX B

BREAKDOWN OF F-104 FLYING HOUR REQUIREMENT

PHASE	TYPE OF FLIGHT	HOURS PER STUDENT	TOTAL
Performance	Specific energy flight testing	5:00	
	Time required/student this phase	5:00	
	Students (16) X time per student		80:00
Stability	Longitudinal stability	1:30	
	Maneuvering flight	1:30	
	Dynamics	1:30	
	Time required/student this phase	4:30	
	Students (16) X time per student		72:00
Instructors 60-2, etc.	Instructors (4) X 4:00		16:00
	Total F-104 time required each four months		168:00

NUMBER OF F-104 AIRCRAFT REQUIRED

$$\text{Number of aircraft required equals } \frac{\text{Total time required each four months}}{\text{4 X time available/aircraft per month}}$$

$$\text{equals } \frac{168}{4 \times (20)} \text{ equals } 2.1 \text{ equals } 2$$

APPENDIX B

BREAKDOWN OF U-3A FLYING HOUR REQUIREMENTS

PHASE	TYPE OF FLIGHT	HOURS PER STUDENT	TOTAL
Performance	Checkout	2:00	
	Low altitude speed course	2:00	
	Check climb (Recip)	1:00	
	Sawtooth Climb (Recip)	5:00	
	Speed power (Recip)	5:00	
	60-2	4:10	
	Time required/student this phase	19:10	
	Students (16) X time per student		306:40
Stability	Qualitative flights	1:00	
	60-2	4:10	
	Time required/student this phase	5:10	
	Students (16) X time per student		82:40
Instructor 60-2, etc.	Instructors (9) X 6:10		55:30
	Total U-3A time required each four months		444:50

NUMBER OF U-3A AIRCRAFT REQUIRED

Number of aircraft required equals $\frac{\text{Total time required each four months}}{\text{4 X time available/aircraft per month}}$

$$\text{equals } \frac{445}{4 \times (54)} \text{ equals } 2.06 \text{ equals } 2$$

APPENDIX B

BREAKDOWN OF H-43 FLYING HOUR REQUIREMENT

PHASE	TYPE OF FLYING	HOURS PER STUDENT	TOTAL
Performance	Hovering performance	1:00	
	Takeoff and landing performance	1:00	
	Time required/student this phase	2:00	
	Students (16) X time per student		32:00
Stability	Static stability	1:00	
	Dynamic stability	1:00	
	Control stability	1:00	
	Time required/student this phase	3:00	
	Students (16) X time per student		48:00
Instructors	Instructors (3) X 4:00		12:00
	Total H-43 time required each four months		92:00

NUMBER OF H-43 AIRCRAFT REQUIRED

Number of aircraft required equals $\frac{92}{4 \times (24)}$ equals 0.96 equals 1

APPENDIX B

EXPERIMENTAL TEST PILOT COURSE
FLYING TRAINING PROGRAM
PERFORMANCE PHASE 16 WEEKS

Aircraft Type	Mission	Training Objective	No. of Flts	No. of Hrs	Non-Standard Instrumentation
H-43, T-38, T-33 F-86, T-28, U-3A	Calibration Testing	Training & Experience in Calibration Testing of Instruments & Airborne Equipment	5	5:00	Performance Cockpit Instrumentation
T-38, T-33, T-28 H-43, F-104B	Climb Perf. Testing	Training & Experience in Conducting Climb Performance Tests	9	9:00	Performance Cockpit Instrumentation & Photo Panel
T-28, T-33, T-38 F-86, TF-102, F-104B, H-43	Level Flight Performance	Training & Experience in Level Flight Performance Testing	12	17:30	Performance Cockpit Instrumentation & Photo Panel
TF-102, T-38, T-33 F-104B	Turning Performance	Training & Experience in Turning Performance Testing	2	1:30	Performance Cockpit Instrumentation
F-104B	Specific Energy Flight Testing	Experience in Using Specific Energy Flight Testing Techniques	7	5:00	Performance Cockpit Instrumentation & Photo Panel
T-38, T-33, T-28	Transition & Rechecks	Accomplish Required Rechecks	7*	7*	None
Various Aircraft	Special Project	To Give Pilot Experience in Planning and Executing a Test Program	2	1:10	Varied Depending on Project

*NOTE: This will be the minimum number of flights. If initial checkouts are required, this number will be much higher.

