HEADQUARTERS
AIR FORCE FLIGHT TEST CENTER
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
EDWARDS AIR FORCE BASE, CALIFORNIA
93523

REPLY TO
ATTN OF: FTRA/Mr Schweikhard

10 NOV 1964

SUBJECT: Revised Aerospace Trainer QOR

TO: AFSC (SCMOL/Col Fite)
Wash DC 20331

Attached is the revised QOR for the Aerospace Trainer. This has been done in accordance with the letter from AFORQCT to AFSC dated 8 January 1964, and in response to AFSC's instructions to update this document on an annual basis. Renewed interest in this project has prompted its updating at this time.

for Col R.A. Gould Jr

IRVING L. BRANCH
Brigadier General, USAF
Commander

1 Atch
QOR

Copy to:
AFSC/SCL

TPS
T-27 Aerospace Training Simulator
1960s
in my file. !!
G

QUALITATIVE OPERATIONAL REQUIREMENT

FOR

AEROSPACE TRAINER

Revised

9 November 1964

INTRODUCTION

The mission of the USAF man in space is becoming more clearly defined each day. The MOL program is defining in detail the precise tasks and operations to be performed. Soon to follow will be long duration operational station and a lifting reentry vehicle to allow a routine recovery and landing on conventional runways. The USAF transition into the space era is requiring and will continue to require completely new research and operational space equipment. It follows therefore, that the need for space research pilots trained in the most modern equipment available will continue to be an essential part of the overall program.

Because of the extreme costs of modern systems and the close integration of the pilot into these systems, modifications are prohibitively expensive after the design has been frozen and fabrication has begun. Therefore, it is important the pilot's inputs be incorporated early in the design phase. The Air Force has no backlog of first hand pilot experience for space vehicles, similar to that which is available for aircraft, from which to draw and make decisions concerning the pilot's integration into the system. The problems associated with space vehicles are quite different from conventional aircraft so that a mere extension of aircraft technology and experience will not suffice. Thus, to insure that pilots with the proper training and experience necessary to qualify them to make a real contribution during the early design and development phase are available, it is essential that the training vehicles parallel if not lead the design and development of the space flight hardware.

Since the era of lifting reentry vehicles will soon be upon us it is necessary to consider what type of vehicle is necessary to provide this essential training and experience. Five areas of training must be provided:

a. Piloted Boost - a vehicle is needed that will provide the acceleration and other environmental stresses and control problems associated with a pilot flying a booster into space.

b. Space Attitude Control and Zero G - a vehicle is needed that will provide a significant period of time at low dynamic pressures where the pilot can gain valuable experience in the use of reaction controls to position and point the vehicle as required in space as well as to experience weightlessness while accomplishing this task.

c. Reentry - a vehicle is required that can duplicate the final phase of reentry from 125,000 feet at 3.5 Mach number. This is the most demanding portion of the reentry, as far as the pilot is concerned, for the success of this portion of the mission depends on his judgment and piloting skills.

d. Approach and Landing - a vehicle is required that can simulate approach and landing characteristics of lifting reentry vehicles as a conclusion of the reentry phase described previously.

e. Environmental and Personal Equipment Training - it is necessary that a vehicle be provided to allow crewmen to use and become intimately familiar with spacelike environmental control systems and space suits under actual operational conditions and to experience the problems of performing these operations with this equipment.

To accomplish this training objective, a singularly important consideration is clear. Continued reliance on high performance modified and unmodified turbojet aircraft to accomplish this type training will result in the USAF falling considerably short of providing that degree of research pilot experience considered necessary. The readily identifiable deficiencies in current equipment include:

a. Serious deficiencies in required training capability.

b. A decrease in suitable high performance turbojet inventory during the next decade with no known plans for a follow-on procurement.

Suitable high performance turbojets in this instance are aircraft that can be feasibly modified to incorporate supplemental rocket power. Due to the lack of developed rocket engines suitable for installation and use in turbojet aircraft, the number of operational turbojet types that can be classified as "suitable" are restricted to one aircraft, the F-104. Because the only flight qualified rocket engine is in the 6000 pound thrust class the F-101, F-102, F-105, F-106, F-110, and F-111 aircraft are unsuitable for this purpose since their larger weight reduces the performance increase provided by this class of rocket engine. To provide appreciable performance gains with supplemental rocket power, a rocket engine capable of producing 10-15,000 pounds of thrust is required for these aircraft. Unfortunately, there are no known rocket engines currently developed with this thrust capability. Although Rocketdyne Division of North American Aviation, Inc. has desinged a 10-12,000 pound thrust engine, this particular rocket engine is still in a design status and has not been test fired. Furthermore, there are no plans to continue the development effort due to lack of DOD interest and company funds.

A training concept that has important ramifications when considering a flight aerospace trainer is the training role of ground based simulators. Although ground based trainers have provided invaluable assistance in training programs, this type of trainer in no way can be considered more than an important supplement to a complete training program. The pilot's performance in a ground based simulator is frequently quite different from his performance in the actual environment. Motivational factors and the pressure of the particular situation are things that can never be duplicated in a simulator. The capability to expose a pilot to the actual environment in which tests are to be performed remains of cardinal importance.

In addition to the training capabilities, it appears that there are other areas which can be identified in which the proposed aerospace trainer can be of additional service. These include, but are not necessarily limited to the following areas:

a. Special high altitude research programs could be examined by substituting a sensor package for one of the crew positions. It is visualized that this Research Bay could be used to investigate various types of sensors, their applications, limitations, and operational effectiveness.

b. Maintenance of proficiency by active space pilots between space missions.

c. Orientation/familiarization flights for non-pilot scientist crew members.

Several possible uses of this vehicle as a research tool will be discussed. These requirements will be indicated for the purpose of identifying possible applications in addition to the training requirement which is an integral part of the School curricula.

PURPOSE

The purpose of this document is to establish an operational requirement for an advanced aerospace trainer to be utilized initially by the USAF Aerospace Research Pilot School, Edwards Air Force Base, California. This vehicle, or an outgrowth thereof, may ultimately be considered as a trainer to be used in the Air Training Command as an advanced trainer for future operational aerospace pilots. Informal coordination on this vehicle concept has been made with Headquarters ATC personnel. However, no formal Air Training Command position has been received.

MISSION

The mission of the USAF Aerospace Research Pilot School as stated in AFR 53-19, 1 May 1963, is: "The USAF Aerospace Research Pilot School trains selected officers to monitor or perform flight tests of research, experimental, or production type vehicles. These tests are made to determine flight characteristics, performance, stability, and functional utility, and to obtain technical information on serviceability and functioning of installed equipment and component parts."

PRESENT CAPABILITIES AND EQUIPMENT LIMITATIONS

The USAF Aerospace Research Pilot School has only limited capability to train pilots to fly and land lifting reentry vehicles. The configuration of these vehicles make them fly unlike conventional aircraft. They are a hybrid of an aircraft and a space capsule and their flying characteristics are a cross between the two. This is especially true in the final

phase of recovery where the pilot's task is demanding in that he must visually take over and fly the vehicle to its intended landing site.

The School's curriculum is divided into four separate but closely integrated areas. They are:

a. Academic training.

b. Simulator training.

c. Flying training.

d. Bioastronautics training.

The simulator and flying training serves as the laboratory for the academic and bioastronautics training. It is during the simulation and flying training that the student's theoretical knowledge becomes firmly implanted by observing and performing tasks directly related to the theoretical material he studies. Furthermore, he learns to perform specific missions which are typical of the space vehicles he may someday fly. The strength of the ARPS training program lies in this careful combination of theory and practice. If the student studies but does not perform the practical aspects concerning a certain critical area he is denied an important part of his training and experience.

The recovery and landing of spacelike vehicles is handled in this way. The student learns the principles and theory and then applies this knowledge to the flying of the aircraft through actual maneuvers. The penetration approach and landing of a lifting reentry vehicle is not like a conventional aircraft. The initial part of the penetration begins at about 125,000 feet at Mach numbers of 3.0 or greater. The rate of descent is extremely high because of the high drag configuration of this type of vehicle. To cope with this type of approach requires considerable experience and training in a vehicle which is more forgiving; that is, one that has auxiliary thrust to break the rate of descent or extend the glide to the eventual landing site. This sort of approach and landing requires careful timing, good judgment, and extreme faith in the theory which predicts the ultimate success of the mission when using the predicted techniques. Though extreme this may seem areas of flight that require split second timing and keen coordination between what the pilot sees in the outside world and what he does with the controls cannot be adequately simulated.

The F-104 and F-106 aircraft are currently used for training in the recovery, approach and landing of space vehicles like the X-15 and X-20. The NF-104 (rocket augmented F-104) will come into the training program early next year. It will be used to provide a limited amount of training in rocket operation and boost, short periods of zero "g" and reaction control time and limited reentry approach and landing training. More specifically, the prime shortcomings of the NF-104 are that low acceleration during rocket operation does not approach that of an actual booster, the time at zero "g" and low dynamic pressure does not provide sufficient time for con-

trolling the attitude of the vehicle with reaction controls and the reentry simulation is unrealistic because the correct altitude-Mach number combination that will produce a realistic reentry angle are not duplicated. While the NF-104 has good altitude capability it is incapable of attaining the required high Mach number necessary to place it into the reentry corridor shown in Figure 1.

In short, a vehicle having a high altitude and high Mach number capability is required and existing conventional aircraft cannot meet this requirement.

CONCEPT OF EMPLOYMENT

The aerospace trainers will be used in two basic modes of operation. The first is a "boost and reentry mission" which involves a conventional horizontal takeoff and pullup to intercept a boost profile which becomes level at about 125,000 feet and Mach 3.0 or more. Being thus placed on the equilibrium glide path the student will perform the final phase of reentry, approach and landing. The second mode of operation is a low dynamic pressure "reaction control mission" which involves a steeper boost trajectory which lofts the aircraft to altitudes well in excess of 150,000 feet for several minutes during which time the student controls the vehicle with reaction controls performing programmed maneuvers prior to reentry. It is anticipated that the peak altitude on this mission may be more then 300,000 feet. Both of these missions will also serve to familiarize non-pilot crewmen and scientists with spacelike operations and allow them to perform functions related to their own crew duties during the flight profile. These vehicles will be utilized throughout the training program to transition the students to rocket powered aircraft and through buildup flights to prepare them to fly the forementioned missions. Based on experience with the NF-104, special purpose aircraft of this type can be counted on for no more than ten to fifteen flights per month so that a minimum of four aircraft are required to provide training and proficiency flying for the current student output

and instructors. The precise number of vehicles required cannot be specified. The quantities required will be dependent on the following general considerations:

a. Number of trainees and number of flights per trainee. Number of trainees will be estimated by USAF requirements while number of flights per trainee will be dependent on the School's curriculum. The curriculum will be developed basically on the vehicle's training capability per flight, and the number of familiarization flights required to prepare the student for the full performance missions. It is estimated that ten sorties will be required per student.

b. The vehicle's predicted utilization rate.

c. Attrition estimates.

Once a specific aerospace trainer concept is approved, more definitive quantity estimates can be made.

While it would be desirable to be able to place the vehicle on the equilibrium glide path at a higher velocity in the entry corridor it is not deemed advisable because of the disproportionately high cost of attaining this capability for the amount of training that is derived. The early phase of a typical lifting reentry mission is performed almost entirely on instruments with little reference to the outside world. This is because of the high reentry angle of attack and the requirement for heat shields over the forward windows during this region of high heating. Also, because of the heating and low dynamic pressure condition this portion of the flight involves few complicated maneuvers and can be easily simulated on the ground. On the other hand, once the critical heating region is passed and the heat shield is jettisoned the pilot's job becomes more critical. He must then take over with visual reference to the outside world and fly the vehicle to a landing site. This occurs in a typical reentry mission at 100,000-150,000 feet at 3.0 to 5.0 Mach number. Since this portion of the entry relies entirely on the pilot's judgement and proficiency it is essential that he be trained in the various techniques of flying his vehicle to a particular landing site. For instance, a landing site that lies right under the nose can present as large a problem for an unpowered vehicle that is traveling at high velocity as one that is far off in the distance. Special techniques of handling this and other problems must become second nature to pilots who must perform this type of mission.

Thus, the operational concept of this training vehicle is to remain at speeds well below the critical heating regions but at high enough velocities to gain the full benefit of the final phase of reentry that requires a high degree of pilot proficiency and skill.

Because this velocity capability requires such a large rocket propulsion system it is possible to develop a vehicle that has more thrust than weight. It can, therefore, accelerate vertically along booster type flight paths and with accelerations that approach the first stage characteristics of existing

and future manned booster systems. Since pilot control of boost is planned for several Air Force and NASA manned space shots, this is a very desirable feature to be incorporated in this vehicle. A typical boost trajectory for a manned booster is shown in Figure 1. It is noted that the boost trajectory crosses the reentry corridor at 120,000 feet and Mach 4.0 (i.e., the same point at which the pilot takes over for the final phase of reentry and landing). Thus, training can be accomplished not only in the final phase of reentry, but also in the very critical early phase of boost. Piloted boost is a less severe problem above 100,000 feet because the aerodynamic forces are so low.

The aerospace trainer as conceived for this development will be used solely by ARPS to train pilots to fly boost, reentry, and zero "g" space trajectories; however, an adjunct to this program is their concurrent use as a test bed and first stage launch vehicle for various types of basic and applied research and for development of operational systems and components to be used on satellites, space probes, and manned space vehicles. Many areas of research and development have been identified which this vehicle could satisfy. They include:

a. Basic bioastronautics type research as well as obtaining base line medical data on space crew candidates under space operational conditions.

b. Test Bed Operations:

(1) Functional and reliability tests of operation equipment could be conducted prior to its being committed to a manned or unmanned space flight. This could include test and evaluation of subsystems for use in satellites under realistic conditions and with the following advantages over unmanned rocket flight, or orbital test:

(a) The booster (aerospace trainer)would be recoverable.

(b) Auxiliary test and monitoring equipment could be carried in the same vehicle with the subsystem under test.

(c) The subsystem and test equipment would be recovered and would be immediately available for post flight examination, ground testing or re-use.

(d) The pilot would be available for participation in tests of equipment both as a monitor and as an active participant for equipment intended for use on manned space vehicles.

(2) Various types of displays (energy management, flight directors, terminal guidance systems, etc.) and flight controls can be evaluated and developed under actual reentry and space flight conditions.

(3) A variety of sensors (electromagnetic,photographic and IR) for tests against launch vehicles as well as ground targets could be carried. It could also be used for upper atmosphere research for gathering basic scientific data (sampling and physical measurements) and for making routine meteorological measurements.

c. Launch Vehicle Operations: The aerospace trainer can also be used as a launch vehicle.

(1) As a passive launch vehicle it could release a variety of payloads including passive objects for tracking by ground equipment, or a variety of active instrument packages for taking meteorological and physical measurements during descent.

(2) As an active launch vehicle the aerospace trainer could carry an external second stage launch vehicle of 500 pounds or more which could be fired to extreme altitudes or speeds for the purpose of obtaining data in the far reaches of the atmosphere or for launching hypersonic research models or instrument payloads to hypersonic velocities to obtain heating and aerodynamic data.

In summary the aerospace trainer type vehicle may well have a research and development role of its own completely apart from the training function. If this capability were brought to the attention of potential using activities it could well be that additional vehicles might be procured solely to support this work.

The trainer should be procured as a complete system to include all peculiar support equipment and facilities. Since Edwards AFB has extensive facilities for this type vehicle, facilities cost should be considerably less for the initial procurement. These facilities include exotic fuels storage and servicing equipment, high pressure gas generating, storing, and servicing equipment, rocket engine maintenance and overhaul facilities, a large fully instrumented range with numerous emergency landing fields and a terminal landing area complex that is more than adequate.

In consonance with the concept research pilot training vehicles must parallel or precede their space flight counterparts. This trainer should be available by 1968. With a three year test and development cycle this system must be initiated as soon as funds can be made available.

PERFORMANCE CHARACTERISTICS

1. General characteristics: To accomplish the intended mission the aerospace trainer must be a two place vehicle with conventional and sidestick controls in both cockpits. It must take off and land conventionally and for student missions it must launch and recover at the same site. Air

launch capability is optional. It must be capable of repeated operation with a minimum sustained flight rate of ten flights per trainer per month. Minimum time for turn around, periodic inspections, and general maintenance must be a prime consideration in the design of these vehicles.

2. Operational Characteristics: It is desired that the aerospace trainers be capable of repeated operation from conventional runways with a minimum of special support equipment and personnel. Two design missions are envisioned for this vehicle. The first involves a conventional takeoff cruise out to an initial point at low altitude apply full power and pull up in a simulated first stage boost trajectory that brings the aircraft level at 125,000 feet and Mach 3.0 or greater at burnout. Being thus in the reentry corridor (Figure 1) a reentry mission, including penetration approach and landing, is flown back to the base. The second mission involves a similar procedure up through the pull-up phase at which point a steeper trajectory is flown which carries the vehicle to extreme altitudes where programmed space type maneuvers can be performed with reaction controls during the three or more minutes available prior to reentry. The reentry will be more typical of an X-15 steep angle reentry than that of an orbital vehicle. Even though this reentry is not typical of a true orbital space vehicle it is a worthy mission to be performed because of the long periods of zero "g" and attitude control training that can be accomplished. The engines must be throttleable to allow reasonable ground handling and conventional low level-low acceleration aircraft type flight.

3. Performance Requirements: The desired performance characteristics of this vehicle must include:

a. Boost acceleration and steep attitude combinations that approach the characteristics of the first stage of modern man rated space boosters like Titan 2 and 3, or Saturn 1B and 5. It must be capable of injecting the vehicle into a reentry corridor at 125,000 feet and a speed in excess of Mach 3.0. It must also be capable of providing zero "g" and low dynamic pressure reaction control time of more than three minutes above 150,000 feet.

b. Reentry - It must be possible to reenter from any altitude and speed combination that can be reached by the boosted vehicle. That is, it must not be so closely designed around a specific design mission that it is incapable of safely performing off design missions such as might be required during the checkout of a new pilot. Flexibility and safety must be by-words with this vehicle. While reentry "g" stresses need not be identically duplicated they should be a sizable fraction of a typical lifting body reentry profile. It would be desirable to have a basic low drag design equipped with drag devices so that a wide range of higher drag configurations could be simulated.

c. Recovery and Landing - The recovery phase is essentially an energy management problem involving an unpowered landing. The performance of the proposed trainer must permit recovery from the point of completion of the reentry phase to the initial takeoff point. There must be sufficient margin in altitude at the landing site following a non-optimum recovery to compensate

for reasonable errors in energy management on the part of the pilot. Although not mandatory, a sustainer type jet engine to compensate for such errors is desirable. Drag devices must be provided so that a wide range of drag configurations can be simulated.

d. Space Operations - The aerospace trainer must be capable of operating in a space environment for a considerable period of time. It should be capable of profiles that provide dynamic pressures less than 10 psf at altitudes between 200,000 and 400,000 feet for periods exceeding three minutes. This will provide adequate time for use of reaction controls, practice various maneuvers, and establish reentry attitude. Except for vehicle velocity relative to the earth, a 300,000 foot maximum altitude places the vehicle in a space environment somewhat like an orbital vehicle. The reaction control system must be capable of manual control with and without automatic stability augmentation in all three axes.

4. Stability and Control Requirements: Stability augmentation must be provided for both the aerodynamic and reaction control systems as required. It is desired to have a limited degree of variable stability so that wider range of boost, reentry and recovery characteristics can be simulated.

5. Structure: The structural integrity of this vehicle must be of the highest standards providing ample margin for error or off design mission profiles that may be anticipated during the transitioning of new pilots into the vehicle. This aircraft should be capable of withstanding a normal load factor of -2 to +5 g's and longitudinal load factor of $\pm$ 3 g's while being exposed to the heating conditions of .03 Mach number greater than the limit speed.

6. Cockpit and Environmental Control System: Cockpit controls will be conventional in all respects except that a sidearm controller will be provided for flight in the high acceleration regions. This will also provide valuable experience in the use of the type of controller that will be used in future space vehicles. The cockpit instrument displays will be typical of space reentry systems of this type. In as much as this vehicle will operate in the near space environment where air data sensors do not function it is desirable that an inertial reference system be incorporated in the design and that a more sophisticated air data sensing system be considered for use at the extreme altitudes. Since this vehicle will operate in space, it will have space type life support equipment which will provide student familiarization with important life support equipment operation and design. The life support system should provide a shirt-sleeve environment throughout the flight with full pressure suit backup for safety..

7. Military Specifications Compliances: Except as specifically stated, this vehicle will not be built to military specifications since they do not apply to this type of vehicle. However, they will be used as a guide and applied where applicable.

POSSIBLE SOLUTIONS

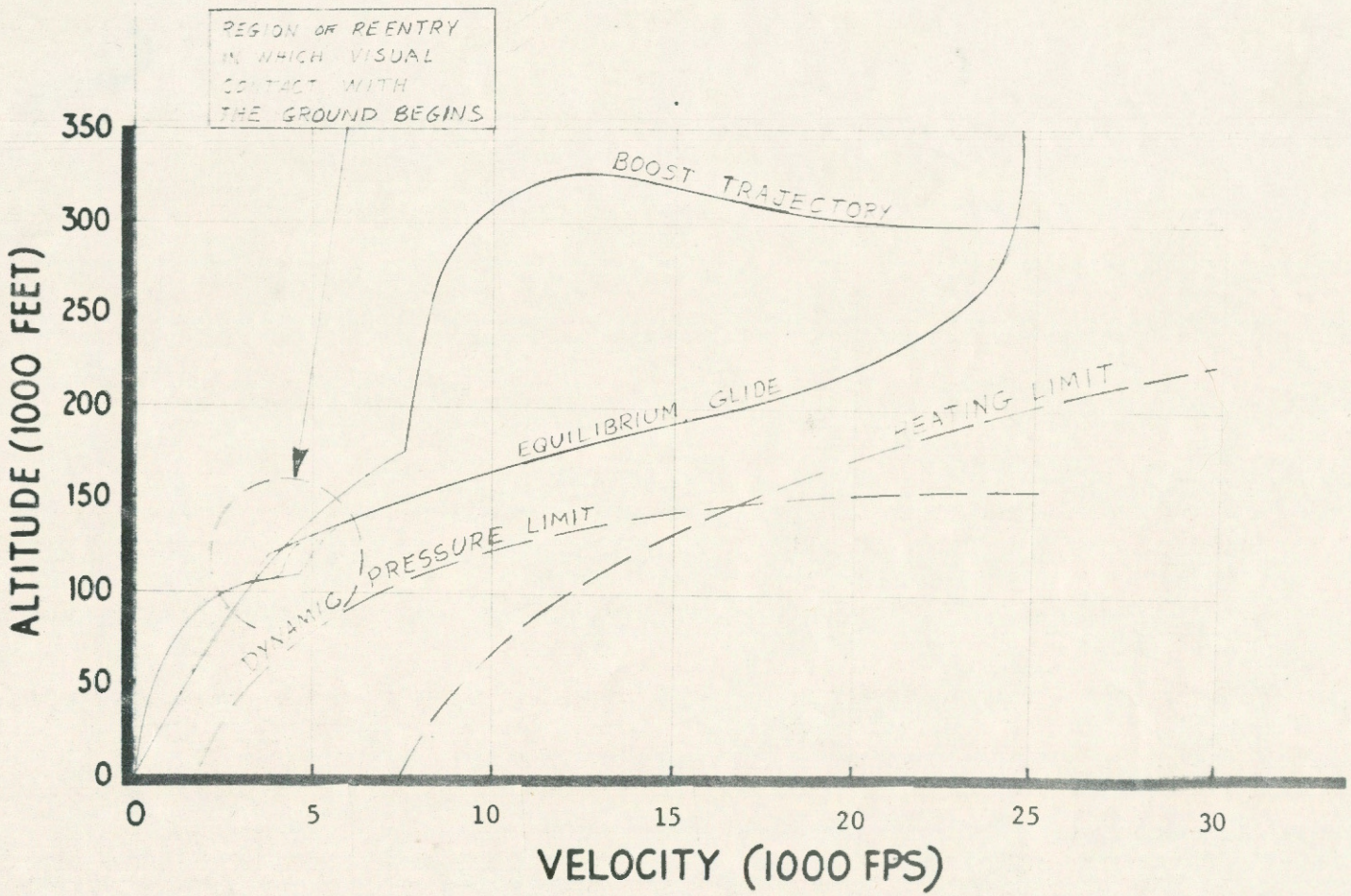
Two contractors are currently investigating the feasibility of modifying operational high performance turbojets (T-38's and F-104's) to an aerospace trainer configuration. This approach, should it prove feasible, will undoubtedly decrease initial procurement costs since much of their basic aerodynamic, design and structural data will be applicable. However, it should be noted that the modified vehicles will have to incorporate extensive system changes such as propulsion, fuel, auxiliary power, flight control, life support, and cockpit display. In addition, extensive structural and materiel changes will be required.

Another possible solution is procurement of modified X-15's with conventional landing gear and a second seat. This approach is particularly appealing because the vast experience and proof testing that has been done by NASA and USAF leave few unknowns in the critical high speed heating region. However, this solution also requires thorough investigation of its feasibility.

In the event the solutions mentioned above prove unsuitable, a completely new specifically designed vehicle will be required.

Figure 1

TYPICAL FLIGHT ENVELOPE



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON 25, D.C.

8 JAN 196

REPLY TO ATTN OF: AFORQCT

SUBJECT: Qualitative Operational Requirement for an Aerospace Trainer

TO: AFSC

1. Reference is made to your letter, subject: Qualitative Operational Requirement (QOR), Aerospace Trainer, dated 9 October 1963.

2. We have reviewed the QOR for an Aerospace Trainer and concur with your proposal to review and update this requirement periodically. Accordingly, the QOR is being returned without further action. Events of recent weeks indicate that establishment of a firm requirement at this time would be premature. In addition to your proposed review in conjunction with the Aerospace Research Pilot School's expansion plan, we recommend that this trainer requirement be included in the space mission training studies being conducted by the Aerospace Medical Division.

3. We request that you apprize us of your progress with this study whenever significant changes to the current concept become evident.

FOR THE CHIEF OF STAFF

William W Momyer

WILLIAM W. MOMYER
Major General, USAF
Director of Operational Requirements
DCS/Programs and Requirements

1 Atch
Ltr, ARPS (FTT), 7 Aug 63,
subj as above, w/4 atch
and 1st Ind AFFTC (FTO),
12 Aug 63

Copy to:
AFFTC (FTO), Edwards AFB, Calif

SCP 64-60

Ltr, AFFTC (FTT) Edwards AFB, Calif, Subj: Qualitative Operational Requirement, Aerospace Trainer

1st Ind (FTO) 12 AUG 1963

Hq AFFTC, Edwards AFB, California

TO: AFSC (SCP)

1. The need for an Aerospace Trainer is a critical requirement for updating the capability of the Aerospace Research Pilot School. Acquisition of self-launched trainer with near-space capability is believed to be the most economical method of providing this training.

2. Recommend approval.

FOR THE COMMANDER

H. H. WITTROCK
Colonel, USAF
DCS/Plans & Operations

4 Atchs
n/c

atch 1
SCP-13-1659

SCGC

9 OCT 1963

Qualitative Operational Requirement (QOR), Aerospace Trainer

HQ USAF (AFRSTC)

1. The USAF Aerospace Research Pilot School has prepared a QOR on an Aerospace Trainer. (Atch 1)

2. The QOR has been staffed at this headquarters, and, subject to your concurrence, the following course of action is proposed:

a. The Aerospace Trainer QOR be included in the ARPS Expansion Plan to be reviewed and updated annually (reference SCP letter, subject: "Requirements for, and Utilization of, Aerospace Research Pilot School Graduates," dated 11 September 1963).

b. Evaluate the utilization, competency gained and projected life of the rocket modified NF104A.

c. Anticipate a probable requirement for a true Aerospace Trainer based upon a clearly defined military man in space mission.

d. Initiate a formal procurement cycle for an Aerospace Trainer at your direction and as the requirement becomes more definitive.

FOR THE COMMANDER

SIGNED

W. E. LEONHARD
Brigadier General, USAF
Chief of Staff

1 Atch
Ltr, ARPS (FTT), 7 Aug 63, subj as above, w/4 atch and 1st Ind. AFFTC (FTO), 12 Aug 63

SCPTP

Capt Horne, SCPTP, 2322, 26 Sep 63
Revised by Gen Leonhard/vu

SCGV

Qualitative Operational Requirement (QOR), Aerospace Trainer

HQ USAF (AFRSTC)

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c. Anticipate a probable requirement for a true Aerospace Trainer based upon a clearly defined military man in space mission.

d. Initiate a formal procurement cycle for an Aerospace Trainer at your direction or as a requirement becomes more definitive.

1 Atch
Ltr, ARPS (FTT), 7 Aug 63,
subject as above, w/4 atchs
and 1st Ind, AFFTC (FTO)
12 Aug 63

RETYPED WITH PAR 2a & 3
CHANGE

NAME, GRADE OR TITLE & OFFICE SYMBOL OF ORIGINATOR	DATE	TELEPHONE NUMBER	TYPIST INITIALS
Capt Horne/SCPTP	26Sep63	2322	LLC

COMMAND SECTION
SCG
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SCGM
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SCGB
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MSF
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SCE
SCI
SCJ
SCW
SCX
SCO
DEPUTY CHIEFS
SCC
SCF
SCK
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SCM
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SCT
OTHER
SCQ

AFSC HQ FORM JUN 63 16 AFSC (AAFB) 1963 COORDINATION SHEET

PREVIOUS EDITION OF THIS FORM MAY BE USED.

19 Sep 763

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
ANDREWS AIR FORCE BASE
Washington 25, D. C.

DATE

30 SEP 1963

MEMORANDUM FOR: SCGC

1. The QOR for the Aerospace Trainer was not endorsed for adoption by the Hq AFSC staff.

2. The coordinated position, however, of all interested staff agencies is that the QOR should be included in our basic plan (ARPS Expansion Plan) to be reviewed and up-dated on an annual basis.

3. The present NF104A rocket modified trainer will be included in the curriculum soon for the seeable future. A follow-on or true Aerospace Trainer, as proposed in the QOR, might be considered for inclusion in the curriculum at a future date depending upon known requirements, and most importantly, a more clearly defined military man in space mission.

4. In view of the above, it is recommended that the basic letter outlining the Hq AFSC position be resubmitted to the Vice-Commander for signature. It is felt that HQ USAF should have the opportunity to approve our "watch and wait" position regarding a future aerospace trainer and to review the QOR itself.

GERHARD J. SCHRIEVER
COLONEL, USAF
DCS PERSONNEL

19 Sep 762

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

DATE 21 Sep 63

MEMORANDUM FOR: SCP

1. Please note the Vice Commander's desk memo attached. The requirement for an Aerospace Trainer of the character proposed is highly suspect. A detailed analysis needs to be made of the actual benefit achieved from rocketing a trainer to the altitude proposed in this plan vs a more modest and practical requirement associated with Aerospace Training, landing an unpowered glider simulating conditions to be experienced in the low altitude phase of the DYNA-SOAR recovery.

2. It is requested that this matter be thoroughly studied by the staff and that a presentation be made to the AFSC Council if the staff (through the DCS level) considers the requirement valid and supportable.

1 Atch
SCPTP proposed ltr to
Hq USAF, subj: QOR,
Aerospace Trainer w/
Vice Cdr's desk memo
dtd 20 Sep

WEL

W. E. LEONHARD
BRIGADIER GENERAL, USAF
CHIEF OF STAFF

DO NOT REMOVE THIS REFERRAL SLIP FROM DOCUMENT

19 Sep 76 3

COMMAND SECTION	INFO	SIGN	INITIALS	STAFF
SCG				ACTION COPY FURNISHED
SCGV		✓		INFO COPY FURNISHED
SCGC	✓		[illegible]	
SCGC-1	✓		[illegible]	REFERENCE ATTACHED
SCGCA	✓		[illegible]	REFERENCE NOT AVAILABLE IN SCGCA
				SCGE — INFO / SIGN / INITIALS

COMMENTS

20 Sept.

C/S

This may well be a valid and important requirement. I think, however, we should study possible alternatives a bit more. Then put on a presentation for AFSC Council. If Council agrees then we should forward the QOR

HOWELL M. ESTES, JR.
Lt General, USAF
Vice Commander

DO NOT REMOVE THIS REFERRAL SLIP FROM DOCUMENT

#9-18-2-M

19 SEP 7 63

STAFF SUMMARY SHEET

TO	ROUTE	DESIRED ACTION	SIGNATURE	DATE	
SCS	1	Coordination		13 SEP 1963	
MSF	2	Coordination			
SCC	3	Coordination		OFFICE OF PREPARATION	
SCL	4	Coordination		SCPTP	
SCM	5	Coordination			
SCO	6	Coordination		GRADE · SURNAME	PHONE
SCP	7	Review			
SCGCA	8	Process		Capt Horne	2322

SUBJECT

Qualitative Operational Requirement, Aerospace Trainer

SUMMARY

DISCUSSION:

1. The USAF Aerospace Research Pilot School staff has submitted a qualitative operational requirement (QOR) for a future aerospace trainer.

2. The QOR has been staffed by appropriate Hq AFSC staff agencies. See attachments a through g.

3. An analysis of the staff comments indicate that there will undoubtedly be a future requirement - probably after 1970 - for an aerospace trainer, but a definite and near future requirement is obscure.

4. The school is preparing a detailed, five year ARPS Expansion Plan. It is felt that the QOR should be a part of that plan and reconsidered in the future in light of a more clearly defined military manned space flight mission; an evaluation of the performance and qualities of the NF104A; a definition of USAF input to advanced programs such as the National Orbital Space Station (NOSS)

RECOMMENDATION:

5. Request the Vice-Commander, Headquarters AFSC, sign the attached letter.

KENNETH E. MARTS
Colonel, USAF
Asst DCS/Personnel

8 Atch
1. Tab A-Ltr, SCS, subject as above, 6Sep63
2. Tab B-Ltr, MSF, subject as above, 10Sep63
3. Tab C-Ltr, SCC, subject as above, 9Sep63
4. Tab D-Ltr, SCL, subject as above, 11Sep63
5. Tab E-Ltr, SCM, subject as above, 6Sep63
6. Tab F-Ltr, SCO, subject as above, 28Aug63
7. Tab G-Ltr, SCPTP, subject as above, 23 Aug 63
8. Proposed ltr to Hq USAF, (AFRSTC)

Do not forward to Command Section until this block has been signed and dated by the appropriate OPI. This block, when signed, signifies completed coordination and that the OPI is aware of concurrence, non-concurrence and either resolution of difference or why the non-concurrence should be overridden.

Signature _____ Date 19 Sept 63

AFSC FORM 149 PREVIOUS EDITION OF THIS FORM MAY BE USED.

19 SEP 1963

SCGV

Qualitative Operational Requirement (QOR), Aerospace Trainer

Hq USAF (AFRSTG)

1. The USAF Aerospace Research Pilot School has prepared a QOR on an Aerospace Trainer. (Atch 1)

2. The QOR has been staffed at this Headquarters and, subject to your concurrence, the following course of action is proposed:

a. Approve the Aerospace Trainer QOR for inclusion in the ARPS Expansion Plan for annual updating and review (Reference SCP letter, subject, Requirements for, and Utilization of Aerospace Research Pilot School Graduates, dated 31 July 1963).

b. Evaluate the utilization, competency gained and projected life of the rocket modified NF104A.

c. Anticipate a probable requirement for a true Aerospace Trainer based upon a clearly defined military man in space mission.

d. Initiate a formal procurement cycle for an Aerospace Trainer at your direction or as a requirement becomes more definitive.

3. Request your evaluation of the QOR and analysis of the Hq AFSC position as outlined in the above.

1 Atch
Ltr, ARPS (FTT), 7 Aug 63, subject as above, w/4 atchs and 1st Ind, AFTTC (FTO) 12 Aug 63

Retyped Changed Par 2a

SCO-3 Jamesthe4e

MSFAM B.J. Jones, Maj

Rwb delay SCSA

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NAME, GRADE OR TITLE & OFFICE SYMBOL OF ORIGINATOR	DATE	TELEPHONE NUMBER	TYPIST INITIALS
CAPT R. G. HORNE, SCPTP RETYPED WITH SUBJ CHANGE	12 SEP 63	2322	rwn

AFSC HQ FORM JUN 63 16 AFSC (AAFB) 1963 COORDINATION SHEET

PREVIOUS EDITION OF THIS FORM MAY BE USED.

SCL

11 SEP 1963

Qualitative Operational Requirement, Aerospace Trainer

SCP

1. Reference SCPTP letter dated 28 Aug 63, subject as above.

2. Subject QOR has been reviewed as requested. SCL concurs with the Aerospace Research Pilot School in that a follow-on procurement to the NF-104A in the form of a more advanced aerospace trainer will be required in the post 1973 period.

3. The NF-104A should provide adequate pilot training for Dyna-Soar, Gemini and Apollo through 1968, and possibly later. This training should suffice for the operation of these vehicles during the 1968-1973 time period.

4. The period 1973-1978 is, therefore, the period we feel a requirement could, and probably will, exist for a more sophisticated and advanced space trainer.

5. At this time, however, it is not possible to precisely postulate trainer performance requirements for that period, since follow-on systems to Dyna-Soar, Gemini and Apollo are not yet defined. The performance requirements stated in the QOR represent a best estimate based on the facts at hand now, and may or may not be realistic in the final analysis.

6. Despite this fact, it is recommended the QOR be approved in order to formally initiate the procurement cycle for the space trainer, and also in order to utilize available lead time to maximum extent possible.

7. It is further recommended that a study be initiated to determine the state-of-the-art envisioned in propulsion, control, and life support systems for the 1973, and after, time period.

8. This study, plus inputs from other investigations and yet to be effected studies on manned space systems envisioned after Dyna-Soar, Gemini, and Apollo, should enable us to periodically update QOR performance parameters and more realistically define trainer system requirements for post 1973.

W. B. Keese
Maj Gen, USAF
DCS/Plans

SCOPS

9 SEP 1963

Qualitative Operational Requirement, Aerospace Trainer

SCOTR

ASD has no comment as to the requirement for this Aerospace Trainer. The following considerations are offered on satisfying this requirement, if it is validated:

a. If the QOR is forwarded to Hq USAF with Command approval, it is suggested that ASD be requested to study the cost-effectiveness of the T-38/F-104 approach vs. modified X-15 vs. a new vehicle. This type of analysis will be required ultimately and time can be saved if the study is initiated immediately.

b. A cost-effectiveness study should also be requested on a 10-15000 pound thrust capability so that heavier fighter type aircraft may be considered in evaluating the approach to be taken in an Aerospace Trainer.

c. An additional consideration is that, historically trainers have evolved from operational systems. At this point in time this approach cannot be taken since our first operational aerospace craft (X-20) is some years away. The Aerospace Trainer would not be available in time to be used in training our initial group of pilots for this program. Consideration should be given to awaiting early results of the X-20 program and basing the development of a trainer on results obtained. In the interim period, the T-38/F-104/X-15/10-15000 lb rocket engine method of training be used.

DUWARD L. CROW
Brigadier General, USAF
DCS/Comptroller

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: MSFAM

10 SEP 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCPTP

1. Reference your 28 August 1963 letter, same subject. We are in agreement that there will undoubtedly be a requirement for training significant numbers of Air Force officers as the Air Force expands its manned operations in space. However, on the basis of the present and forecast manned military space program, we do not concur that the QOR is justified at this time.

a. The only approved military manned space program is the X-20. Pilots for this program have been selected and have been undergoing specific-mission training for a period of years. An advanced trainer could not be available in time to benefit that program.

b. Both a follow-on Dyna-Soar and follow-on Gemini are potential programs, but the probability of approval of such programs is not high enough to justify acquisition of an advanced trainer. As far as the National Orbital Space Station (NOSS) is concerned, USAF plans to initiate studies leading to acquisition of NOSS. However, NOSS is too nebulous at the present time to justify the large expenditure for an advanced trainer.

2. The future of military manned space flight is presently in a state of flux. We anticipate that the role of the military in space will crystallize during the next few years. When it does, a QOR based upon more definite requirements can be better justified, and, if approved, will permit acquisition of an advanced aerospace trainer which represents a quantum jump over the Lockheed, Northrup, and North American proposals presently being considered by ARPS.

J Sanders Jr

for ERWIN A. MEYER, JR.
Colonel, USAF
Director, Military Space Programs
Office, Manned Space Flight

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: SCL

11 SEP 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCP

1. Reference SCPTP letter dated 28 Aug 63, subject as above.

2. Subject QOR has been reviewed as requested. SCL concurs with the Aerospace Research Pilot School in that a follow-on procurement to the NF-104A in the form of a more advanced aerospace trainer will be required in the post 1973 period.

3. The NF-104A should provide adequate pilot training for Dyna-Soar, Gemini and Apollo through 1968, and possibly later. This training should suffice for the operation of these vehicles during the 1968-1973 time period.

4. The period 1973-1978 is, therefore, the period we feel a requirement could, and probably will, exist for a more sophisticated and advanced space trainer.

5. At this time, however, it is not possible to precisely postulate trainer performance requirements for that period, since follow-on systems to Dyna-Soar, Gemini and Apollo are not yet defined. The performance requirements stated in the QOR represent a best estimate based on the facts at hand now, and may or may not be realistic in the final analysis.

6. Despite this fact, it is recommended the QOR be approved in order to formally initiate the procurement cycle for the space trainer, and also in order to utilize available lead time to maximum extent possible.

7. It is further recommended that a study be initiated to determine the state-of-the-art envisioned in propulsion, control, and life support systems for the 1973, and after, time period.

8. This study, plus inputs from other investigations and yet to be effected studies on manned space systems envisioned after Dyna-Soar, Gemini, and Apollo, should enable us to periodically update QOR performance parameters and more realistically define trainer system requirements for post 1973.

George R. Kemberling
for
W. B. Keese
Maj Gen, USAF
DCS/Plans

FORGING MILITARY SPACEPOWER

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: SCCPS

9 SEP 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCPTR

SCC has no comment as to the requirement for this Aerospace Trainer. The following considerations are offered on satisfying this requirement, if it is validated:

a. If the QOR is forwarded to Hq USAF with Command approval, it is suggested that ASD be requested to study the cost-effectiveness of the T-38/F-104 approach vs. modified X-15 vs. a new vehicle. This type of analysis will be required ultimately and time can be saved if the study is initiated immediately.

b. A cost-effectiveness study should also be requested on a 10-15000 pound thrust capability so that heavier fighter type aircraft may be considered in evaluating the approach to be taken in an Aerospace Trainer.

c. An additional consideration is that, historically trainers have evolved from operational systems. At this point in time this approach cannot be taken since our first operational aerospace craft (X-20) is some years away. The Aerospace Trainer would not be available in time to be used in training our initial group of pilots for this program. Consideration should be given to awaiting early results of the X-20 program and basing the development of a trainer on results obtained. In the interim period, the T-38/F-104/X-15/10-15000 lb rocket engine method of training be used.

DUWARD L. CROW
Brigadier General, USAF
DCS/Comptroller

8-29-4-0

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: SCMO

6 SEP 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

WB

TO: SCPTP

1. Reference your memo dtd 28 Aug 63, subject as above.

2. I concur in the requirement for an improved Aerospace Trainer over and above the NF-104A. While I concur in principle with the principles outlined in paragraph 6 of Captain Horne's memorandum, I do not consider that we should hold up development indefinitely.

3. In summary, it is recommended that a determination be made as to what is technically feasible development wise over the next several years.

Calvin W. Fite

CALVIN W. FITE, JR.
Colonel, USAF
Director of Operations
DCS/Materiel

Copy to:
SCM

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: SCSAB/Lt Colonel Benefiel/5104

6 SEP 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCPTP

1. It is considered premature, at this time, to establish a firm requirement for an Aerospace Trainer.

2. The NF-104A should provide valuable data on technical and operational factors that will contribute significantly to the establishment of firm requirements.