APPENDIX B

EXPERIMENTAL TEST PILOT COURSE
FLYING TRAINING PROGRAM
STABILITY PHASE 16 WEEKS

Aircraft Type	Mission	Training Objective	No. of Flts	No. of Hrs	Non-Standard Instrumentation
B-57E, F-104	Stalls	Training & Experience in the Various Tests Required to Investigate the Stability & Control Qualities of an Aircraft	3	4:00	Photopanel & Oscillograph
T-33	Longitudinal Static Stability		5	6:15	Photopanel
T-33, B-57E	Maneuvering Flight		4	4:45	Photopanel
T-33	Sideslips (Static Directional Stability)		2	1:50	Photopanel
T-33, B-57E	Aileron Rolls		2	3:00	Photopanel & Oscillograph
B-57E	Asymmetric Power		1	1:45	Photopanel
B-57, F-104, TF-102	Dynamics		2	3:00	Oscillograph
B-57, T-33, TF-102	Trim Changes		1	1:00	Photopanel & Oscillograph
T-28, T-33 F-86	Spins		2	1:45	None
T-33	Attitude Flying Pilot Rating Scales		1 1	1:30 1:00	None
Varied	Qualitative Flight Testing		2	2:00	None
Varied	Special Project		2	1:45	Varied depending on project

APPENDIX B

EXPERIMENTAL TEST PILOT COURSE
ACADEMIC PROGRAM

PERFORMANCE PHASE
(Sixteen Weeks)

A. Theory:

1.	Calculus Review	12 hours
2.	Slide Rule Review	2
3.	Physics Review	2
4.	Atmosphere & Pressure Instruments	4
5.	Basic Aeordynamics	10
6.	Drag Aerodynamics	12
7.	Takeoff & Landing Performance	4
8.	Climb Performance	2
9.	Engines	11
10.	Supersonic & Transonic Aerodynamics	20
11.	Energy concepts of Flight Testing	6

B. Flight Test Techniques and Data Reduction:

1.	Calibration Testing	11
2.	Climb Performance Testing	6
3.	Level Flight Performance Testing	6
4.	Turning Performance	2
5.	Special Project	2
6.	Specific Energy Flight Testing	6

C. Miscellaneous:

1.	Examinations	20
2.	Report Writing	2
	Total	140 hours

D. Data Reduction & Report Writing:

1.	Data Reduction	35 hours
2.	Report Writing	70
	Total	105 hours

STABILITY PHASE
(Sixteen Weeks)

A. Theory:

1.	Aerodynamics Review	3 hours
2.	Static Longitudinal Stability	20
3.	Maneuvering Flight	6
4.	Static Lateral-Directional Stability	9
5.	Dynamic Stability	12
6.	High Speed Stability	8
7.	Aircraft Control Systems	8

B. Flight Test Techniques and Data Reduction:

1.	Stalls	4
2.	Longitudinal Stability	4
3.	Maneuvering Flight	4
4.	Sideslips	2
5.	Aileron Rolls	2
6.	Dynamics	4
7.	Trim Changes	3
8.	Spins	2
9.	Qualitative Flight Testing	6

C. Miscellaneous:

1.	Examinations & Exam Critiques	33
2.	Special Project Briefings	1
3.	Report Writing	2
4.	Instrumentation	3
	Total	136 hours

D. Data Reduction & Report Writing:

1.	Data Reduction	43 hours
2.	Report Writing	80
	Total	123 hours

APPENDIX B

SEMINARS
EXPERIMENTAL TEST PILOT COURSE

Category Concept of Flight Testing
Joint Test Forces
AFFTC Flight Test Directorate
Preparation of Pilot's Handbooks
Pilot's Handbook Conferences
Federal Aviation Agency Flight Test Programs
Naval Ordnance Test Center
Source Selection Boards
AFFTC Space Positioning Facility
Functions of Flight Research Computer Facility
Flight Research - Human Factors
Organization and Function of ARDC Centers

The above seminars are conducted for each class in the Experimental Test Pilot Course. In addition, seminars of timely interest reporting progress or results of specific test programs are conducted as appropriate. The latter area comprises approximately fifty percent of the seminar program.

APPENDIX B

AIRCRAFT INSTRUMENTATION REQUIREMENTS

1. Performance Cockpit Instrumentation: All performance aircraft require the following calibrated instruments in the cockpit:

   a. Airspeed Indicator
   b. Altimeter
   c. Accelerometer
   d. Fuel Counter
   e. Tachometer
   f. Clock
   g. Free Air Temperature

2. Performance Photo Panel: Performance aircraft equipped with a photopanel must be instrumented so that the following parameters can be photographically recorded as desired:

   a. Airspeed
   b. Altitude
   c. Load factor (accelerometer)
   d. Fuel Count
   e. Time
   f. Free Air Temperature
   g. Camera Counter

3. Stability Photopanel: The photopanel for complete stability and control measurements contains the following calibrated instruments.

   a. Airspeed
   b. Altitude
   c. Control Forces (aileron, stick and rudder)
   d. Control Positions (aileron, elevator and rudder)
   e. Rate of Roll
   f. Attitude indication
   g. Sideslip
   h. Angle of attack
   i. All of the instruments contained in the performance photopanel.