3. It is recommended that approval of the subject requirement be withheld pending results of operating the NF-104A.

R W Soderberg Col

T. T. OMOHUNDRO, Colonel, USAF
Director, Aeronautical Systems
DCS/Systems

6 SEP 1963

SCMO

Qualitative Operational Requirement, Aerospace Trainer

SCPTP

1. Reference your memo dtd 28 Aug 63, subject as above.

2. I concur in the requirement for an improved Aerospace Trainer over and above the NF-104A. While I concur in principle with the principles outlined in paragraph 6 of Captain Horne's memorandum, I do not consider that we should hold up development indefinitely.

3. In summary, it is recommended that a determination be made as to what is technically feasible development wise over the next several years.

CALVIN W. FITE, JR.
Colonel, USAF
Director of Operations
DCS/Materiel

Copy to:
SCM

6 SEP 1963

SCSAB/Lt Colonel Benefiel/5104

Qualitative Operational Requirement, Aerospace Trainer

SCPTP

1. It is considered premature, at this time, to establish a firm requirement for an Aerospace Trainer.

2. The NF-104A should provide valuable data on technical and operational factors that will contribute significantly to the establishment of firm requirements.

3. It is recommended that approval of the subject requirement be withheld pending results of operating the NF-104A.

SIGNED
ROBERT W. SODERBERG

T. T. OMOHUNDRO, Colonel, USAF
Director, Aeronautical Systems
DCS/Systems

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO ATTN OF: SCPTP

28 August 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCM SCS MCF SCL SCC SCO -3

1. Request your review, comments and recommendations concerning the attached by 6 Sep 63. (Atch 1) The position of this office, as coordinated with the DCS/Personnel, is attached for your information. (Atch 2)

2. Subsequent to our receipt of your views regarding the aerospace trainer, a coordinated AFSC position will be developed and forwarded to the appropriate Air Staff agency.

RICHARD G. MOORE, Captain, USAF
Chief, Career Programs
Personnel Plans & Training
DCS/Personnel

2 Atch
1. Ltr, AFTTC (FTX), dtd 7 Aug 63, w/1st Ind, AFTTC (FTO), dtd 12 Aug 63
2. Ltr, SCPTP, dtd 23 Aug 63

1st Ind (SCO-3)

Hq AFSC

4 September 1963

TO: SCPTP

No Comment.

JOSEPH M McPHIE
Lt Col, USAF
Chief, Long Range Plans Office
Office of Manpower & Organization

2 Atch n/c

FORGING MILITARY SPACEPOWER

A.
2596

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO ATTN OF: SCPTP

28 August 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCM SCS MSF SCL SCC SCO -3

1. Request your review, comments and recommendations concerning the attached by 6 Sep. 63. (Atch 1) The position of this office, as coordinated with the DCS/Personnel, is attached for your information. (Atch 2)

2. Subsequent to our receipt of your views regarding the aerospace trainer, a coordinated AFSC position will be developed and forwarded to the appropriate Air Staff agency.

RICHARD G. HORNE, Captain, USAF
Chief, Career Programs
Personnel Plans & Training
DCS/Personnel

2 Atch
1. Ltr, AFFTC (FTT), dtd 7 Aug 63, w/1st Ind, AFFTC (FTO), dtd 12 Aug 63
2. Ltr, SCPTP, dtd 23 Aug 63

1st Ind (SCO-3)

Hq AFSC

4 September 1963

TO: SCPTP

No Comment.

for JOSEPH M McPHIE
Lt Col, USAF
Chief, Long Range Plans Office
Office of Manpower & Organization

2 Atch n/c

FORGING MILITARY SPACEPOWER

H.
2596

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: SCPTP

23 AUG 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCPT
SCP
IN TURN

1. The NF-104A, rocket modified trainer now being developed is, at best, a transitional aerospace trainer. It should bridge the gap from conventional F-104 aircraft to a true (one that trains in space, i.e., +50 miles) aerospace trainer of tomorrow.

2. In the logical progression of the school, more sophisticated training aircraft must eventually be conceived, planned, acquired and utilized.

3. The AFFTC statement as to a "critical requirement for updating the capability of the Aerospace Research Pilot School" is questioned. At the earliest, a true aerospace trainer could not be delivered in a quantity of six until 2 to 3 years from a given start date. Factors bearing on the non-critical nature of the aerospace trainer are:

a. The NF-104A is rapidly coming into the inventory.

b. There is not now a clearly defined military man in space mission.

c. The student output in quality and numbers is meeting today's needs.

4. Two companies and possibly a third have been working on the aerospace trainer concept at their own respective expense. The time has come to either develop a firm AFSC position regarding its further development or to run the risk of falling behind in terms of the future competency of our Aerospace Research Pilot School type graduates. Industry will have difficulty in selling the Aerospace Trainer as merely an Aerospace Research Pilot School-use aircraft.

atch 2

5. The life of the NF-104A is approximately 4-5 years. By 1968, a follow-on trainer or simply a better replacement appears to be a reasonable requirement.

6. My general comment is this: that the proposed true aerospace trainer is not a significant enough improvement over the NF-104A to be acquired for the school. Industry should be more visionary in developing an aerospace trainer. For example: the present apogee of the NF-104 will be approximately 122,000,000 feet and 1-2 minutes of weightlessness. If the Northrop, Lockheed and North American Aviation proposed trainer tripled this apogee and the minutes of weightlessness (Zero "G") this is not progress enough. I would think that increasing the apogee/weightlessness by ten-fold would be the objective for tomorrow's trainer. To be useful in space, man must be exposed to extended periods of weightlessness, variety of re-entry problems and a broad spectrum of activity. An extension of the NF-104A aircraft is not, in my judgement, the way to proceed. I believe that future aerospace craft must be as different in character, use and power as the atomic bomb was to the TNT "blockbuster." Finally, too much time is spent in launch and recovery of the present and proposed trainers as compared to the time actually spent (or proposed) experiencing ballistic controls, utilization and the effects of Zero "G."

7. The following is recommended:

a. Staff the QOR within the Headquarters.

b. Provide the Headquarters USAF Aerospace Research Pilot School OPR the AFSC position based upon the staff comments.

c. Subsequent to the Headquarters USAF review and direction either:

(1) Move forward with an aerospace trainer acquisition action.

(2) Maintain the aerospace trainer as an important part of the Aerospace Research Pilot School 5 Year Expansion Plan.

RICHARD G. HORNE, Captain, USAF
Chief, Career Programs
Personnel Plans & Training
DCS/Personnel

2 Atch
1. 1st Ind, AFFTC (FTO), dtd 12 Aug 63
2. Basic Ltr, AFFTC (FTT), dtd 7 Aug 63, w/4 atchs

USAF
AEROSPACE RESEARCH PILOT SCHOOL
AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA

REPLY TO
ATTN OF: FTT

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

7 AUG 1963

TO: FTO

1. The following information is submitted in accordance with procedures outlined in AFR 57-3, 4 June 1963.

2. The USAF space mission is becoming more clearly defined each day. That the USAF will have operational manned space systems and vehicles within the next decade is now a foregone conclusion even though a great deal of controversy is currently associated with this premise. The USAF transition into the space era is requiring and will continue to require completely new research and operational space equipment. It follows therefore, that the need for space research pilots trained in the most modern equipment available will continue to be an essential part of the overall program.

To accomplish this training objective, a singularly important consideration is clear. Continued reliance on high performance modified and unmodified turbojet aircraft to accomplish this type training will result in the USAF falling considerably short of providing that degree of research pilot experience considered necessary. The readily identifiable deficiencies in current equipment include:

a. Serious deficiencies in required training capability.

b. A decrease in suitable high performance turbojet inventory during the next decade with no known plans for a follow-on procurement. Suitable high performance turbojets in this instance are aircraft that can be feasibly modified to incorporate supplemental rocket power.

Due to lack of developed rocket engines suitable for installation and use in turbojet aircraft, the number of operational turbojet types that can be classified as "suitable", are restricted to one aircraft, the F-104, because a flight qualified rocket engine (6000 pound thrust) is available for use in the F-104. F-101, F-102, F-105, F-106, F-110 and TFX aircraft are unsuitable due to their weight. To provide appreciable performance gains for these aircraft, a rocket engine capable of producing 10-15000 pound thrust is required. Unfortunately, there are no known rocket engines currently developed with a 10-15000 pound thrust capability although Rocketdyne Div., of NAA, Inc., has designed a 10-12000 pound thrust engine. This particular rocket engine is still in a design status, has not been test fired and no plans have been made for continued development effort due to lack of DOD interest and company funds.

A training concept that has important ramifications when considering a flight aerospace trainer is the training role of ground based simulators. Although ground based trainers have provided invaluable assistance in training programs, this type of trainer in no way can be considered more than an important supplement to a complete training program. The capability to expose a pilot to the actual environment in which tests are to be performed remains of cardinal importance.

In addition to the above required capabilities, it appears to be a valid assumption that other identifiable mission capabilities could be applied to this proposed aerospace trainer. These include, but are not necessarily limited to the following areas:

(1) Special high altitude research programs could be examined by substituting a sensor package for one of the crew positions. It is visualized that this Research Bay could be used to investigate various types of sensors, their applications, limitations and operational effectiveness.

(2) Maintenance of proficiency by active space pilots between space missions.

(3) Orientation/familiarization flights for non-pilot scientist crew members.

Since the requirements above are not specified as part of the Aerospace Research Pilot School mission responsibility, further definition and discussion concerning them will not be included in subsequent paragraphs. These requirements are indicated for the purpose of identifying possible applications in addition to the training requirement which is an integral part of the School curricula.

3. The mission of the USAF Aerospace Research Pilot School as stated in AFR 53-19, 1 May 1963, is: "The USAF Aerospace Research Pilot School trains selected officers to monitor or perform flight tests of research, experimental, or production type vehicles. These tests are made to determine flight characteristics, performance, stability, and functional utility, and to obtain technical information on serviceability and functioning of installed equipment and component parts".

4. The School's curriculum is segmented into four general areas which are:

a. Academic Training

b. Simulator Training

c. Bio-astronautics Training

d. Flying Training 192

This requirement is directly related to the flying training portion of the curriculum so the first three areas mentioned above will not be discussed further. At present, flying training is accomplished in operational high performance turbo-jet aircraft. These aircraft provide satisfactory training in all flying training areas except the broad areas directly pertaining to aerospace flight such as:

(1) Launch and ascent

(2) Operations in space

(3) Re-entry

(4) Recovery

To provide limited flying training in the areas above, a Class V modification project on three F-104A aircraft assigned to the School is currently being performed by Lockheed Aircraft Corporation. Each of these modified aircraft will have a 6000 pound liquid rocket engine for supplemental thrust, a reaction control system, an auxiliary cockpit pressurization system and other non-standard equipment such as special cockpit instrumentation and in-flight data recorders. Graphs showing predicted performance of these modified aircraft are attached. In addition, a Class V modification program on two F-106B aircraft assigned to the School has been approved and is currently in the initial stages of the procurement cycle. These two aircraft will be modified to incorporate a variable stability flight control system which will be capable of demonstrating normal and peculiar handling qualities of future aerospace vehicles during atmospheric flight. Completion of these two modification projects will greatly increase the School's ability to adequately train Aerospace Research Pilots, but their limitations, as discussed in the following paragraphs dictate a follow-on vehicle with a much greater capability.

5. The basic limitation in current or near term aerospace flying training equipment is lack of performance. Review of the predicted performance graphs (attached) for the modified NF-104A's, show the following primary performance limitations:

a. Dynamic pressure (q) below 12 psf - approximately 60 seconds during a maximum trajectory profile. Low dynamic pressures are required for effective training using reaction controls. Longer periods of reaction control training are highly desireable.

b. Peak Altitude - approximately 122,000 feet during maximum trajectory profile. High altitudes are required to place the trainee in a space environment. The modified NF-104A's perform considerably better than unmodified aircraft; however, 122,000 feet maximum altitude

is far short of a true space environment. Time above 100,000 feet (approximately 65 seconds) is also quite short.

c. Maximum Mach Number - 2.2. An important required pilot skill which has not received extensive publicity, is the ability to judge and plan the terminal portion of a flight while approaching the terminal point at extremely high velocities and altitudes. This pilot skill becomes increasingly important in vehicles such as the X-15 with a no-go-around capability. The comparatively slow approach speeds of the modified NF-104A's with their go-around capability allows very limited training in this area.

d. High Longitudinal Acceleration Effects. Although not included in the attached graphs, since it is negligible in the modified NF-104A's, longitudinal acceleration during rocket boost phases of flight is considered to be an important training area. X-15 pilot experience has shown head movements during periods of high longitudinal acceleration create sensory illusions which can be quite serious unless properly understood and compensated for. The low longitudinal acceleration capability in the modified NF-104A's offers extremely limited training in this area.

e. Re-entry. Training in re-entry piloting techniques and procedures is essential for the successful completion of any space mission. Studies of the re-entry vehicle profile and its related problems regarding acceleration forces, heating, and vehicle dynamics, have proven that this portion of the flight is most critical and particularly sensitive to pilot control techniques. These control techniques involve piloting the vehicle with regard to limits as defined by a particular re-entry corridor. Knowledge of re-entry corridor parameters and the method of maintaining a desired equilibrium glide path by controlling these parameters is essential for application of proper control procedures.

The NF-104A does not provide us with acceleration limits, heating limits, and because of the nature of its trajectory, does not afford sufficient variables to approach a re-entry corridor of significant dimensions.

6. The overall performance capabilities of the proposed aerospace trainer must, to the maximum degree practical, present significant environmental conditions and piloting tasks encountered during boost, space operations, re-entry, and recovery. The environmental conditions and piloting tasks need not duplicate those of actual orbital spacecraft, but should cover in type and relative severity, those phases of space flight which make the greatest demands on the pilot's judgement, endurance, and piloting skills.

Design philosophy must be based on maximum operating flexibility, high use rate, low operating costs and levels of performance that provide

adequate training in the four phases of space flight mentioned previously. A vehicle which has these ground handling and operating characteristics will not have the performance of an orbital vehicle and will therefore be a compromise between a high performance turbojet and an orbital vehicle.

More specific performance capabilities are discussed below:

A. BOOST PERFORMANCE

The unusual environmental conditions associated with boost are:

(1) High longitudinal accelerations:

Boost accelerations of typical sub-orbital and orbital vehicles range from +4 to +10G's over time intervals of up to one minute. A typical X-15 longitudinal acceleration profile is shown in the attached graphs. The acceleration profile of an Atlas launched Mercury is not included since it is classified, however, its profile is considerably more severe and would represent one extreme of the range of possible longitudinal acceleration profiles.

The combination of control demands, acceleration, and other stresses placed on the pilot simultaneously are of more significance than the severity of the control problems or stresses alone. In this vehicle the boost accelerations will begin with the takeoff roll and continue through the transition from horizontal to near-vertical flight. Therefore, peak longitudinal accelerations of +3G's and burn times exceeding 90 seconds will present a combination of longitudinal acceleration, rapid attitude change, and control problems that will require precision control and rapid responses comparable to that of a boosting orbital vehicle.

(2) Rapid attitude changes and steep climb angles:

Rapid attitude changes during boost are inherent in a vehicle that takes off or launches from a horizontal attitude and transitions into vertical or near vertical climb angles. Boost performance should be such that altitudes of 200,000 to 300,000 feet can be attained, using 70° to 90° climb angles. Shallower climb angles (25° to 45°) to intermediate altitudes with dynamic pressures near the apex that will afford use of reaction controls should also be possible. Performance in these ranges will give satisfactory approximation to boost trajectories of vertically boosted vehicles. In addition, while in boost environment, the pilot will be required to precisely control:

(a) Attitude

(b) Flight path

(c) Thrust

1 Thrust level

2 Burn time

(c) Thrust

1 Thrust level

2 Burn time

(d) Velocity Profile

(e) Test instrumentation and data recording equipment.

(3) Control during boost:

Precision thrust variation to afford accurate control of velocity and cut-off should be possible. Flight instrumentation, using both airborne and ground inputs, should allow the pilot to fly a precise flight profile. This will require altitude, attitude, space position, and velocity indications with near zero lag.

B. SPACE OPERATIONS

(1) Unusual environmental conditions, piloting tasks, and special equipment associated with space operations include:

(a) Low dynamic pressure: The trainer should be capable of profiles that provide dynamic pressures less than 10 psf at altitudes between 200,000 and 400,000 feet for periods exceeding two minutes. This will provide adequate time for use of reaction controls to practice various maneuvers and establish re-entry attitude. Except for vehicle velocity relative to the earth, a 300,000 foot maximum altitude places the vehicle in a space environment closely approximating an orbital vehicle. The reaction control system must be capable of manual control with and without automatic stability augmentation in all 3 axes. Various roll, pitch and yaw rates should be capable of being preset on the ground.

(b) Life Support Systems: Since the vehicle will operate in space, space type life support equipment will be required to provide student familiarization with important life support equipment operation and design. The life support system should be capable of providing a shirt-sleeve environment with full pressure suit backup for safety.

(c) Maneuvering in Space: Ideally the vehicle should provide the capability of changing its position relative to another vehicle or frame of reference while in the space environment. However, this capability would require a store of rocket fuel very much in excess of that needed to achieve the desired sub-orbital profile. The initial and operating costs for this type vehicle would be prohibitive for a training operation. Therefore, this particular feature is not considered a mandatory requirement.

C. RE-ENTRY

(1) Unusual environmental and piloting tasks associated with re-entry are:

(a) Longitudinal and normal g forces. Depending on re-entry angle and type of vehicle, orbital re-entry "g" forces vary from approximately 1 "g" to in excess of 10 "g's". Considering pilot tolerance, practical maximum "g" loads are: "10 g's" eyeballs in; 3-5 "g's" eyeballs out and 5 "g's" eyeballs down.

The "g" forces during re-entry of the proposed trainer will be determined by its boost performance. A vehicle with longitudinal accelerations of 2 to 4 g's and exit angles 70 to 90 degrees during boost will reproduce re-entry "g" loads of from -1 to -3.5 longitudinally and from 4.75 to 5.5 in a normal direction. The duration of the "g" forces in re-entry will only be a fraction of that for actual orbital re-entry. However, in keeping with the basic idea of heavy training operations at minimum costs, adequate coverage rather than duplication will be satisfactory.

(b) Control during re-entry: An ideal re-entry trainer would be capable of being inserted into orbital re-entry profiles along a corridor ranging from very shallow to relatively steep paths of several degrees. However, such a capability would require velocity and altitude performance approaching orbital flight. To keep initial and operating costs low and provide high use rates, re-entry performance for the proposed trainer should be limited to that which is compatible with the boost performance previously described. This necessarily restricts re-entry velocities and angles to a narrow range. They will generally be steep (70-90°) and comparatively slow. Although the re-entry profile will be considerably different from that of an actual orbital re-entry vehicle, the piloting tasks confronting the pilot will be approximately the same and of the same order of difficulty as those encountered in an orbital re-entry vehicle. These re-entry tasks will include:

1 Precise vehicle attitude control longitudinally and laterally in response to an energy management and vehicle heating display.

2 Relying on and following directions from ground stations.

3 Monitoring and controlling test instrumentation and data recording equipment.

4 Doing all of the above with decreased cockpit visibility because of heat shielding required during re-entry.

D. RECOVERY

The recovery phase is essentially an energy management problem involving an unpowered landing. The performance of the proposed trainer must permit recovery from the point of completion of the re-entry phase to the initial takeoff point. There must be sufficient margin in altitude at the landing site following a non-optimum recovery to compensate for reasonable errors in energy management on the part of the pilot. Although not mandatory, a sustainer type jet engine to compensate for such errors is desirable.

E. SUMMARY OF MANDATORY DESIGN FEATURES AND PERFORMANCE REQUIREMENTS

(1) Two-place vehicle (controllable from both cockpits)

(2) Capable of sustained flight rate of ten flights per trainer per month.

(3) Launch and recovery at the same site.

(4) Longitudinal "g" forces during boost to reach at least 3 "g's".

(5) Horizontal takeoff and landing from lakebed or runway. Air launch capability optional.

(6) Altitude capability in excess of fifty miles.

(7) Capability for boost trajectories (25° to 45°) to intermediate altitudes with dynamic pressures less than 10 psf at apex.

(8) Other:

(a) Aerodynamic control

(b) Reaction controls

(c) Stability augmentation for both types of flight controls

(d) Throttleable thrust control 50% to 100% range.

(e) Instrument display that will allow precise pilot control during all phases of flight.

7. If an advanced aerospace trainer were available now, it could be effectively utilized to provide training for Gemini, and X-20 crews. However, due to lead time considerations, this vehicle's future use should be considered to be for post X-20 projects. Useful life is estimated to be ten years since it will be capable of providing training that is appropriate for near term aerospace vehicles. In other words,

manned space vehicles within the next 10-15 years will have the same general propulsion, control, instrument display, and life support systems that current space vehicles have and will have generally the same type flight limitations and problems.

8. This vehicle will initially be employed by the USAF Aerospace Research Pilot School to train Aerospace Research Pilots for future aerospace research vehicles. If the demand for operational space pilots ultimately requires an operational space pilot training program, a follow-on procurement of this vehicle for the Air Training Command might be considered if it is still considered to be suitable for aerospace vehicle crew training.

The trainer should be procured as a complete system to include all peculiar support equipment and facilities. Since Edwards AFB has extensive facilities for this type vehicle, facilities costs should be considerably less for the initial procurement. These facilities include exotic fuels storage and servicing equipment, high pressure gas generating, storing and servicing equipment, rocket engine maintenance and overhaul facilities, a large fully instrumented range with numerous emergency landing fields and a terminal landing area complex that is more than adequate.

Quantities required will be dependent on the following general considerations:

a. Number of trainees and number of flights per trainee. Number of trainees will be estimated by USAF requirements while number of flights per trainee will be dependent on the School's curriculum. The curriculum will be developed basically on the vehicle's training capability per flight.

b. The vehicle's predicted utilization rate.

c. Attrition estimates

Once a specific aerospace trainer concept is approved, more definitive quantity estimates can be made.

9. Two contractors are currently investigating the feasibility of modifying operational high-performance turbojets (T-38's and F-104's) to an aerospace trainer configuration. This approach, should it prove feasible, will undoubtedly decrease initial procurement costs since much of their basic aerodynamic, design and structural data will be applicable. However, it should be noted that the modified vehicles will have to incorporate extensive system changes such as propulsion, fuel, auxiliary power, flight control, life support and cockpit display.

In addition, extensive structural and materiel changes will be required.

Another possible solution is procurement of modified X-15's. This solution will also require thorough investigation into feasibility.

In the event the solutions mentioned above prove unsuitable, a completely new specifically designed vehicle will be required.

For J. H. Curtis LT/COL USAF

CHARLES E. YEAGER, Colonel, USAF
Commandant

4 atchs
1. Design Trajectory, J79-3B Engine (Fig. 1)
2. Design Trajectory, J79-3B Engine (Fig. 2)
3. Nominal Trajectory (Fig. 3)
4. X-15 Long. Accel Profile (Fig. 4)

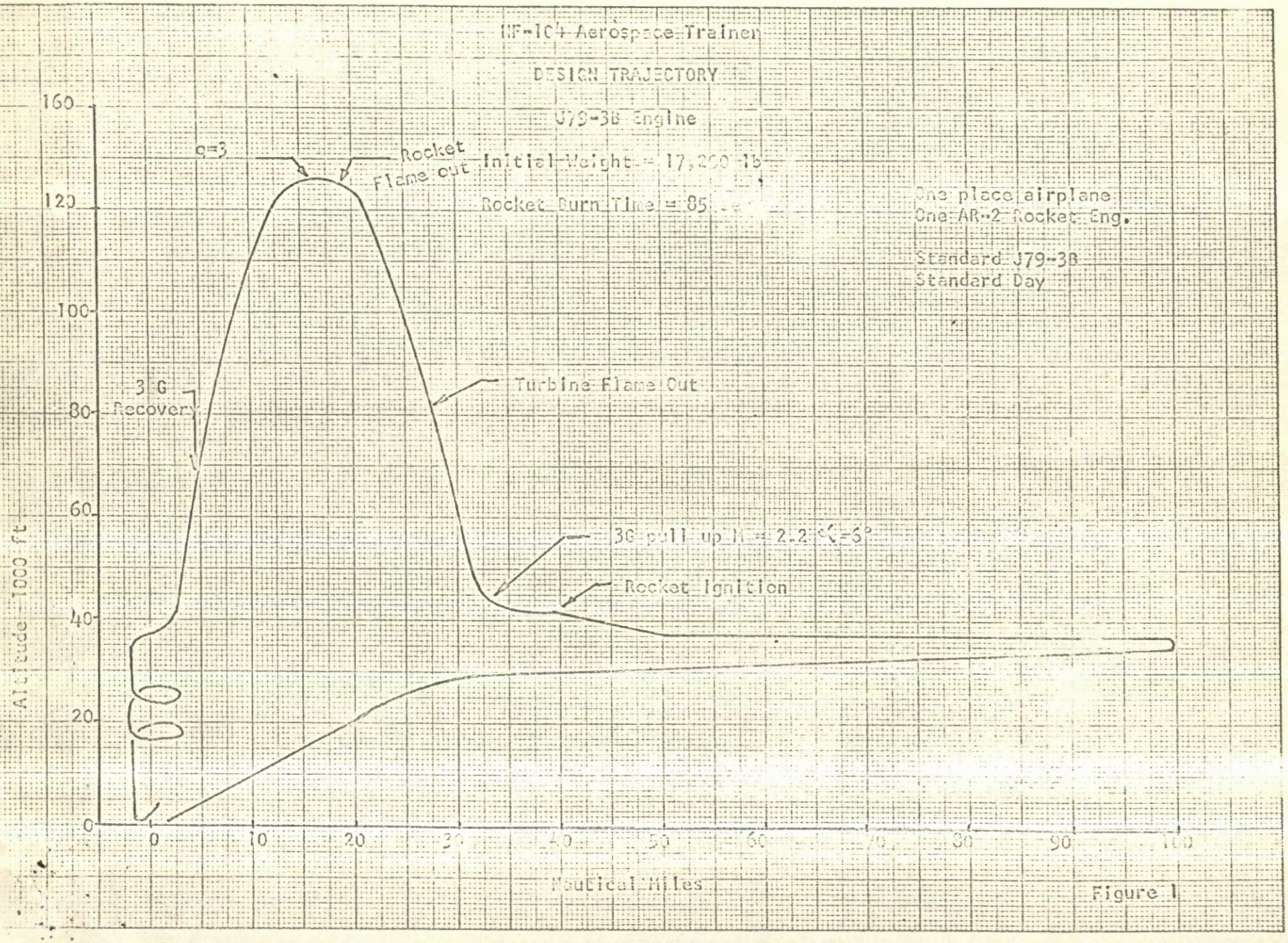
NF-104 Aerospace Trainer
DESIGN TRAJECTORY
J79-3B Engine
Initial Weight = 17,200 lb
Rocket Burn Time = 85
One place airplane
One AR-2 Rocket Eng.
Standard J79-3B
Standard Day
Rocket Flame out
3 G Recovery
Turbine Flame Out
Rocket Ignition
Altitude 1000 ft
Nautical Miles
160
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100

Figure 1

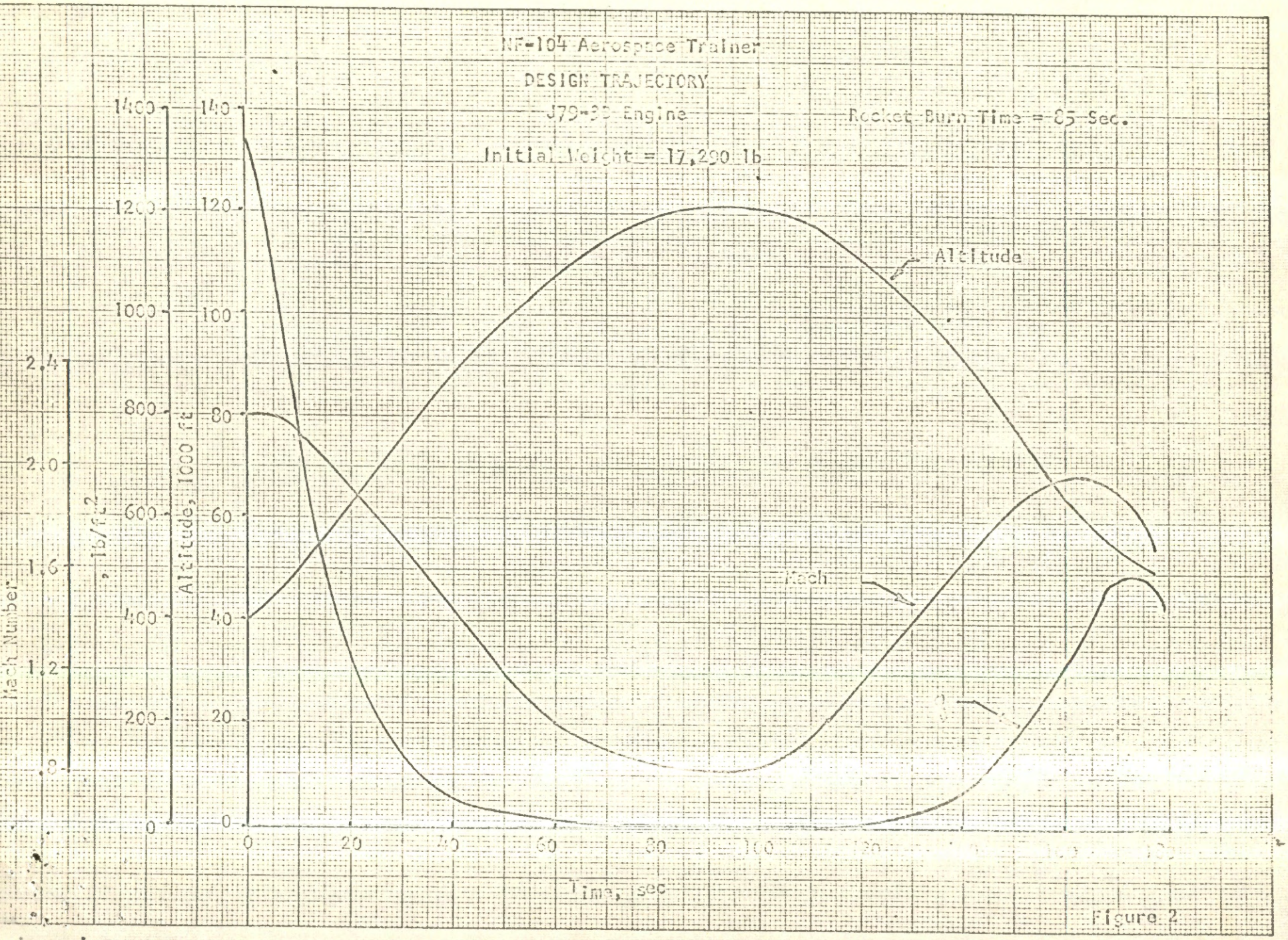
NF-104 Aerospace Trainer
DESIGN TRAJECTORY
J79-GE-3 Engine
Rocket Burn Time = 85 Sec.
Initial Weight = 17,290 lb
Altitude
Mach
Mach Number
q, lb/ft2
Altitude, 1000 ft
Time, sec
0
20
40
60
80
100
200
400
600
800
1000
1200
1400
.8
1.2
1.6
2.0
2.4

Figure 2

KEUFFEL & ESSER CO. MADE IN U.S.A.

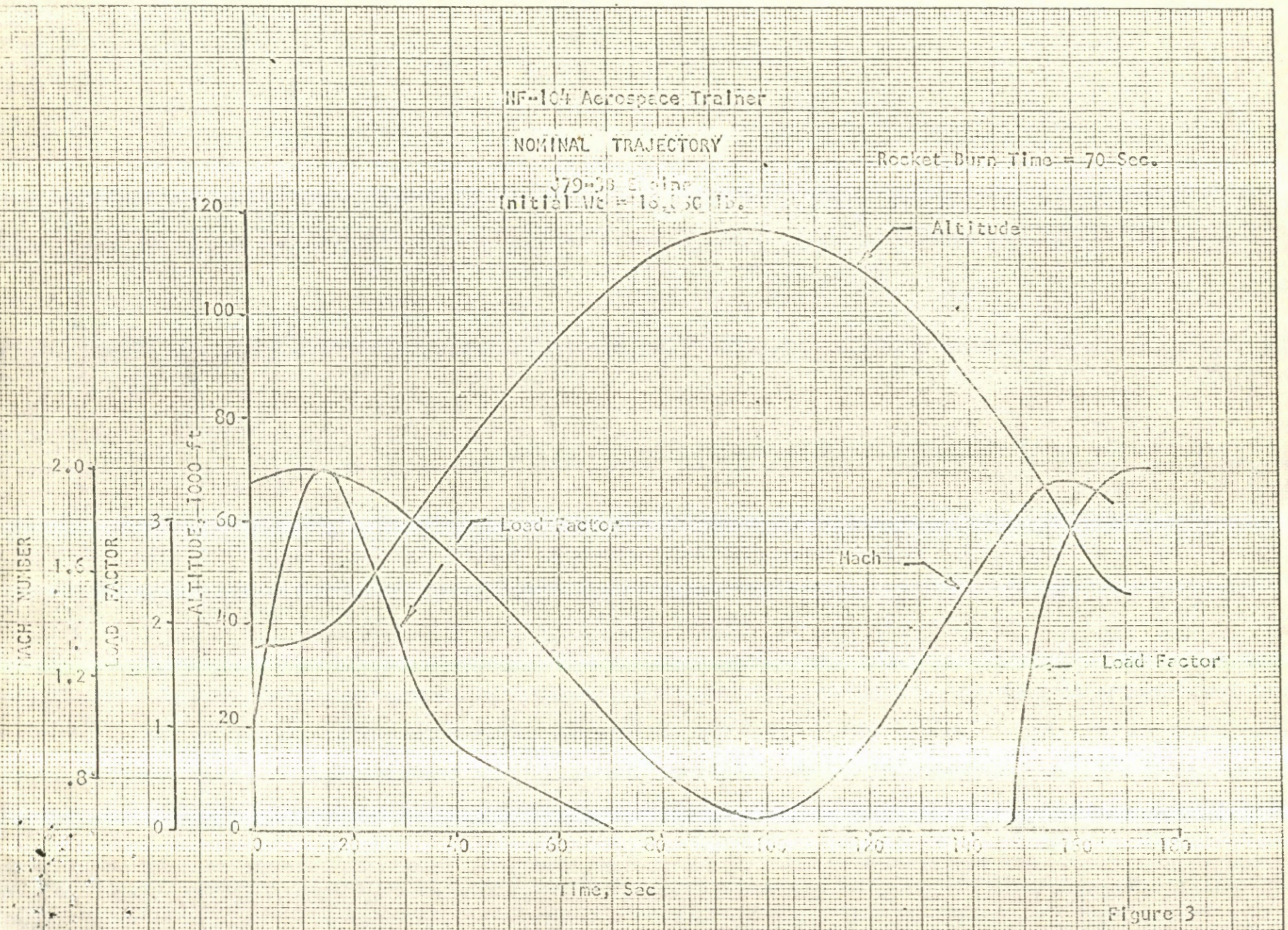

Figure 3

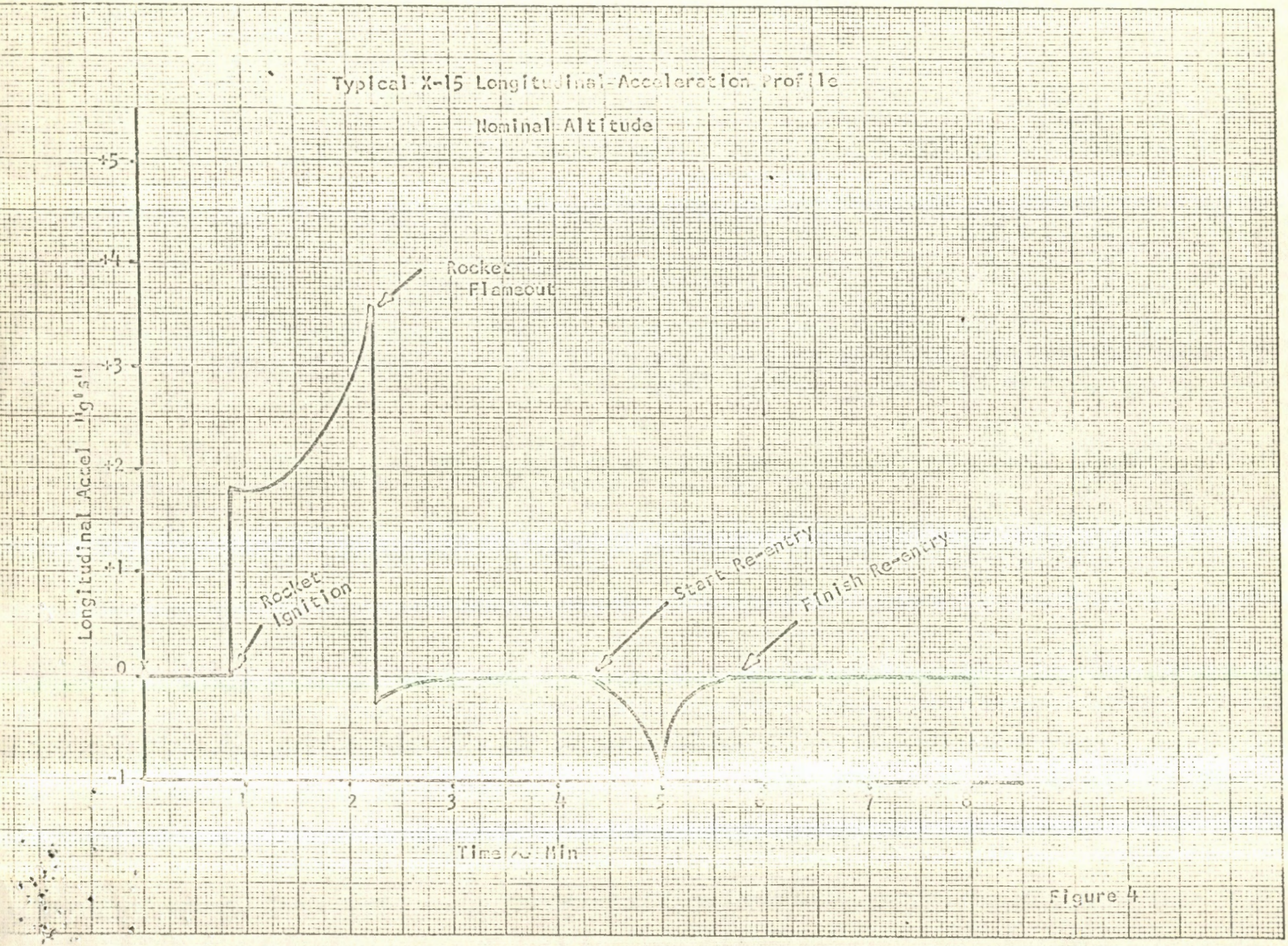
Typical X-15 Longitudinal-Acceleration Profile
Nominal Altitude
Longitudinal Accel "g's"
+5
+4
+3
+2
+1
0
-1
Rocket Flameout
Rocket Ignition
Start Re-entry
Finish Re-entry
1
2
3
4
5
6
7
8
Time Min

Figure 4

19 Sep 763

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
ANDREWS AIR FORCE BASE
Washington 25, D. C.

DATE
30 SEP 1963

MEMORANDUM FOR: SCGC

1. The QOR for the Aerospace Trainer was not endorsed for adoption by the Hq AFSC staff.

2. The coordinated position, however, of all interested staff agencies is that the QOR should be included in our basic plan (ARPS Expansion Plan) to be reviewed and up-dated on an annual basis.

3. The present NF104A rocket modified trainer will be included in the curriculum soon for the seeable future. A follow-on or true Aerospace Trainer, as proposed in the QOR, might be considered for inclusion in the curriculum at a future date depending upon known requirements, and most importantly, a more clearly defined military man in space mission.

4. In view of the above, it is recommended that the basic letter outlining the Hq AFSC position be resubmitted to the Vice-Commander for signature. It is felt that HQ USAF should have the opportunity to approve our "watch and wait" position regarding a future aerospace trainer and to review the QOR itself.

GERHARD J. SCHRIEVER
COLONEL, USAF
DCS PERSONNEL

RECEIVED
COMMAND ADMIN
HQ AFSC

SEP 30 12 34 PM '63

19 Sep 763

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

DATE 21 Sep 63

MEMORANDUM FOR: SCP

1. Please note the Vice Commander's desk memo attached. The requirement for an Aerospace Trainer of the character proposed is highly suspect. A detailed analysis needs to be made of the actual benefit achieved from rocketing a trainer to the altitude proposed in this plan vs a more modest and practical requirement associated with Aerospace Training of landing an unpowered glider simulating conditions to be experienced in the low altitude phase of the DYNA-SOAR recovery.

2. It is requested that this matter be thoroughly studied by the staff and that a presentation be made to the AFSC Council if the staff (through the DCS level) considers the requirement valid and supportable.

I Atch
SCPTP proposed ltr to
Hq USAF, subj: QOR,
Aerospace Trainer w/
Vice Cdr's desk memo
dtd 20 Sep

WEL

W. E. LEONHARD
BRIGADIER GENERAL, USAF
CHIEF OF STAFF

DO NOT REMOVE THIS REFERRAL SLIP FROM DOCUMENT

19 Sep 763

COMMAND SECTION	INFO	SIGN	INITIALS	STAFF			
SCG				ACTION COPY FURNISHED			
SCGV		✓					
				INFO COPY FURNISHED			
SCGC	✓		CWR				
SCGC-1	✓		H		REFERENCE ATTACHED		
					REFERENCE NOT AVAILABLE IN SCGCA		
SCGCA	✓		DR	SCGE	INFO	SIGN	INITIALS

COMMENTS

20 Sept

C/S

This may well be a valid and important requirement. I think, however, we should study possible alternatives a bit more before we put on a presentation for AFSC Council. If Council agrees then we should forward the QOR

HOWELL M. ESTES, JR.
Lt General, USAF
Vice Commander

DO NOT REMOVE THIS REFERRAL SLIP FROM DOCUMENT

SCGC

Qualitative Operational Requirement (QOR), Aerospace Trainer 9 OCT 1963

HQ USAF (AFRSTC)

1. The USAF Aerospace Research Pilot School has prepared a QOR on an Aerospace Trainer. (Atch 1)

2. The QOR has been staffed at this headquarters, and, subject to your concurrence, the following course of action is proposed:

a. The Aerospace Trainer QOR be included in the ARPS Expansion Plan to be reviewed and updated annually (reference SCP letter, subject: "Requirements for, and Utilization of, Aerospace Research Pilot School Graduates," dated 11 September 1963).

b. Evaluate the utilization, competency gained and projected life of the rocket modified NF104A.

c. Anticipate a probable requirement for a true Aerospace Trainer based upon a clearly defined military man in space mission.

d. Initiate a formal procurement cycle for an Aerospace Trainer at your direction and as the requirement becomes more definitive.

FOR THE COMMANDER

SIGNED

W. E. LEONHARD
Brigadier General, USAF
Chief of Staff

1 Atch
Ltr, ARPS (FTT), 7 Aug 63, subj as above, w/4 atch and 1st Ind. AFFTC (FTO), 12 Aug 63

SCPTP

Capt Horne, SCPTP, 2322, 26 Sep 63
Revised by Gen Leonhard/vu

SCGV

Qualitative Operational Requirement (QOR), Aerospace Trainer

HQ USAF (AFRSTC)

1. The USAF Aerospace Research Pilot School has prepared a QOR on an Aerospace Trainer. (Atch 1)

2. The QOR has been staffed at this Headquarters and, subject to your concurrence, the following course of action is proposed:

a. The Aerospace Trainer QOR be included in the ARPS [illegible] a[illegible]sion Plan to be reviewed and updated annually (reference SCP letter, subject: Requirements for, and Utilization of, Aerospace Research Pilot School Graduates, dated 11 Sep 63).

b. Evaluate the utilization, competency gained and projected life of the rocket modified NF104A.

c. Anticipate a probable requirement for a true Aerospace Trainer based upon a clearly defined military man in space [illegible].

d. Initiate a formal procurement cycle for an Aerospace [illegible] at your direction or as a requirement becomes more definitive.