4. Stability Oscillograph: Stability and control aircraft equipped with an oscillograph must be instrumented for recording the following parameters:

   a. Airspeed
   b. Control Forces (aileron, stick and rudder)
   c. Control Positions (aileron, elevator and rudder)

d. Rates of roll, pitch and yaw
e. Sideslip
f. Angle of attack
g. Pitch angle
h. Bank angle
i. Load Factor

APPENDIX C

SPACE RESEARCH PILOT COURSE

FLYING TRAINING PROGRAM

APPENDIX C

SPACE RESEARCH PILOT COURSE
FLYING TRAINING PROGRAM

A/C TYPE	MISSION	TRAINING OBJECTIVE	NO. OF FLTS	NO. OF HRS	NON-STANDARD INSTRUMENTATION	SPECIAL SUPPORT OR SPECIAL MODIFICATIONS
T-38	Stability & Control Investigation	Provide Experience in Planning & Conducting a Flight Evaluation	10	10	Complete Stability	None
F-104	Zero "g" Flight	Familiarization with zero "g" & training in profile control to obtain maximum aircraft performance	4	4	Sensitive Normal & Longitudinal Accelerometers	None
F-104	Simulated Power-Off Low L/D Landings	Checkout & practice in making power-off low L/D landings characteristic of lifting re-entry vehicles	4	4	None	None
F-104	Same	Evaluation of various recovery & approach techniques for lifting re-entry type vehicles	6	6	None	Askania Space Positioning Coverage
F-104	Performance Evaluations & Energy Management	Planning & Flying Flight profiles & trajectories to obtain desired combinations of altitude, speed, & range	6	4	Sensitive 3-axis attitude indication. Angle of attack sensor. Complete performance	Askania Space Positioning Coverage
F-104	Raction Control Investigation	Training in attitude control with reaction controls & evaluation of various response rates & control powers	4	3	None	Aircraft Modified with Reaction Controls

APPENDIX C

SPACE RESEARCH PILOT COURSE
FLYING TRAINING PROGRAM

A/C TYPE	MISSION	TRAINING OBJECTIVE	NO. OF FLTS	NO. OF HRS	NON-STANDARD INSTRUMENTATION	SPECIAL SUPPORT OR SPECIAL MODIFICATIONS
Varied	Qualitative Evaluations	Qualitatively evaluating various high performance aircraft to broaden experience & knowledge of qualitative evaluation techniques & procedures	4-6	4-6	None	None
Variable Stability	Stability & Control Investigation	Evaluation of the peculiar stability characteristics associated with portions of spacecraft flight profiles	3	4	None	Requires Special Aircraft
Space Trainer 2-Place X-15	Check-out	Check-out & evaluation of performance & stability & control characteristics at medium altitudes & Mach numbers.	1	1/3 (excluding captive time)	None	Requires availability of space trainer & mother ship
Same	Profiles	Maximum altitude, range & speed profiles to acquaint pilot with the numerous funtions & test methods peculiar to space flight	2	3/4	None	High Range & Askania Coverage

APPENDIX D

SPACE RESEARCH PILOT COURSE

ACADEMIC PROGRAM,

SEMINARS, AND FIELD TRIPS

APPENDIX D

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APPENDIX D

SPACE RESEARCH PILOT COURSE
ACADEMIC PROGRAM
18 WEEKS

GENERAL THEORY

SUBJECT	HOURS
Newtonian Mechanics **	6
Thermodynamics **	4
Fluid Mechanics **	2
Boundary Layer Theory **	2
High Speed Aerodynamics **	6
Aerodynamic Heating	4
Heat Transfer	4
Dynamics of Rarified Gases	2
Relativistic Effects	2
Differential Equations & Vector Analysis	6
Total	38

APPLIED THEORY

SUBJECT	HOURS
Physics of the Upper Atmosphere	2
Propulsion Systems **	10
Orbital Mechanics	18
Stability & Control **	12
Vehicle Performance	8
Vehicle Systems	4
Man in Space	6
Instrumentation	6
Astronomy	4
Navigations and Communication	10
Meterology	2
Computers	8
Total	90