1 Atch
Ltr, ARPS (FTT), 7 Aug 63, subject as above, w/4 atchs and 1st Ind, AFFTC (FTO) 12 Aug 63

RETYPED WITH PAR 2a & 3 CHANGE

NAME, GRADE OR TITLE & OFFICE SYMBOL OF ORIGINATOR	DATE	TELEPHONE NUMBER	TYPIST INITIALS
Capt Horne/SCPTP	26Sep63	2322	LLC

COMMAND SECTION
SCG
SCGE
SCGV
SCGC
SCGS
SCGM
SCGCA
SCGB
SCH
MSF
SPECIAL STAFF
SCA
SCD
SCE
SCI
SCJ
SCW
SCX
SCO
DEPUTY CHIEFS
SCC
SCF
SCK
SCL
SCM
SCP
SCS
SCT
OTHER
SCQ

AFSC HQ FORM JUN 63 16 AFSC (AAFB) 1963 COORDINATION SHEET

PREVIOUS EDITION OF THIS FORM MAY BE USED.

19 SEP 7 6 3

SCGV

Qualitative Operational Requirement (QOR), Aerospace Trainer

Hq USAF (AFRSTC)

1. The USAF Aerospace Research Pilot School has prepared a QOR on an Aerospace Trainer. (Atch 1)

2. The QOR has been staffed at this Headquarters and, subject to your concurrance, the following course of action is proposed:

a. Approve the Aerospace Trainer QOR for inclusion in the ARPS Expansion Plan for annual updating and review (Reference SCP letter, subject, Requirements for, and Utilization of Aerospace Research Pilot School Graduates, dated 31 July 1963).

b. Evaluate the utilization, competency gained and projected life of the rocket modified NF104A.

c. Anticipate a probable requirement for a true Aerospace Trainer based upon a clearly defined military man in space mission.

d. Initiate a formal procurement cycle for an Aerospace Trainer at your direction or as a requirement becomes more definitive.

3. Request your evaluation of the QOR and analysis of the Hq AFSC position as outlined in the above.

1 Atch
Ltr, ARPS (FTT), 7 Aug 63, subject as above, w/4 atchs and 1st Ind, AFFTC (FTO) 12 Aug 63

Retyped Changed Par 2a

SCO-3 MSFAM B. J. Ford, Maj

NAME, GRADE OR TITLE & OFFICE SYMBOL OF ORIGINATOR	DATE	TELEPHONE NUMBER	TYPIST INITIALS
CAPT R. G. HORNE, SCPTP RETYPED WITH SUBJ CHANGE	12 SEP 63	2322	rwn

AFSC HQ FORM JUN 63 16 AFSC (AAFB) 1963 COORDINATION SHEET

PREVIOUS EDITION OF THIS FORM MAY BE USED.

SCG
SCGE
SCGV
SCGC
SCGS
SCGM
SCGCA
SCGB
SCH
MSF
SPECIAL STAFF
SCA
SCD
SCE
SCI
SCJ
SCW
SCX
SCO
DEPUTY CHIEFS
SCC
SCF
SCK
SCL
SCM
SCP
SCS
SCT
OTHER
SCQ

9-18-2-M

19 SEP 7 63

STAFF SUMMARY SHEET

TO	ROUTE	DESIRED ACTION	SIGNATURE	DATE
SCS	1	Coordination		13 SEP 1963
MSF	2	Coordination		
SCC	3	Coordination		OFFICE OF PREPARATION
SCL	4	Coordination		SCPTP
SCM	5	Coordination		
SCO	6	Coordination		GRADE - SURNAME / PHONE
SCP	7	Review		
SCGCA	8	Process		Capt Horne / 2322

SUBJECT

Qualitative Operational Requirement, Aerospace Trainer

SUMMARY

DISCUSSION:

1. The USAF Aerospace Research Pilot School staff has submitted a qualitative operational requirement (QOR) for a future aerospace trainer.

2. The QOR has been staffed by appropriate Hq AFSC staff agencies. See attachments a through g.

3. An analysis of the staff comments indicate that there will undoubtedly be a future requirement - probably after 1970 - for an aerospace trainer, but a definite and near future requirement is obscure.

4. The school is preparing a detailed, five year ARPS Expansion Plan. It is felt that the QOR should be a part of that plan and reconsidered in the future in light of a more clearly defined military manned space flight mission; an evaluation of the performance and qualities of the NF104A; a definition of USAF input to advanced programs such as the National Orbital Space Station (NOSS)

RECOMMENDATION:

5. Request the Vice-Commander, Headquarters AFSC, sign the attached letter.

KENNETH E. MARTS
Colonel, USAF
Asst DCS/Personnel

8 Atch
1. Tab A-Ltr, SCS, subject as above, 6Sep63
2. Tab B-Ltr, MSF, subject as above, 10Sep63
3. Tab C-Ltr, SCC, subject as above, 9Sep63
4. Tab D-Ltr, SCL, subject as above, 11Sep63
5. Tab E-Ltr, SCM, subject as above, 6Sep63
6. Tab F-Ltr, SCO, subject as above, 28Aug63
7. Tab G-Ltr, SCPTP, subject as above, 23 Aug 63
8. Proposed ltr to Hq USAF, (AFRSTC)

Do not forward to Command Section until this block has been signed and dated by the appropriate OPI. This block, when signed, signifies completed coordination and that the OPI is aware of concurrence, non-concurrence and either resolution of difference or why the non-concurrence should be overridden.

Signature Chief Cmd Cm Sgt Sgt Maj Date 19 Sept 63

AFSC FORM SEP 61 149 PREVIOUS EDITION OF THIS FORM MAY BE USED.

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO ATTN OF: SCL

11 SEP 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCP

1. Reference SCPTP letter dated 28 Aug 63, subject as above.

2. Subject QOR has been reviewed as requested. SCL concurs with the Aerospace Research Pilot School in that a follow-on procurement to the NF-104A in the form of a more advanced aerospace trainer will be required in the post 1973 period.

3. The NF-104A should provide adequate pilot training for Dyna-Soar, Gemini and Apollo through 1968, and possibly later. This training should suffice for the operation of these vehicles during the 1968-1973 time period.

4. The period 1973-1978 is, therefore, the period we feel a requirement could, and probably will, exist for a more sophisticated and advanced space trainer.

5. At this time, however, it is not possible to precisely postulate trainer performance requirements for that period, since follow-on systems to Dyna-Soar, Gemini and Apollo are not yet defined. The performance requirements stated in the QOR represent a best estimate based on the facts at hand now, and may or may not be realistic in the final analysis.

6. Despite this fact, it is recommended the QOR be approved in order to formally initiate the procurement cycle for the space trainer, and also in order to utilize available lead time to maximum extent possible.

7. It is further recommended that a study be initiated to determine the state-of-the-art envisioned in propulsion, control, and life support systems for the 1973, and after, time period.

8. This study, plus inputs from other investigations and yet to be effected studies on manned space systems envisioned after Dyna-Soar, Gemini, and Apollo, should enable us to periodically update QOR performance parameters and more realistically define trainer system requirements for post 1973.

George R. Kemberling
for
W. B. Keese
Maj Gen, USAF
DCS/Plans

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: MSFAM

10 SEP 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCPTP

1. Reference your 28 August 1963 letter, same subject. We are in agreement that there will undoubtedly be a requirement for training significant numbers of Air Force officers as the Air Force expands its manned operations in space. However, on the basis of the present and forecast manned military space program, we do not concur that the QOR is justified at this time.

a. The only approved military manned space program is the X-20. Pilots for this program have been selected and have been undergoing specific-mission training for a period of years. An advanced trainer could not be available in time to benefit that program.

b. Both a follow-on Dyna-Soar and follow-on Gemini are potential programs, but the probability of approval of such programs is not high enough to justify acquisition of an advanced trainer. As far as the National Orbital Space Station (NOSS) is concerned, USAF plans to initiate studies leading to acquisition of NOSS. However, NOSS is too nebulous at the present time to justify the large expenditure for an advanced trainer.

2. The future of military manned space flight is presently in a state of flux. We anticipate that the role of the military in space will crystallize during the next few years. When it does, a QOR based upon more definite requirements can be better justified, and, if approved, will permit acquisition of an advanced aerospace trainer which represents a quantum jump over the Lockheed, Northrup, and North American proposals presently being considered by ARPS.

J Sanders Jr

ERWIN A. MEYER, JR.
Colonel, USAF
Director, Military Space Programs
Office, Manned Space Flight

H E A D Q U A R T E R S
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: SCCPS

9 SEP 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCPTR

SCC has no comment as to the requirement for this Aerospace Trainer. The following considerations are offered on satisfying this requirement, if it is validated:

a. If the QOR is forwarded to Hq USAF with Command approval, it is suggested that ASD be requested to study the cost-effectiveness of the T-38/F-104 approach vs. modified X-15 vs. a new vehicle. This type of analysis will be required ultimately and time can be saved if the study is initiated immediately.

b. A cost-effectiveness study should also be requested on a 10-15000 pound thrust capability so that heavier fighter type aircraft may be considered in evaluating the approach to be taken in an Aerospace Trainer.

c. An additional consideration is that, historically trainers have evolved from operational systems. At this point in time this approach cannot be taken since our first operational aerospace craft (X-20) is some years away. The Aerospace Trainer would not be available in time to be used in training our initial group of pilots for this program. Consideration should be given to awaiting early results of the X-20 program and basing the development of a trainer on results obtained. In the interim period, the T-38/F-104/X-15/10-15000 lb rocket engine method of training be used.

DUWARD L. CROW
Brigadier General, USAF
DCS/Comptroller

6 SEP 1963

SCSAB/Lt Colonel Benefiel/5104

Qualitative Operational Requirement, Aerospace Trainer

SCPTP

1. It is considered premature, at this time, to establish a firm requirement for an Aerospace Trainer.

2. The NF-104A should provide valuable data on technical and operational factors that will contribute significantly to the establishment of firm requirements.

3. It is recommended that approval of the subject requirement be withheld pending results of operating the NF-104A.

SIGNED
ROBERT W. SODERBERG

T. T. OMOHUNDRO, Colonel, USAF
Director, Aeronautical Systems
DCS/Systems

8-29-4-0

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO ATTN OF: SCMO

6 SEP 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCPTP

1. Reference your memo dtd 28 Aug 63, subject as above.

2. I concur in the requirement for an improved Aerospace Trainer over and above the NF-104A. While I concur in principle with the principles outlined in paragraph 6 of Captain Horne's memorandum, I do not consider that we should hold up development indefinitely.

3. In summary, it is recommended that a determination be made as to what is technically feasible development wise over the next several years.

CALVIN W. FITE, JR.
Colonel, USAF
Director of Operations
DCS/Materiel

Copy to:
SCM

H E A D Q U A R T E R S
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: SCSAB/Lt Colonel Benefiel/5104

6 SEP 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCPTP

1. It is considered premature, at this time, to establish a firm requirement for an Aerospace Trainer.

2. The NF-104A should provide valuable data on technical and operational factors that will contribute significantly to the establishment of firm requirements.

3. It is recommended that approval of the subject requirement be withheld pending results of operating the NF-104A.

R W Soderberg Col
for T. T. OMOHUNDRO, Colonel, USAF
Director, Aeronautical Systems
DCS/Systems

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO ATTN OF: SCPTP

28 August 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCM SCS MSF SCL SCC SCO -3

1. Request your review, comments and recommendations concerning the attached by 6 Sep 63. (Atch 1) The position of this office, as coordinated with the DCS/Personnel, is attached for your information. (Atch 2)

2. Subsequent to our receipt of your views regarding the aerospace trainer, a coordinated AFSC position will be developed and forwarded to the appropriate Air Staff agency.

RICHARD G. HORNE, Captain, USAF
Chief, Career Programs
Personnel Plans & Training
DCS/Personnel

2 Atch
1. Ltr, AFFTC (FTT), dtd 7 Aug 63, w/1st Ind, AFFTC (FTO), dtd 12 Aug 63
2. Ltr, SCPTP, dtd 23 Aug 63

1st Ind (SCO-3)

Hq AFSC

4 September 1963

TO: SCPTP

No Comment.

for Earl L. McCabe
JOSEPH M McPHIE
Lt Col, USAF
Chief, Long Range Plans Office
Office of Manpower & Organization

2 Atch n/c

FORGING MILITARY SPACEPOWER

H.
2596

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: SCPTP

23 AUG 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCPT
SCP
IN TURN

1. The NF-104A, rocket modified trainer now being developed is, at best, a transitional aerospace trainer. It should bridge the gap from conventional F-104 aircraft to a true (one that trains in space, i.e., +50 miles) aerospace trainer of tomorrow.

2. In the logical progression of the school, more sophisticated training aircraft must eventually be conceived, planned, acquired and utilized.

3. The AFFTC statement as to a "critical requirement for updating the capability of the Aerospace Research Pilot School" is questioned. At the earliest, a true aerospace trainer could not be delivered in a quantity of six until 2 to 3 years from a given start date. Factors bearing on the non-critical nature of the aerospace trainer are:

a. The NF-104A is rapidly coming into the inventory.

b. There is not now a clearly defined military man in space mission.

c. The student output in quality and numbers is meeting today's needs.

4. Two companies and possibly a third have been working on the aerospace trainer concept at their own respective expense. The time has come to either develop a firm AFSC position regarding its further development or to run the risk of falling behind in terms of the future competency of our Aerospace Research Pilot School type graduates. Industry will have difficulty in selling the Aerospace Trainer as merely an Aerospace Research Pilot School-use aircraft.

atch 2

5. The life of the NF-104A is approximately 4-5 years. By 1968, a follow-on trainer or simply a better replacement appears to be a reasonable requirement.

6. My general comment is this: that the proposed true aerospace trainer is not a significant enough improvement over the NF-104A to be acquired for the school. Industry should be more visionary in developing an aerospace trainer. For example: the present apogee of the NF-104 will be approximately 122,000,000 feet and 1-2 minutes of weightlessness. If the Northrop, Lockheed and North American Aviation proposed trainer tripled this apogee and the minutes of weightlessness (Zero "G") this is not progress enough. I would think that increasing the apogee/weightlessness by ten-fold would be the objective for tomorrow's trainer. To be useful in space, man must be exposed to extended periods of weightlessness, variety of re-entry problems and a broad spectrum of activity. An extension of the NF-104A aircraft is not, in my judgement, the way to proceed. I believe that future aerospace craft must be as different in character, use and power as the atomic bomb was to the TNT "blockbuster." Finally, too much time is spent in launch and recovery of the present and proposed trainers as compared to the time actually spent (or proposed) experiencing ballistic controls, utilization and the effects of Zero "G."

7. The following is recommended:

a. Staff the QOR within the Headquarters.

b. Provide the Headquarters USAF Aerospace Research Pilot School OPR the AFSC position based upon the staff comments.

c. Subsequent to the Headquarters USAF review and direction either:

(1) Move forward with an aerospace trainer acquisition action.

(2) Maintain the aerospace trainer as an important part of the Aerospace Research Pilot School 5 Year Expansion Plan.

RICHARD G. HORNE, Captain, USAF
Chief, Career Programs
Personnel Plans & Training
DCS/Personnel

2 Atch
1. 1st Ind, AFFTC (FTO), dtd 12 Aug 63
2. Basic Ltr, AFFTC (FTT), dtd 7 Aug 63, w/4 atchs

SCGV

Qualitative Operational Requirements, Aerospace Trainer

Hq USAF (AFRSTC)

1. The USAF Aerospace Research Pilot School has prepared a QOR on an Aerospace Trainer. (Atch 1)

2. The QOR has been staffed at this Headquarters and, subject to your concurrance, the following course of action is proposed:

a. Approve the Aerospace Trainer QOR for inclusion in the ARPS Expansion Plan for annual updating and review (Reference SCP letter, subject, Requirements for, and Utilization of Aerospace Research Pilot School Graduates, dated 31 July 1963).

b. Evaluate the utilization, competency gained and projected life of the rocket modified NF104A.

c. Anticipate a probable requirement for a true Aerospace Trainer based upon a clearly defined military man in space mission.

d. Initiate a formal procurement cycle for an Aerospace Trainer at your direction or as a requirement becomes more definitive.

3. Request your evaluation of the QOR and analysis of the Hq AFSC position as outlined in the above.

1 Atch
Ltr, ARPS (FTT), 7 Aug 63,
subject as above, w/4 atchs
and 1st Ind, AFFTC (FTO)
12 Aug 63

retyped

JED

NAME, GRADE OR TITLE & OFFICE SYMBOL OF ORIGINATOR	DATE	TELEPHONE NUMBER	TYPIST INITIALS
CAPT R. G. HORNE, SCPTP	11SEP63	2322	rwn

AFSC HQ FORM JUN 63 16 AFSC (AAFB) 1963 COORDINATION SHEET

PREVIOUS EDITION OF THIS FORM MAY BE USED.

COMMAND SECTION
SCG
SCGE
SCGV
SCGC
SCGS
SCGM
SCGCA
SCGB
SCH
MSF
SPECIAL STAFF
SCA
SCD
SCE
SCI
SCJ
SCW
SCX
SCO
DEPUTY CHIEFS
SCC
SCF
SCK
SCL
SCM
SCP
Hear
SCS
SCT
OTHER
SCQ

STAFF SUMMARY SHEET

TO	ROUTE	DESIRED ACTION	SIGNATURE	DATE	
SCS	1	Coordination			
MSF	2	Coordination			
SCC	3	Coordination		OFFICE OF PREPARATION	
SCL	4	Coordination			
SCM	5	Coordination		SCPTP	
SCO	6	Coordination		GRADE - SURNAME	PHONE
SCP	7	Review			
SCGCA	8	Process		Capt Horne	2322

SUBJECT

Qualitative Operational Requirement, Aerospace Trainer

SUMMARY

DISCUSSION:

1. The USAF Aerospace Research Pilot School staff has submitted a qualitative operational requirement (QOR) for a future aerospace trainer.

2. The QOR has been staffed by appropriate Hq AFSC staff agencies. See attachments a through g.

3. An analysis of the staff comments indicate that there will undoubtedly be a future requirement - probably after 1970 - for an aerospace trainer, but a definite and near future requirement is obscure.

4. The school is preparing a detailed, five year ARPS Expansion Plan. It is felt that the QOR should be a part of that plan and reconsidered in the future in light of a more clearly defined military manned space flight mission; an evaluation of the performance and qualities of the NF104A; a definition of USAF input to advanced programs such as the National Orbital Space Station (NOSS)

RECOMMENDATION:

5. Request the Vice-Commander, Headquarters AFSC, sign the attached letter.

7 Atch
1. Tab A-Ltr, SCS, subject as above, 6Sep63
2. Tab B-Ltr, MSF, subject as above,10Sep63
3. Tab C-Ltr, SCC, subject as above, 9Sep63
4. Tab D-Ltr, SCL, subject as above,11Sep63
5. Tab E-Ltr, SCM, subject as above, 6Sep63
6. Tab F-Ltr, SCO, subject as above,28Aug63
7. Tab G-Ltr, SCPTP, subject as above, 23 Aug 63

Do not forward to Command Section until this block has been signed and dated by the appropriate OPI. This block, when signed, signifies completed coordination and that the OPI is aware of concurrence, non-concurrence and either resolution of difference or why the non-concurrence should be overridden.

Signature _____ Date _____

AFSC FORM 149 PREVIOUS EDITION OF THIS FORM MAY BE USED.

SCPTP 28 August 1963

Qualitative Operational Requirement, Aerospace Trainer

SCM SCS MSF SCL SCC SCO

1. Request your review, comments and recommendations concerning the attached by 6 Sep 63. (Atch 1) The position of this office, as coordinated with the DCS/Personnel, is attached for your information. (Atch 2)

2. Subsequent to our receipt of your views regarding the aerospace trainer, a coordinated AFSC position will be developed and forwarded to the appropriate Air Staff agency.

RICHARD G. HORNE, Captain, USAF
Chief, Career Programs
Personnel Plans & Training
DCS/Personnel

2 Atch
1. Ltr, AFFTC (FTT), dtd 7 Aug 63, w/1st Ind, AFFTC (FTO), dtd 12 Aug 63
2. Ltr, SCPTP, dtd 23 Aug 63

COMMAND SECTION
SCG
SCGE
SCGV
SCGC
SCGS
SCGM
SCGCA
SCGB
SCH
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SPECIAL STAFF
SCA
SCD
SCE
SCI
SCJ
SCW
SCX
SCO
DEPUTY CHIEFS
SCC
SCF
SCK
SCL
SCM
SCP
SCS
SCT
OTHER
SCQ

NAME, GRADE OR TITLE & OFFICE SYMBOL OF ORIGINATOR	DATE	TELEPHONE NUMBER	TYPIST INITIALS
Capt Horne/SCPTP	28aug63	2322	LLC

AFSC HQ FORM JUN 63 16 AFSC (AAFB) 1963 COORDINATION SHEET

PREVIOUS EDITION OF THIS FORM MAY BE USED.

Horne

Ltr, AFFTC (FTT) Edwards AFB, Calif, Subj: Qualitative Operational Requirement, Aerospace Trainer

1st Ind (FTO) 12 AUG 1963

Hq AFFTC, Edwards AFB, California

TO: AFSC (SCP)

1. The need for an Aerospace Trainer is a critical requirement for updating the capability of the Aerospace Research Pilot School. Acquisition of self-launched trainer with near-space capability is believed to be the most economical method of providing this training.

2. Recommend approval.

FOR THE COMMANDER

H. H. WITTROCK
Colonel, USAF
DCS/Plans & Operations

4 Atchs
n/c

atch 1
SCP-63-1659

USAF
AEROSPACE RESEARCH PILOT SCHOOL
AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA

REPLY TO
ATTN OF: FTT

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

7 AUG 1963

TO: FTO

1. The following information is submitted in accordance with procedures outlined in AFR 57-3, 4 June 1963.

2. The USAF space mission is becoming more clearly defined each day. That the USAF will have operational manned space systems and vehicles within the next decade is now a foregone conclusion even though a great deal of controversy is currently associated with this premise. The USAF transition into the space era is requiring and will continue to require completely new research and operational space equipment. It follows therefore, that the need for space research pilots trained in the most modern equipment available will continue to be an essential part of the overall program.

To accomplish this training objective, a singularly important consideration is clear. Continued reliance on high performance modified and unmodified turbojet aircraft to accomplish this type training will result in the USAF falling considerably short of providing that degree of research pilot experience considered necessary. The readily identifiable deficiencies in current equipment include:

a. Serious deficiencies in required training capability.

b. A decrease in suitable high performance turbojet inventory during the next decade with no known plans for a follow-on procurement. Suitable high performance turbojets in this instance are aircraft that can be feasibly modified to incorporate supplemental rocket power.

Due to lack of developed rocket engines suitable for installation and use in turbojet aircraft, the number of operational turbojet types that can be classified as "suitable", are restricted to one aircraft, the F-104, because a flight qualified rocket engine (6000 pound thrust) is available for use in the F-104. F-101, F-102, F-105, F-106, F-110 and TFX aircraft are unsuitable due to their weight. To provide appreciable performance gains for these aircraft, a rocket engine capable of producing 10-15000 pound thrust is required. Unfortunately, there are no known rocket engines currently developed with a 10-15000 pound thrust capability although Rocketdyne Div., of NAA, Inc., has designed a 10-12000 pound thrust engine. This particular rocket engine is still in a design status, has not been test fired and no plans have been made for continued development effort due to lack of DOD interest and company funds.

A training concept that has important ramifications when considering a flight aerospace trainer is the training role of ground based simulators. Although ground based trainers have provided invaluable assistance in training programs, this type of trainer in no way can be considered more than an important supplement to a complete training program. The capability to expose a pilot to the actual environment in which tests are to be performed remains of cardinal importance.

In addition to the above required capabilities, it appears to be a valid assumption that other identifiable mission capabilities could be applied to this proposed aerospace trainer. These include, but are not necessarily limited to the following areas:

(1) Special high altitude research programs could be examined by substituting a sensor package for one of the crew positions. It is visualized that this Research Bay could be used to investigate various types of sensors, their applications, limitations and operational effectiveness.

(2) Maintenance of proficiency by active space pilots between space missions.

(3) Orientation/familiarization flights for non-pilot scientist crew members.

Since the requirements above are not specified as part of the Aerospace Research Pilot School mission responsibility, further definition and discussion concerning them will not be included in subsequent paragraphs. These requirements are indicated for the purpose of identifying possible applications in addition to the training requirement which is an integral part of the School curricula.

3. The mission of the USAF Aerospace Research Pilot School as stated in AFR 53-19, 1 May 1963, is: "The USAF Aerospace Research Pilot School trains selected officers to monitor or perform flight tests of research, experimental, or production type vehicles. These tests are made to determine flight characteristics, performance, stability, and functional utility, and to obtain technical information on serviceability and functioning of installed equipment and component parts".

4. The School's curriculum is segmented into four general areas which are:

a. Academic Training

b. Simulator Training

c. Bio-astronautics Training

d. Flying Training

This requirement is directly related to the flying training portion of the curriculum so the first three areas mentioned above will not be discussed further. At present, flying training is accomplished in operational high performance turbo-jet aircraft. These aircraft provide satisfactory training in all flying training areas except the broad areas directly pertaining to aerospace flight such as:

(1) Launch and ascent

(2) Operations in space

(3) Re-entry

(4) Recovery

To provide limited flying training in the areas above, a Class V modification project on three F-104A aircraft assigned to the School is currently being performed by Lockheed Aircraft Corporation. Each of these modified aircraft will have a 6000 pound liquid rocket engine for supplemental thrust, a reaction control system, an auxiliary cockpit pressurization system and other non-standard equipment such as special cockpit instrumentation and in-flight data recorders. Graphs showing predicted performance of these modified aircraft are attached. In addition, a Class V modification program on two F-106B aircraft assigned to the School has been approved and is currently in the initial stages of the procurement cycle. These two aircraft will be modified to incorporate a variable stability flight control system which will be capable of demonstrating normal and peculiar handling qualities of future aerospace vehicles during atmospheric flight. Completion of these two modification projects will greatly increase the School's ability to adequately train Aerospace Research Pilots, but their limitations, as discussed in the following paragraphs dictate a follow-on vehicle with a much greater capability.

5. The basic limitation in current or near term aerospace flying training equipment is lack of performance. Review of the predicted performance graphs (attached) for the modified NF-104A's, show the following primary performance limitations:

a. Dynamic pressure (q) below 12 psf - approximately 60 seconds during a maximum trajectory profile. Low dynamic pressures are required for effective training using reaction controls. Longer periods of reaction control training are highly desireable.

b. Peak Altitude - approximately 122,000 feet during maximum trajectory profile. High altitudes are required to place the trainee in a space environment. The modified NF-104A's perform considerably better than unmodified aircraft; however, 122,000 feet maximum altitude

is far short of a true space environment. Time above 100,000 feet (approximately 65 seconds) is also quite short.

c. Maximum Mach Number - 2.2. An important required pilot skill which has not received extensive publicity, is the ability to judge and plan the terminal portion of a flight while approaching the terminal point at extremely high velocities and altitudes. This pilot skill becomes increasingly important in vehicles such as the X-15 with a no-go-around capability. The comparatively slow approach speeds of the modified NF-104A's with their go-around capability allows very limited training in this area.

d. High Longitudinal Acceleration Effects. Although not included in the attached graphs, since it is negligible in the modified NF-104A's, longitudinal acceleration during rocket boost phases of flight is considered to be an important training area. X-15 pilot experience has shown head movements during periods of high longitudinal acceleration create sensory illusions which can be quite serious unless properly understood and compensated for. The low longitudinal acceleration capability in the modified NF-104A's offers extremely limited training in this area.

e. Re-entry. Training in re-entry piloting techniques and procedures is essential for the successful completion of any space mission. Studies of the re-entry vehicle profile and its related problems regarding acceleration forces, heating, and vehicle dynamics, have proven that this portion of the flight is most critical and particularly sensitive to pilot control techniques. These control techniques involve piloting the vehicle with regard to limits as defined by a particular re-entry corridor. Knowledge of re-entry corridor parameters and the method of maintaining a desired equilibrium glide path by controlling these parameters is essential for application of proper control procedures.

The NF-104A does not provide us with acceleration limits, heating limits, and because of the nature of its trajectory, does not afford sufficient variables to approach a re-entry corridor of significant dimensions.

6. The overall performance capabilities of the proposed aerospace trainer must, to the maximum degree practical, present significant environmental conditions and piloting tasks encountered during boost, space operations, re-entry, and recovery. The environmental conditions and piloting tasks need not duplicate those of actual orbital spacecraft, but should cover in type and relative severity, those phases of space flight which make the greatest demands on the pilot's judgement, endurance, and piloting skills.

Design philosophy must be based on maximum operating flexibility, high use rate, low operating costs and levels of performance that provide

adequate training in the four phases of space flight mentioned previously. A vehicle which has these ground handling and operating characteristics will not have the performance of an orbital vehicle and will therefore be a compromise between a high performance turbojet and an orbital vehicle.

More specific performance capabilities are discussed below:

A. BOOST PERFORMANCE

The unusual environmental conditions associated with boost are:

(1) High longitudinal accelerations:

Boost accelerations of typical sub-orbital and orbital vehicles range from +4 to +10G's over time intervals of up to one minute. A typical X-15 longitudinal acceleration profile is shown in the attached graphs. The acceleration profile of an Atlas launched Mercury is not included since it is classified, however, its profile is considerably more severe and would represent one extreme of the range of possible longitudinal acceleration profiles.

The combination of control demands, acceleration, and other stresses placed on the pilot simultaneously are of more significance than the severity of the control problems or stresses alone. In this vehicle the boost accelerations will begin with the takeoff roll and continue through the transition from horizontal to near-vertical flight. Therefore, peak longitudinal accelerations of +3G's and burn times exceeding 90 seconds will present a combination of longitudinal acceleration, rapid attitude change, and control problems that will require precision control and rapid responses comparable to that of a boosting orbital vehicle.

(2) Rapid attitude changes and steep climb angles:

Rapid attitude changes during boost are inherent in a vehicle that takes off or launches from a horizontal attitude and transitions into vertical or near vertical climb angles. Boost performance should be such that altitudes of 200,000 to 300,000 feet can be attained, using 70° to 90° climb angles. Shallower climb angles (25° to 45°) to intermediate altitudes with dynamic pressures near the apex that will afford use of reaction controls should also be possible. Performance in these ranges will give satisfactory approximation to boost trajectories of vertically boosted vehicles. In addition, while in boost environment, the pilot will be required to precisely control:

(a) Attitude

(b) Flight path

(c) Thrust

1 Thrust level

2 Burn time

(c) Thrust

1 Thrust level

2 Burn time

(d) Velocity Profile

(e) Test instrumentation and data recording equipment.

(3) Control during boost:

Precision thrust variation to afford accurate control of velocity and cut-off should be possible. Flight instrumentation, using both airborne and ground inputs, should allow the pilot to fly a precise flight profile. This will require altitude, attitude, space position, and velocity indications with near zero lag.

B. SPACE OPERATIONS

(1) Unusual environmental conditions, piloting tasks, and special equipment associated with space operations include:

(a) Low dynamic pressure: The trainer should be capable of profiles that provide dynamic pressures less than 10 psf at altitudes between 200,000 and 400,000 feet for periods exceeding two minutes. This will provide adequate time for use of reaction controls to practice various maneuvers and establish re-entry attitude. Except for vehicle velocity relative to the earth, a 300,000 foot maximum altitude places the vehicle in a space environment closely approximating an orbital vehicle. The reaction control system must be capable of manual control with and without automatic stability augmentation in all 3 axes. Various roll, pitch and yaw rates should be capable of being preset on the ground.

(b) Life Support Systems: Since the vehicle will operate in space, space type life support equipment will be required to provide student familiarization with important life support equipment operation and design. The life support system should be capable of providing a shirt-sleeve environment with full pressure suit backup for safety.

(c) Maneuvering in Space: Ideally the vehicle should provide the capability of changing its position relative to another vehicle or frame of reference while in the space environment. However, this capability would require a store of rocket fuel very much in excess of that needed to achieve the desired sub-orbital profile. The initial and operating costs for this type vehicle would be prohibitive for a training operation. Therefore, this particular feature is not considered a mandatory requirement.

C. RE-ENTRY

(1) Unusual environmental and piloting tasks associated with re-entry are:

(a) Longitudinal and normal g forces. Depending on re-entry angle and type of vehicle, orbital re-entry "g" forces vary from approximately 1 "g" to in excess of 10 "g's". Considering pilot tolerance, practical maximum "g" loads are: "10 g's" eyeballs in; 3-5 "g's" eyeballs out and 5 "g's" eyeballs down.

The "g" forces during re-entry of the proposed trainer will be determined by its boost performance. A vehicle with longitudinal accelerations of 2 to 4 g's and exit angles 70 to 90 degrees during boost will reproduce re-entry "g" loads of from -1 to -3.5 longitudinally and from 4.75 to 5.5 in a normal direction. The duration of the "g" forces in re-entry will only be a fraction of that for actual orbital re-entry. However, in keeping with the basic idea of heavy training operations at minimum costs, adequate coverage rather than duplication will be satisfactory.

(b) Control during re-entry: An ideal re-entry trainer would be capable of being inserted into orbital re-entry profiles along a corridor ranging from very shallow to relatively steep paths of several degrees. However, such a capability would require velocity and altitude performance approaching orbital flight. To keep initial and operating costs low and provide high use rates, re-entry performance for the proposed trainer should be limited to that which is compatible with the boost performance previously described. This necessarily restricts re-entry velocities and angles to a narrow range. They will generally be steep (70-90°) and comparatively slow. Although the re-entry profile will be considerably different from that of an actual orbital re-entry vehicle, the piloting tasks confronting the pilot will be approximately the same and of the same order of difficulty as those encountered in an orbital re-entry vehicle. These re-entry tasks will include:

1 Precise vehicle attitude control longitudinally and laterally in response to an energy management and vehicle heating display.

2 Relying on and following directions from ground stations.

3 Monitoring and controlling test instrumentation and data recording equipment.

4 Doing all of the above with decreased cockpit visibility because of heat shielding required during re-entry.

D. RECOVERY

The recovery phase is essentially an energy management problem involving an unpowered landing. The performance of the proposed trainer must permit recovery from the point of completion of the re-entry phase to the initial takeoff point. There must be sufficient margin in altitude at the landing site following a non-optimum recovery to compensate for reasonable errors in energy management on the part of the pilot. Although not mandatory, a sustainer type jet engine to compensate for such errors is desirable.

E. SUMMARY OF MANDATORY DESIGN FEATURES AND PERFORMANCE REQUIREMENTS

(1) Two-place vehicle (controllable from both cockpits)

(2) Capable of sustained flight rate of ten flights per trainer per month.

(3) Launch and recovery at the same site.

(4) Longitudinal "g" forces during boost to reach at least 3 "g's".

(5) Horizontal takeoff and landing from lakebed or runway. Air launch capability optional.

(6) Altitude capability in excess of fifty miles.

(7) Capability for boost trajectories (25° to 45°) to intermediate altitudes with dynamic pressures less than 10 psf at apex.

(8) Other:

(a) Aerodynamic control

(b) Reaction controls

(c) Stability augmentation for both types of flight controls

(d) Throttleable thrust control 50% to 100% range.

(e) Instrument display that will allow precise pilot control during all phases of flight.

7. If an advanced aerospace trainer were available now, it could be effectively utilized to provide training for Gemini, and X-20 crews. However, due to lead time considerations, this vehicle's future use should be considered to be for post X-20 projects. Useful life is estimated to be ten years since it will be capable of providing training that is appropriate for near term aerospace vehicles. In other words,

manned space vehicles within the next 10-15 years will have the same general propulsion, control, instrument display, and life support systems that current space vehicles have and will have generally the same type flight limitations and problems.

8. This vehicle will initially be employed by the USAF Aerospace Research Pilot School to train Aerospace Research Pilots for future aerospace research vehicles. If the demand for operational space pilots ultimately requires an operational space pilot training program, a follow-on procurement of this vehicle for the Air Training Command might be considered if it is still considered to be suitable for aerospace vehicle crew training.

The trainer should be procured as a complete system to include all peculiar support equipment and facilities. Since Edwards AFB has extensive facilities for this type vehicle, facilities costs should be considerably less for the initial procurement. These facilities include exotic fuels storage and servicing equipment, high pressure gas generating, storing and servicing equipment, rocket engine maintenance and overhaul facilities, a large fully instrumented range with numerous emergency landing fields and a terminal landing area complex that is more than adequate.

Quantities required will be dependent on the following general considerations:

a. Number of trainees and number of flights per trainee. Number of trainees will be estimated by USAF requirements while number of flights per trainee will be dependent on the School's curriculum. The curriculum will be developed basically on the vehicle's training capability per flight.

b. The vehicle's predicted utilization rate.

c. Attrition estimates

Once a specific aerospace trainer concept is approved, more definitive quantity estimates can be made.

9. Two contractors are currently investigating the feasibility of modifying operational high-performance turbojets (T-38's and F-104's) to an aerospace trainer configuration. This approach, should it prove feasible, will undoubtedly decrease initial procurement costs since much of their basic aerodynamic, design and structural data will be applicable. However, it should be noted that the modified vehicles will have to incorporate extensive system changes such as propulsion, fuel, auxiliary power, flight control, life support and cockpit display.

In addition, extensive structural and materiel changes will be required.

Another possible solution is procurement of modified X-15's. This solution will also require thorough investigation into feasibility.

In the event the solutions mentioned above prove unsuitable, a completely new specifically designed vehicle will be required.

for J. H. Curtis LT/COL USAF

CHARLES E. YEAGER, Colonel, USAF
Commandant

4 atchs
1. Design Trajectory, J79-3B Engine (Fig. 1)
2. Design Trajectory, J79-3B Engine (Fig. 2)
3. Nominal Trajectory (Fig. 3)
4. X-15 Long. Accel Profile (Fig. 4)

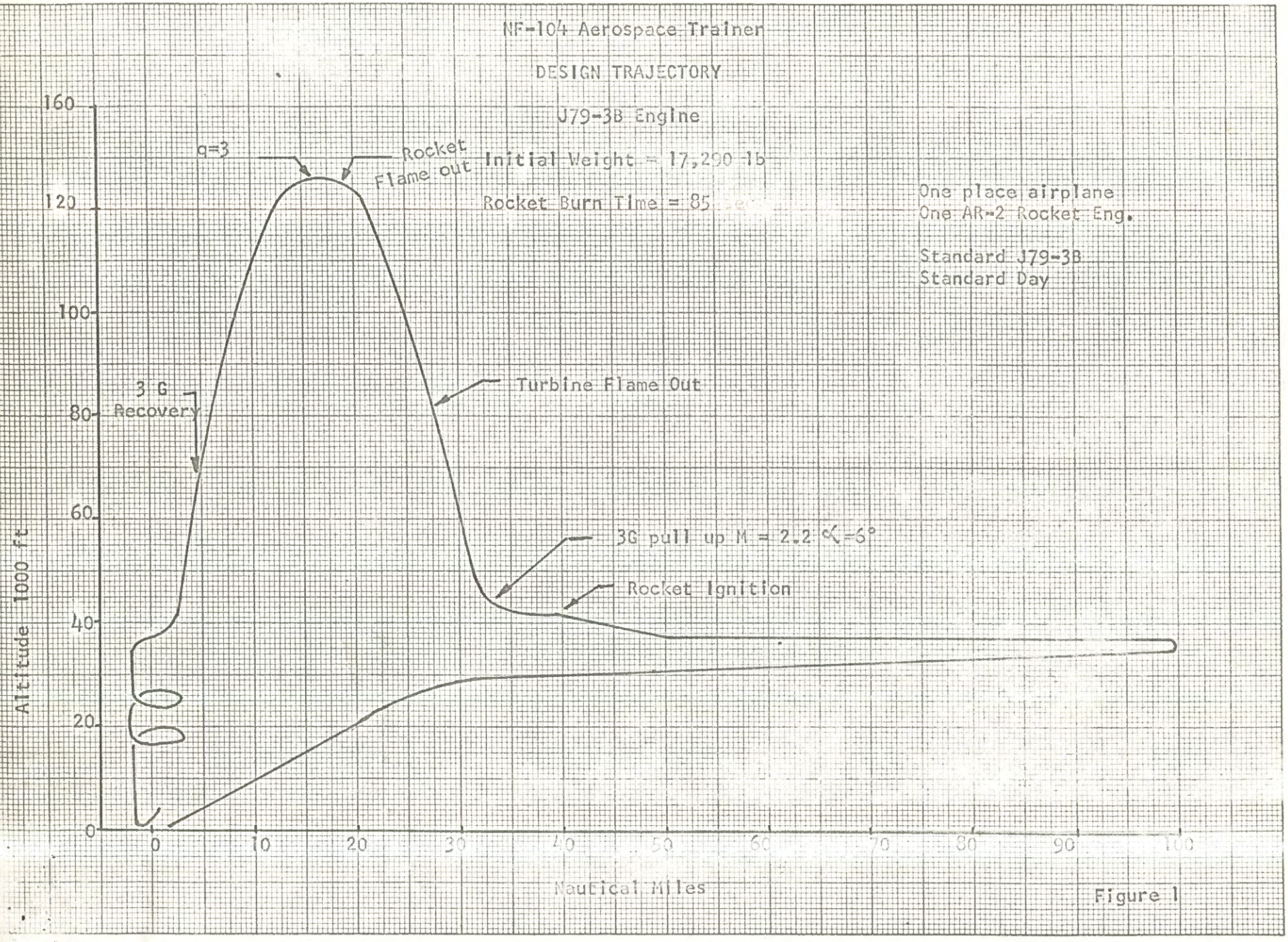

NF-104 Aerospace Trainer
DESIGN TRAJECTORY
J79-3B Engine
Initial Weight = 17,290 lb
Rocket Burn Time = 85 sec
One place airplane
One AR-2 Rocket Eng.
Standard J79-3B
Standard Day
q=3
Rocket Flame out
3 G Recovery
Turbine Flame Out
3G pull up M = 2.2 α=6°
Rocket Ignition
Altitude 1000 ft
Nautical Miles
0
20
40
60
80
100
120
160
0
10
20
30
40
50
60
70
80
90
100