** Partially covered in Experimental Test Pilot Course

SPACE RESEARCH PILOT COURSE
BRIEF ON SCOPE OF ACADEMIC MATERIAL

GENERAL THEORY:

a. Newtonian Mechanics

A brief review of Newton's Laws for bodies traveling along linear and curvilinear paths.

b. Thermodynamics

A basic review of the concepts of thermodynamics including the first and second law of thermodynamics.

c. Fluid Mechanics

Introduction to the mechanics of compressible fluids as related to high speed aerodynamics.

d. Boundary Layer Theory

Introduction to the behavior of a viscous fluid flowing past a surface; includes a study of laminar and turbulent flow at high as well as low speeds.

e. High Speed Aerodynamics

An introduction to shock and expansion theory in two and three dimensions. Applications to supersonic and hypersonic aerodynamics will be discussed along with some considerations of the gas dynamics and aerodynamic heating.

f. Heat Transfer

A review of the basic laws of heat conduction, convection and radiation with specific applications to the transfer of heat away from high speed vehicles.

g. Dynamics of Rarified Gasses

An introduction to the kinetic theory of gasses as related to the creation of aerodynamic lift and drag at high speeds and altitudes. Attention will be directed toward the slip flow region which separates pure kinetic theory and conventional aerodynamics.

h. Theory of Relativity

A brief introduction to the general and special theories of relativity.

APPLIED THEORY

a. Physics of the Upper Atmosphere

Deals with the various layers of the upper atmosphere, their composition and the phenomena that occur there.

b. Propulsion Systems

A study of chemical and nuclear rockets as well as the ion and plasma rockets. Staging will be discussed with respect to both rocket and airbreathing boosters.

c. Orbital Mechanics

An introduction to trajectories and orbits of vehicles in suborbital, orbital and free space flight. Special applications relative to space navigation and guidance requirements will be considered.

d. Stability and Control

A study of the stability and control of vehicle and booster during launch and of the vehicle alone during space operations and re-entry. Special attention will be given to the dynamics of the vehicle and to special non-conventional controls.

e. Vehicle Performance

Study of new performance methods necessary for re-entry shapes with reference to lift-drag ratio and range calculation.

f. Vehicle Systems

A general survey of the systems required in the space environment such as control systems, stability augmentation systems, auxilliary power, etc.

g. Man in Space

A study of the space environment with reference to equipment necessary for the sustenance of a man for short duration and extended space flights. To include such subjects as the ecology of space flight, regenerative cycles (opened and closed), acceleration and weightlessness, personal equipment as well as the psychological aspects of manned space flight.

h. Instrumentation

The study of instruments as related to both pilot presentation and test systems. To include subjects such as gyroscopic theory, stable platforms, and star tracking devices.

i. Navigation and Communication

Covers the subject of space communication not only with reference to voice communication but also with respect to electronic navigational aids. Will

weigh the merits of radio and inertia guidance for various missions.

j. Computers

The fundamental principles of both analog and digital computers will be discussed along with specific applications of each to airborne and fixed base installations.

k. Astronomy

An introductory study of the stars and solar system with particular reference to navigational applications.

l. Meteorology

A brief introduction to the study of weather and the atmosphere.

MATHEMATICS

a. Basic Calculus Review

Covers the fundamentals of differential and integral calculus. (This is a part of the present School curriculum).

b. Differential Equations

An introduction to the fundamentals of setting up and solving certain types of differential equations which will be used in various parts of the course. (Vehicle dynamics, thermodynamics, fluid mechanics, etc.).

c. Vector Analysis

A presentation of basic principles of vector analysis as required for the study of orbital mechanics.

APPENDIX D

SPACE RESEARCH PILOT COURSE
BREAKDOWN OF STUDENT WORK LOAD EXCLUDING FLYING
18 WEEKS

FUNCTION	APPROXIMATE TOTAL HOURS	APPROXIMATE HOURS PER WEEK
Academic Lectures	125	7
Flight Test Technique Lectures	35	2
Flight Test Program Planning	100	6
Data Reduction and Report Writing	125	7
Seminars	35	2
Physical Training	75	4
Examinations and Exam Critiques	35	2
Totals	540	30

APPENDIX D

APPENDIX D

SEMINARS

SPACE RESEARCH PILOT COURSE

Weapons System Project Office
R & D Test Program Structure
ARDC System Management Organization
AMC System Management Organization
Procurement of Test Facilities
Functions of a System Project Office
Dynasoar Test Force
NASA Flight Research Programs
Functions and Organization of Ballistic Missile Division
Missile Static Test
AFFTC Technical Facilities Division
Wright Air Development Division
X-15 Research Program
Dynasoar Research Program
Project Mercury

Additional seminars of timely interest will be conducted as appropriate.