Figure 1

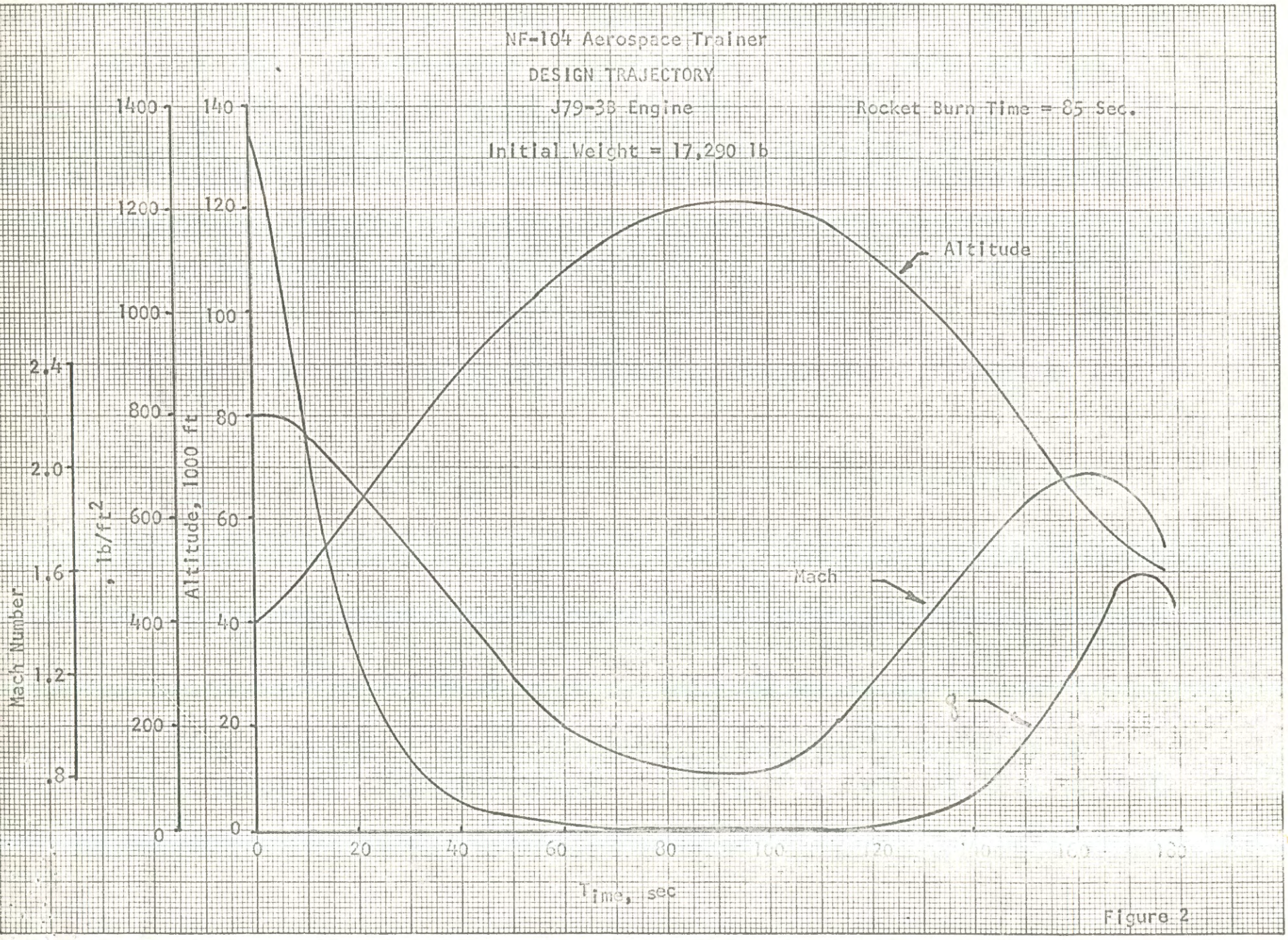

NF-104 Aerospace Trainer
DESIGN TRAJECTORY
J79-3B Engine
Rocket Burn Time = 85 Sec.
Initial Weight = 17,290 lb
Altitude
Mach
q
Mach Number
q, lb/ft2
Altitude, 1000 ft
Time, sec
2.4
2.0
1.6
1.2
.8
1400
1200
1000
800
600
400
200
0
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180

Figure 2

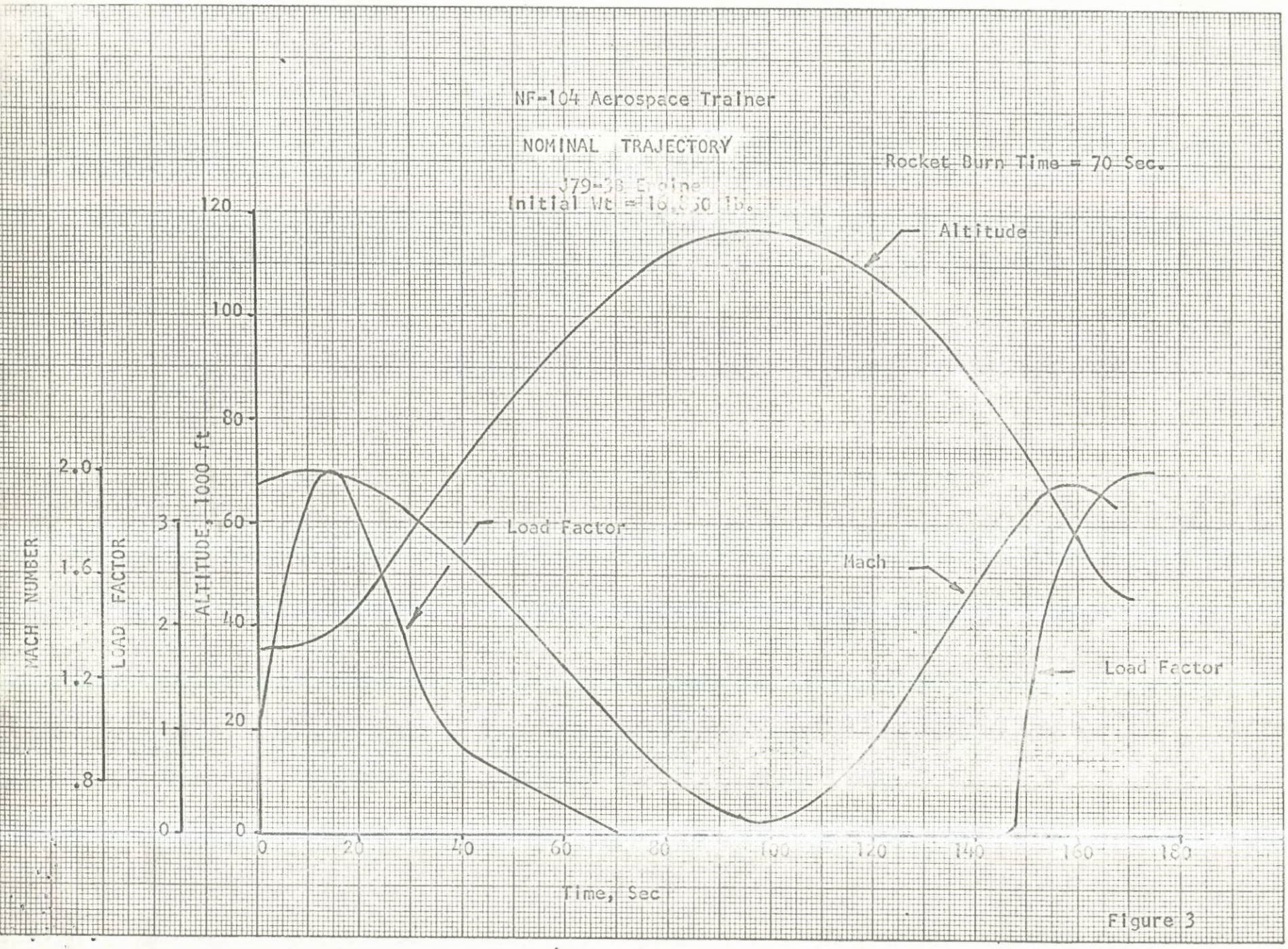

NF-104 Aerospace Trainer
NOMINAL TRAJECTORY
J79-3B Engine
Initial Wt = 16,850 lb.
Rocket Burn Time = 70 Sec.
Altitude
Load Factor
Mach
Load Factor
MACH NUMBER
LOAD FACTOR
ALTITUDE, 1000 ft
Time, Sec
0
20
40
60
80
100
120
140
160
180
.8
1.2
1.6
2.0
1
2
3

Figure 3

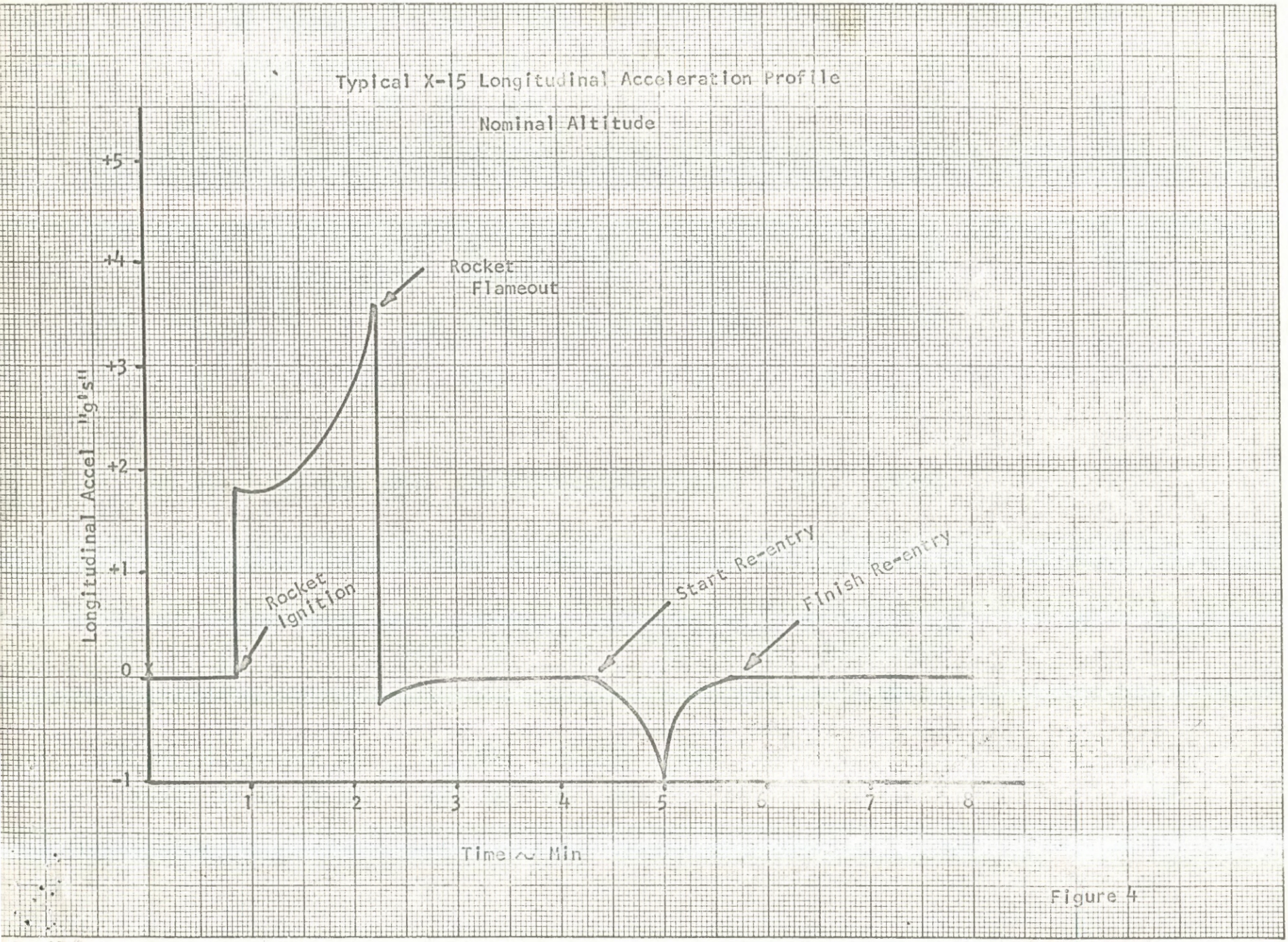

Typical X-15 Longitudinal Acceleration Profile
Nominal Altitude
Longitudinal Accel "g's"
+5
+4
+3
+2
+1
0
-1
Rocket Flameout
Rocket Ignition
Start Re-entry
Finish Re-entry
1
2
3
4
5
6
7
8
Time ~ Min

Figure 4

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

REPLY TO
ATTN OF: SCPTP

23 AUG 1963

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: SCPT
SCP
IN TURN

1. The NF-104A, rocket modified trainer now being developed is, at best, a transitional aerospace trainer. It should bridge the gap from conventional F-104 aircraft to a true (one that trains in space, i.e., +50 miles) aerospace trainer of tomorrow.

2. In the logical progression of the school, more sophisticated training aircraft must eventually be conceived, planned, acquired and utilized.

3. The AFFTC statement as to a "critical requirement for updating the capability of the Aerospace Research Pilot School" is questioned. At the earliest, a true aerospace trainer could not be delivered in a quantity of six until 2 to 3 years from a given start date. Factors bearing on the non-critical nature of the aerospace trainer are:

a. The NF-104A is rapidly coming into the inventory.

b. There is not now a clearly defined military man in space mission.

c. The student output in quality and numbers is meeting today's needs.

4. Two companies and possibly a third have been working on the aerospace trainer concept at their own respective expense. The time has come to either develop a firm AFSC position regarding its further development or to run the risk of falling behind in terms of the future competency of our Aerospace Research Pilot School type graduates. Industry will have difficulty in selling the Aerospace Trainer as merely an Aerospace Research Pilot School-use aircraft.

atch 2

5. The life of the NF-104A is approximately 4-5 years. By 1968, a follow-on trainer or simply a better replacement appears to be a reasonable requirement.

6. My general comment is this: that the proposed true aerospace trainer is not a significant enough improvement over the NF-104A to be acquired for the school. Industry should be more visionary in developing an aerospace trainer. For example: the present apogee of the NF-104 will be approximately 122,000,000 feet and 1-2 minutes of weightlessness. If the Northrop, Lockheed and North American Aviation proposed trainer tripled this apogee and the minutes of weightlessness (Zero "G") this is not progress enough. I would think that increasing the apogee/weightlessness by ten-fold would be the objective for tomorrow's trainer. To be useful in space, man must be exposed to extended periods of weightlessness, variety of re-entry problems and a broad spectrum of activity. An extension of the NF-104A aircraft is not, in my judgement, the way to proceed. I believe that future aerospace craft must be as different in character, use and power as the atomic bomb was to the TNT "blockbuster." Finally, too much time is spent in launch and recovery of the present and proposed trainers as compared to the time actually spent (or proposed) experiencing ballistic controls, utilization and the effects of Zero "G."

7. The following is recommended:

a. Staff the QOR within the Headquarters.

b. Provide the Headquarters USAF Aerospace Research Pilot School OPR the AFSC position based upon the staff comments.

c. Subsequent to the Headquarters USAF review and direction either:

(1) Move forward with an aerospace trainer acquisition action.

(2) Maintain the aerospace trainer as an important part of the Aerospace Research Pilot School 5 Year Expansion Plan.

Richard G. Horne

RICHARD G. HORNE, Captain, USAF
Chief, Career Programs
Personnel Plans & Training
DCS/Personnel

2 Atch
1. 1st Ind, AFFTC (FTO), dtd 12 Aug 63
2. Basic Ltr, AFFTC (FTT), dtd 7 Aug 63, w/4 atchs

Ltr, AFFTC (FTT) Edwards AFB, Calif, Subj: Qualitative Operational Requirement, Aerospace Trainer

12 AUG 1963

1st Ind (FTO)

Hq AFFTC, Edwards AFB, California

TO: AFSC (SCP)

1. The need for an Aerospace Trainer is a critical requirement for updating the capability of the Aerospace Research Pilot School. Acquisition of self-launched trainer with near-space capability is believed to be the most economical method of providing this training.

2. Recommend approval.

FOR THE COMMANDER

H. H. WITTROCK
Colonel, USAF
DCS/Plans & Operations

4 Atchs
n/c

USAF
AEROSPACE RESEARCH PILOT SCHOOL
AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA

7 AUG 1963

REPLY TO ATTN OF: FTT

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer

TO: FTO

1. The following information is submitted in accordance with procedures outlined in AFR 57-3, 4 June 1963.

2. The USAF space mission is becoming more clearly defined each day. That the USAF will have operational manned space systems and vehicles within the next decade is now a foregone conclusion even though a great deal of controversy is currently associated with this premise. The USAF transition into the space era is requiring and will continue to require completely new research and operational space equipment. It follows therefore, that the need for space research pilots trained in the most modern equipment available will continue to be an essential part of the overall program.

To accomplish this training objective, a singularly important consideration is clear. Continued reliance on high performance modified and unmodified turbojet aircraft to accomplish this type training will result in the USAF falling considerably short of providing that degree of research pilot experience considered necessary. The readily identifiable deficiencies in current equipment include:

a. Serious deficiencies in required training capability.

b. A decrease in suitable high performance turbojet inventory during the next decade with no known plans for a follow-on procurement. Suitable high performance turbojets in this instance are aircraft that can be feasibly modified to incorporate supplemental rocket power.

Due to lack of developed rocket engines suitable for installation and use in turbojet aircraft, the number of operational turbojet types that can be classified as "suitable", are restricted to one aircraft, the F-104, because a flight qualified rocket engine (6000 pound thrust) is available for use in the F-104. F-101, F-102, F-105, F-106, F-110 and TFX aircraft are unsuitable due to their weight. To provide appreciable performance gains for these aircraft, a rocket engine capable of producing 10-15000 pound thrust is required. Unfortunately, there are no known rocket engines currently developed with a 10-15000 pound thrust capability although Rocketdyne Div., of NAA, Inc., has designed a 10-12000 pound thrust engine. This particular rocket engine is still in a design status, has not been test fired and no plans have been made for continued development effort due to lack of DOD interest and company funds.

A training concept that has important ramifications when considering a flight aerospace trainer is the training role of ground based simulators. Although ground based trainers have provided invaluable assistance in training programs, this type of trainer in no way can be considered more than an important supplement to a complete training program. The capability to expose a pilot to the actual environment in which tests are to be performed remains of cardinal importance.

In addition to the above required capabilities, it appears to be a valid assumption that other identifiable mission capabilities could be applied to this proposed aerospace trainer. These include, but are not necessarily limited to the following areas:

(1) Special high altitude research programs could be examined by substituting a sensor package for one of the crew positions. It is visualized that this Research Bay could be used to investigate various types of sensors, their applications, limitations and operational effectiveness.

(2) Maintenance of proficiency by active space pilots between space missions.

(3) Orientation/familiarization flights for non-pilot scientist crew members.

Since the requirements above are not specified as part of the Aerospace Research Pilot School mission responsibility, further definition and discussion concerning them will not be included in subsequent paragraphs. These requirements are indicated for the purpose of identifying possible applications in addition to the training requirement which is an integral part of the School curricula.

3. The mission of the USAF Aerospace Research Pilot School as stated in AFR 53-19, 1 May 1963, is: "The USAF Aerospace Research Pilot School trains selected officers to monitor or perform flight tests of research, experimental, or production type vehicles. These tests are made to determine flight characteristics, performance, stability, and functional utility, and to obtain technical information on serviceability and functioning of installed equipment and component parts".

4. The School's curriculum is segmented into four general areas which are:

a. Academic Training

b. Simulator Training

c. Bio-astronautics Training

d. Flying Training

This requirement is directly related to the flying training portion of the curriculum so the first three areas mentioned above will not be discussed further. At present, flying training is accomplished in operational high performance turbo-jet aircraft. These aircraft provide satisfactory training in all flying training areas except the broad areas directly pertaining to aerospace flight such as:

(1) Launch and ascent

(2) Operations in space

(3) Re-entry

(4) Recovery

To provide limited flying training in the areas above, a Class V modification project on three F-104A aircraft assigned to the School is currently being performed by Lockheed Aircraft Corporation. Each of these modified aircraft will have a 6000 pound liquid rocket engine for supplemental thrust, a reaction control system, an auxiliary cockpit pressurization system and other non-standard equipment such as special cockpit instrumentation and in-flight data recorders. Graphs showing predicted performance of these modified aircraft are attached. In addition, a Class V modification program on two F-106B aircraft assigned to the School has been approved and is currently in the initial stages of the procurement cycle. These two aircraft will be modified to incorporate a variable stability flight control system which will be capable of demonstrating normal and peculiar handling qualities of future aerospace vehicles during atmospheric flight. Completion of these two modification projects will greatly increase the School's ability to adequately train Aerospace Research Pilots, but their limitations, as discussed in the following paragraphs dictate a follow-on vehicle with a much greater capability.

5. The basic limitation in current or near term aerospace flying training equipment is lack of performance. Review of the predicted performance graphs (attached) for the modified NF-104A's, show the following primary performance limitations:

a. Dynamic pressure (q) below 12 psf - approximately 60 seconds during a maximum trajectory profile. Low dynamic pressures are required for effective training using reaction controls. Longer periods of reaction control training are highly desireable.

b. Peak Altitude - approximately 122,000 feet during maximum trajectory profile. High altitudes are required to place the trainee in a space environment. The modified NF-104A's perform considerably better than unmodified aircraft; however, 122,000 feet maximum altitude

is far short of a true space environment. Time above 100,000 feet (approximately 65 seconds) is also quite short.

c. Maximum Mach Number - 2.2. An important required pilot skill which has not received extensive publicity, is the ability to judge and plan the terminal portion of a flight while approaching the terminal point at extremely high velocities and altitudes. This pilot skill becomes increasingly important in vehicles such as the X-15 with a no-go-around capability. The comparatively slow approach speeds of the modified NF-104A's with their go-around capability allows very limited training in this area.

d. High Longitudinal Acceleration Effects. Although not included in the attached graphs, since it is negligible in the modified NF-104A's, longitudinal acceleration during rocket boost phases of flight is considered to be an important training area. X-15 pilot experience has shown head movements during periods of high longitudinal acceleration create sensory illusions which can be quite serious unless properly understood and compensated for. The low longitudinal acceleration capability in the modified NF-104A's offers extremely limited training in this area.

e. Re-entry. Training in re-entry piloting techniques and procedures is essential for the successful completion of any space mission. Studies of the re-entry vehicle profile and its related problems regarding acceleration forces, heating, and vehicle dynamics, have proven that this portion of the flight is most critical and particularly sensitive to pilot control techniques. These control techniques involve piloting the vehicle with regard to limits as defined by a particular re-entry corridor. Knowledge of re-entry corridor parameters and the method of maintaining a desired equilibrium glide path by controlling these parameters is essential for application of proper control procedures.

The NF-104A does not provide us with acceleration limits, heating limits, and because of the nature of its trajectory, does not afford sufficient variables to approach a re-entry corridor of significant dimensions.