APPENDIX D

FIELD TRIPS

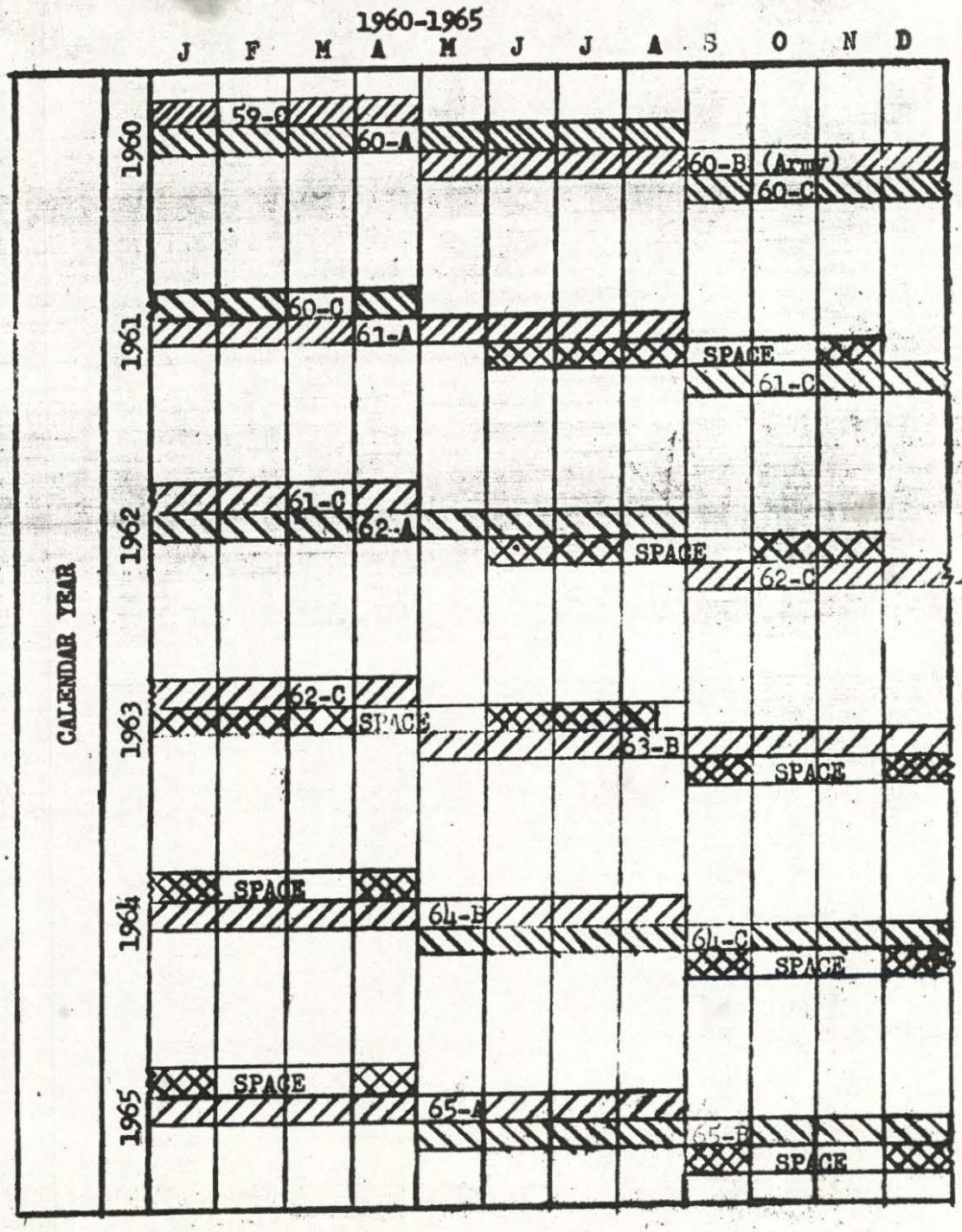
SPACE RESEARCH PILOT COURSE

Missile Static Test Site
Vandenberg Air Force Base
NASA High Speed Flight Station
X-15 High Range Control and Data Handling Facility
Contractor Research, Manufacturing, and Test Facilities
AFFTC Flight Test Engineering Division
NASA Space Task Force

APPENDIX E

PROPOSED SCHEDULE OF COURSES

APPENDIX E

USAF AEROSPACE RESEARCH TEST PILOT SCHOOL

Proposed Course Schedule