6. The overall performance capabilities of the proposed aerospace trainer must, to the maximum degree practical, present significant environmental conditions and piloting tasks encountered during boost, space operations, re-entry, and recovery. The environmental conditions and piloting tasks need not duplicate those of actual orbital spacecraft, but should cover in type and relative severity, those phases of space flight which make the greatest demands on the pilot's judgement, endurance, and piloting skills.

Design philosophy must be based on maximum operating flexibility, high use rate, low operating costs and levels of performance that provide

adequate training in the four phases of space flight mentioned previously. A vehicle which has these ground handling and operating characteristics will not have the performance of an orbital vehicle and will therefore be a compromise between a high performance turbojet and an orbital vehicle.

More specific performance capabilities are discussed below:

A. BOOST PERFORMANCE

The unusual environmental conditions associated with boost are:

(1) High longitudinal accelerations:

Boost accelerations of typical sub-orbital and orbital vehicles range from +4 to +10G's over time intervals of up to one minute. A typical X-15 longitudinal acceleration profile is shown in the attached graphs. The acceleration profile of an Atlas launched Mercury is not included since it is classified, however, its profile is considerably more severe and would represent one extreme of the range of possible longitudinal acceleration profiles.

The combination of control demands, acceleration, and other stresses placed on the pilot simultaneously are of more significance than the severity of the control problems or stresses alone. In this vehicle the boost accelerations will begin with the takeoff roll and continue through the transition from horizontal to near-vertical flight. Therefore, peak longitudinal accelerations of +3G's and burn times exceeding 90 seconds will present a combination of longitudinal acceleration, rapid attitude change, and control problems that will require precision control and rapid responses comparable to that of a boosting orbital vehicle.

(2) Rapid attitude changes and steep climb angles:

Rapid attitude changes during boost are inherent in a vehicle that takes off or launches from a horizontal attitude and transitions into vertical or near vertical climb angles. Boost performance should be such that altitudes of 200,000 to 300,000 feet can be attained, using 70° to 90° climb angles. Shallower climb angles (25° to 45°) to intermediate altitudes with dynamic pressures near the apex that will afford use of reaction controls should also be possible. Performance in these ranges will give satisfactory approximation to boost trajectories of vertically boosted vehicles. In addition, while in boost environment, the pilot will be required to precisely control:

(a) Attitude

(b) Flight path

(c) Thrust

1 Thrust level

2 Burn time

(c) Thrust

1 Thrust level

2 Burn time

(d) Velocity Profile

(e) Test instrumentation and data recording equipment.

(3) Control during boost:

Precision thrust variation to afford accurate control of velocity and cut-off should be possible. Flight instrumentation, using both airborne and ground inputs, should allow the pilot to fly a precise flight profile. This will require altitude, attitude, space position, and velocity indications with near zero lag.

B. SPACE OPERATIONS

(1) Unusual environmental conditions, piloting tasks, and special equipment associated with space operations include:

(a) Low dynamic pressure: The trainer should be capable of profiles that provide dynamic pressures less than 10 psf at altitudes between 200,000 and 400,000 feet for periods exceeding two minutes. This will provide adequate time for use of reaction controls to practice various maneuvers and establish re-entry attitude. Except for vehicle velocity relative to the earth, a 300,000 foot maximum altitude places the vehicle in a space environment closely approximating an orbital vehicle. The reaction control system must be capable of manual control with and without automatic stability augmentation in all 3 axes. Various roll, pitch and yaw rates should be capable of being preset on the ground.

(b) Life Support Systems: Since the vehicle will operate in space, space type life support equipment will be required to provide student familiarization with important life support equipment operation and design. The life support system should be capable of providing a shirt-sleeve environment with full pressure suit backup for safety.

(c) Maneuvering in Space: Ideally the vehicle should provide the capability of changing its position relative to another vehicle or frame of reference while in the space environment. However, this capability would require a store of rocket fuel very much in excess of that needed to achieve the desired sub-orbital profile. The initial and operating costs for this type vehicle would be prohibitive for a training operation. Therefore, this particular feature is not considered a mandatory requirement.

C. RE-ENTRY

(1) Unusual environmental and piloting tasks associated with re-entry are:

(a) Longitudinal and normal g forces. Depending on re-entry angle and type of vehicle, orbital re-entry "g" forces vary from approximately 1 "g" to in excess of 10 "g's". Considering pilot tolerance, practical maximum "g" loads are: "10 g's" eyeballs in; 3-5 "g's" eyeballs out and 5 "g's" eyeballs down.

The "g" forces during re-entry of the proposed trainer will be determined by its boost performance. A vehicle with longitudinal accelerations of 2 to 4 g's and exit angles 70 to 90 degrees during boost will reproduce re-entry "g" loads of from -1 to -3.5 longitudinally and from 4.75 to 5.5 in a normal direction. The duration of the "g" forces in re-entry will only be a fraction of that for actual orbital re-entry. However, in keeping with the basic idea of heavy training operations at minimum costs, adequate coverage rather than duplication will be satisfactory.

(b) Control during re-entry: An ideal re-entry trainer would be capable of being inserted into orbital re-entry profiles along a corridor ranging from very shallow to relatively steep paths of several degrees. However, such a capability would require velocity and altitude performance approaching orbital flight. To keep initial and operating costs low and provide high use rates, re-entry performance for the proposed trainer should be limited to that which is compatible with the boost performance previously described. This necessarily restricts re-entry velocities and angles to a narrow range. They will generally be steep (70-90°) and comparatively slow. Although the re-entry profile will be considerably different from that of an actual orbital re-entry vehicle, the piloting tasks confronting the pilot will be approximately the same and of the same order of difficulty as those encountered in an orbital re-entry vehicle. These re-entry tasks will include:

1 Precise vehicle attitude control longitudinally and laterally in response to an energy management and vehicle heating display.

2 Relying on and following directions from ground stations.

3 Monitoring and controlling test instrumentation and data recording equipment.

4 Doing all of the above with decreased cockpit visibility because of heat shielding required during re-entry.

D. RECOVERY

The recovery phase is essentially an energy management problem involving an unpowered landing. The performance of the proposed trainer must permit recovery from the point of completion of the re-entry phase to the initial takeoff point. There must be sufficient margin in altitude at the landing site following a non-optimum recovery to compensate for reasonable errors in energy management on the part of the pilot. Although not mandatory, a sustainer type jet engine to compensate for such errors is desirable.

E. SUMMARY OF MANDATORY DESIGN FEATURES AND PERFORMANCE REQUIREMENTS

(1) Two-place vehicle (controllable from both cockpits)

(2) Capable of sustained flight rate of ten flights per trainer per month.

(3) Launch and recovery at the same site.

(4) Longitudinal "g" forces during boost to reach at least 3 "g's".

(5) Horizontal takeoff and landing from lakebed or runway. Air launch capability optional.

(6) Altitude capability in excess of fifty miles.

(7) Capability for boost trajectories (25° to 45°) to intermediate altitudes with dynamic pressures less than 10 psf at apex.

(8) Other:

(a) Aerodynamic control

(b) Reaction controls

(c) Stability augmentation for both types of flight controls

(d) Throttleable thrust control 50% to 100% range.

(e) Instrument display that will allow precise pilot control during all phases of flight.

7. If an advanced aerospace trainer were available now, it could be effectively utilized to provide training for Gemini, and X-20 crews. However, due to lead time considerations, this vehicle's future use should be considered to be for post X-20 projects. Useful life is estimated to be ten years since it will be capable of providing training that is appropriate for near term aerospace vehicles. In other words,

manned space vehicles within the next 10-15 years will have the same general propulsion, control, instrument display, and life support systems that current space vehicles have and will have generally the same type flight limitations and problems.

8. This vehicle will initially be employed by the USAF Aerospace Research Pilot School to train Aerospace Research Pilots for future aerospace research vehicles. If the demand for operational space pilots ultimately requires an operational space pilot training program, a follow-on procurement of this vehicle for the Air Training Command might be considered if it is still considered to be suitable for aerospace vehicle crew training.

The trainer should be procured as a complete system to include all peculiar support equipment and facilities. Since Edwards AFB has extensive facilities for this type vehicle, facilities costs should be considerably less for the initial procurement. These facilities include exotic fuels storage and servicing equipment, high pressure gas generating, storing and servicing equipment, rocket engine maintenance and overhaul facilities, a large fully instrumented range with numerous emergency landing fields and a terminal landing area complex that is more than adequate.

Quantities required will be dependent on the following general considerations:

a. Number of trainees and number of flights per trainee. Number of trainees will be estimated by USAF requirements while number of flights per trainee will be dependent on the School's curriculum. The curriculum will be developed basically on the vehicle's training capability per flight.

b. The vehicle's predicted utilization rate.

c. Attrition estimates

Once a specific aerospace trainer concept is approved, more definitive quantity estimates can be made.

9. Two contractors are currently investigating the feasibility of modifying operational high-performance turbojets (T-38's and F-104's) to an aerospace trainer configuration. This approach, should it prove feasible, will undoubtedly decrease initial procurement costs since much of their basic aerodynamic, design and structural data will be applicable. However, it should be noted that the modified vehicles will have to incorporate extensive system changes such as propulsion, fuel, auxiliary power, flight control, life support and cockpit display.

In addition, extensive structural and materiel changes will be required.

Another possible solution is procurement of modified X-15's. This solution will also require thorough investigation into feasibility.

In the event the solutions mentioned above prove unsuitable, a completely new specifically designed vehicle will be required.

CHARLES E. YEAGER, Colonel, USAF
Commandant

4 atchs
1. Design Trajectory, J79-3B Engine (Fig. 1)
2. Design Trajectory, J79-3B Engine (Fig. 2)
3. Nominal Trajectory (Fig. 3)
4. X-15 Long. Accel Profile (Fig. 4)

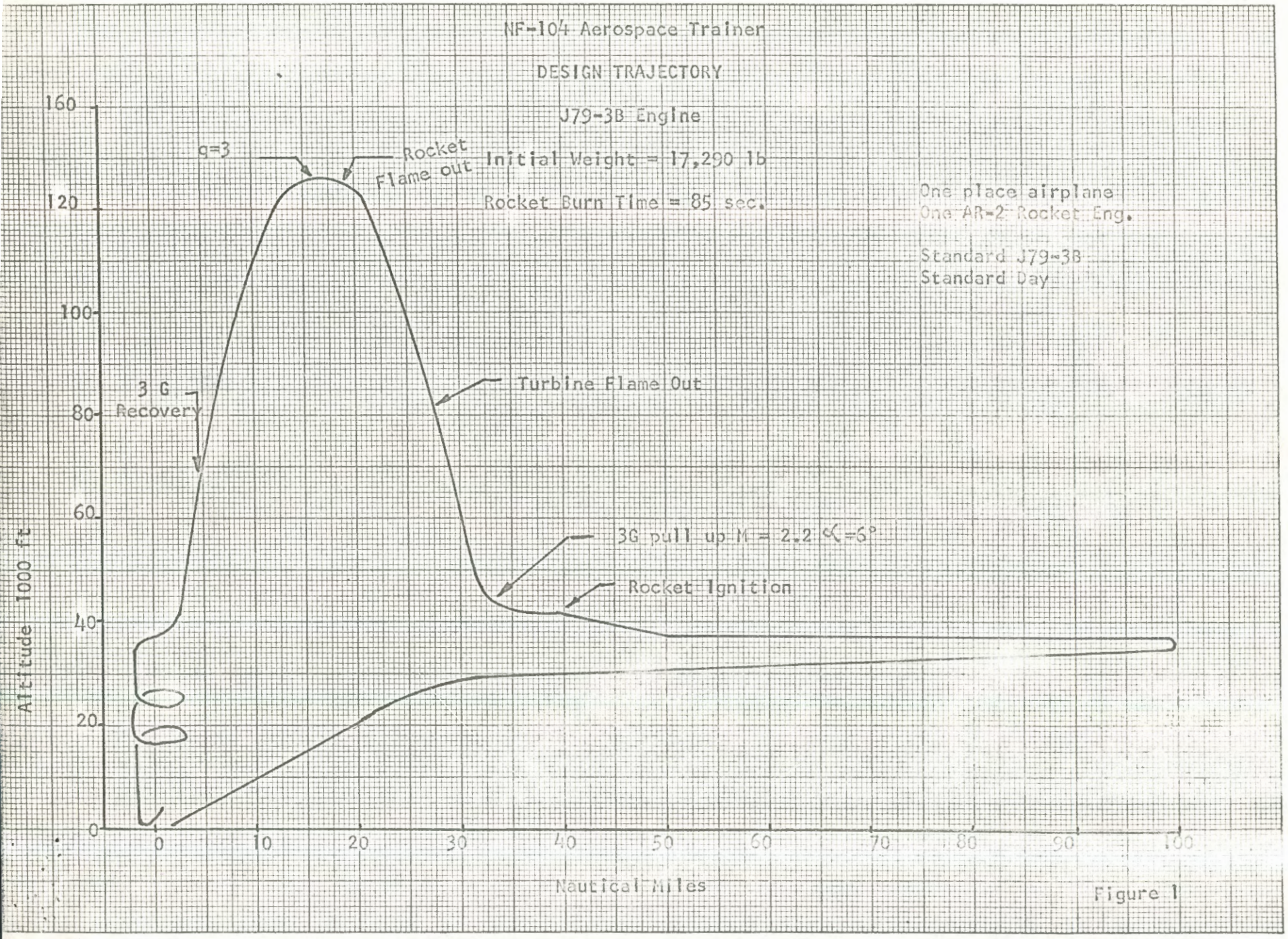
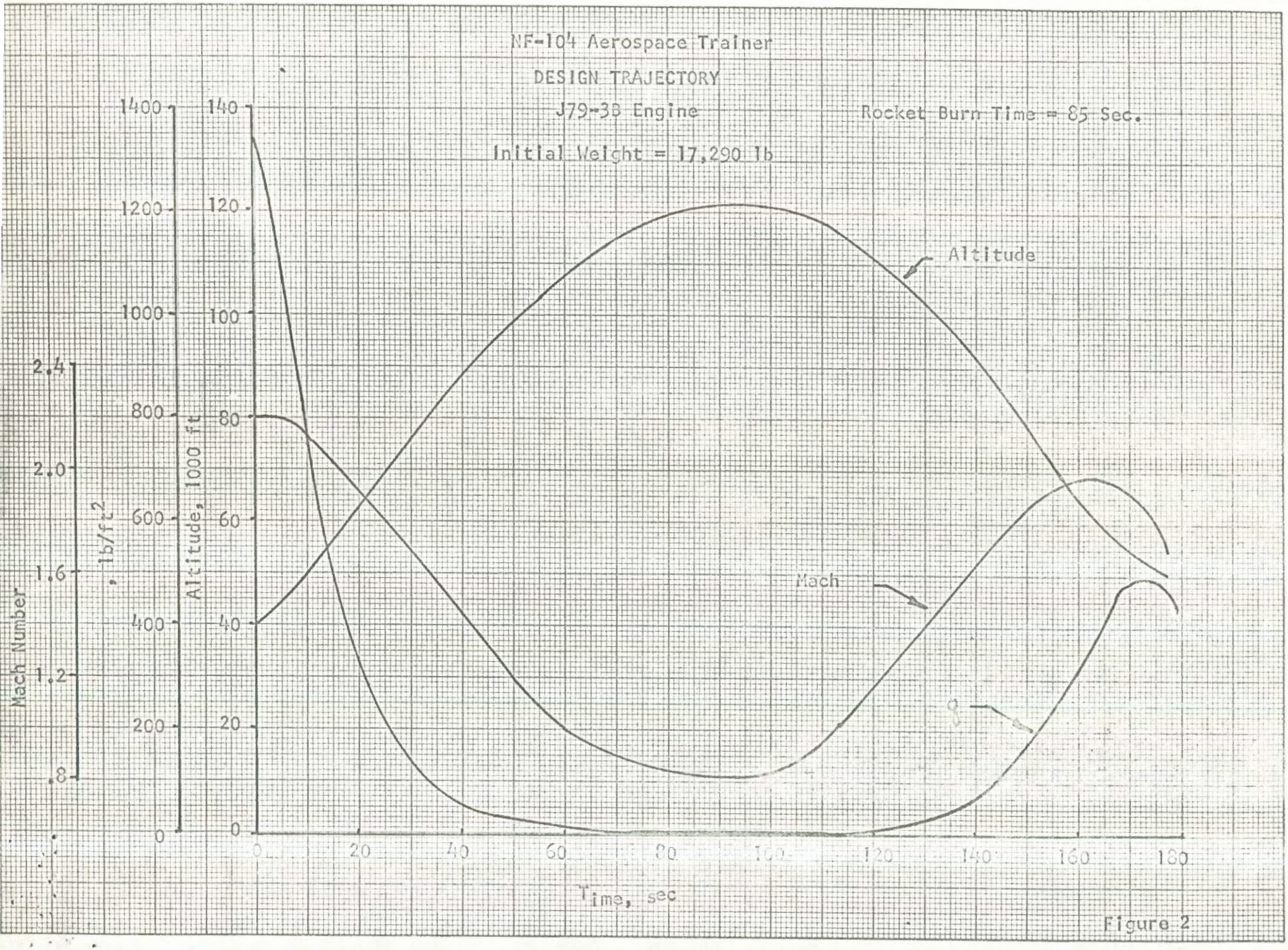

NF-104 Aerospace Trainer
DESIGN TRAJECTORY
J79-3B Engine
Initial Weight = 17,290 lb
Rocket Burn Time = 85 sec.
One place airplane
One AR-2 Rocket Eng.
Standard J79-3B
Standard Day
g=3
Rocket Flame out
3 G Recovery
Turbine Flame Out
3G pull up M = 2.2 α=6°
Rocket Ignition
Altitude 1000 ft
Nautical Miles
0
20
40
60
80
100
120
160
0
10
20
30
40
50
60
70
80
90
100

Figure 1


NF-104 Aerospace Trainer
DESIGN TRAJECTORY
J79-3B Engine
Initial Weight = 17,290 lb
Rocket Burn Time = 85 Sec.
Altitude
Mach
q
Mach Number
q, lb/ft2
Altitude, 1000 ft
Time, sec
2.4
2.0
1.6
1.2
.8
1400
1200
1000
800
600
400
200
0
140
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100
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0
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120
140
160
180

Figure 2

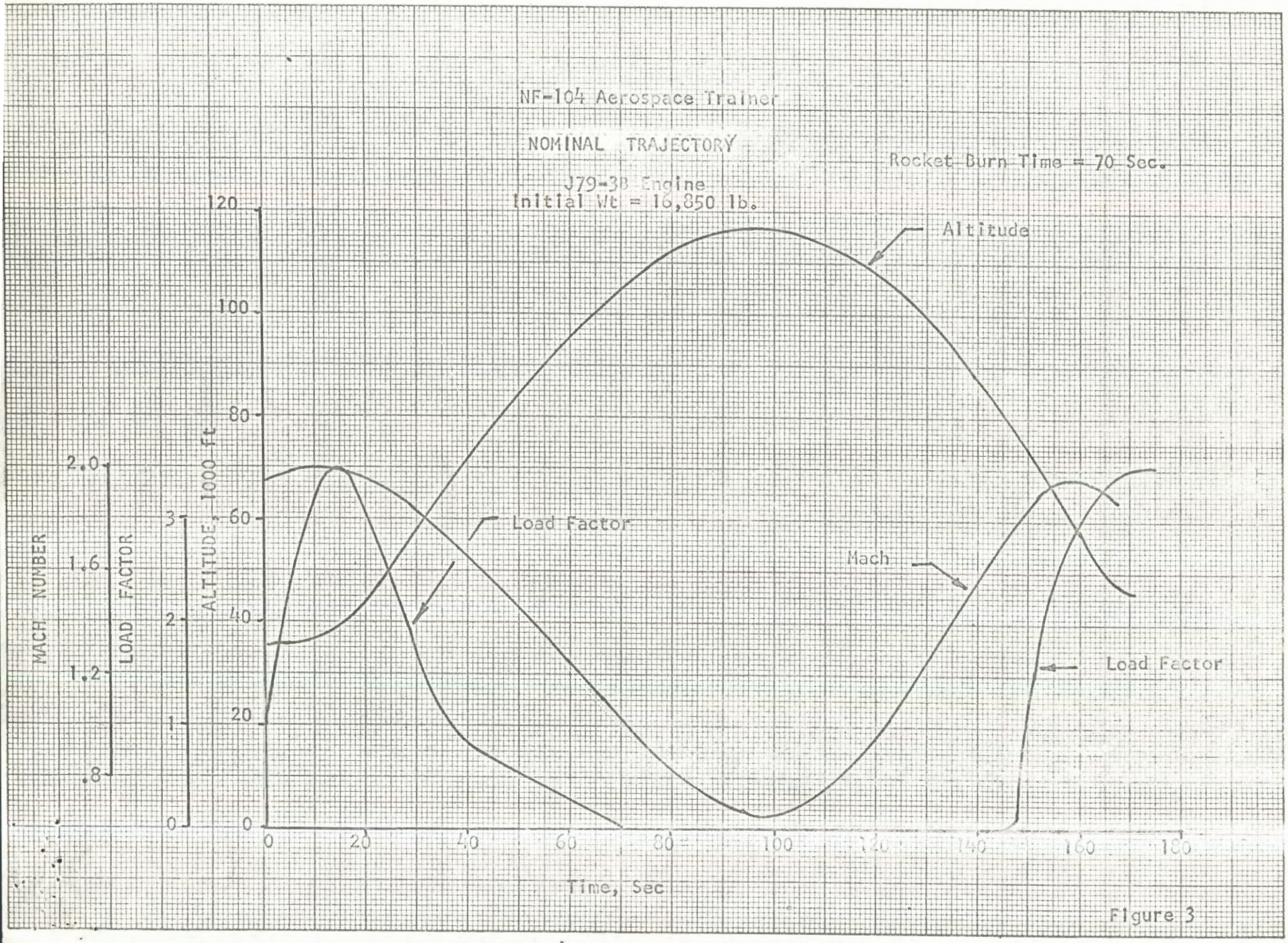
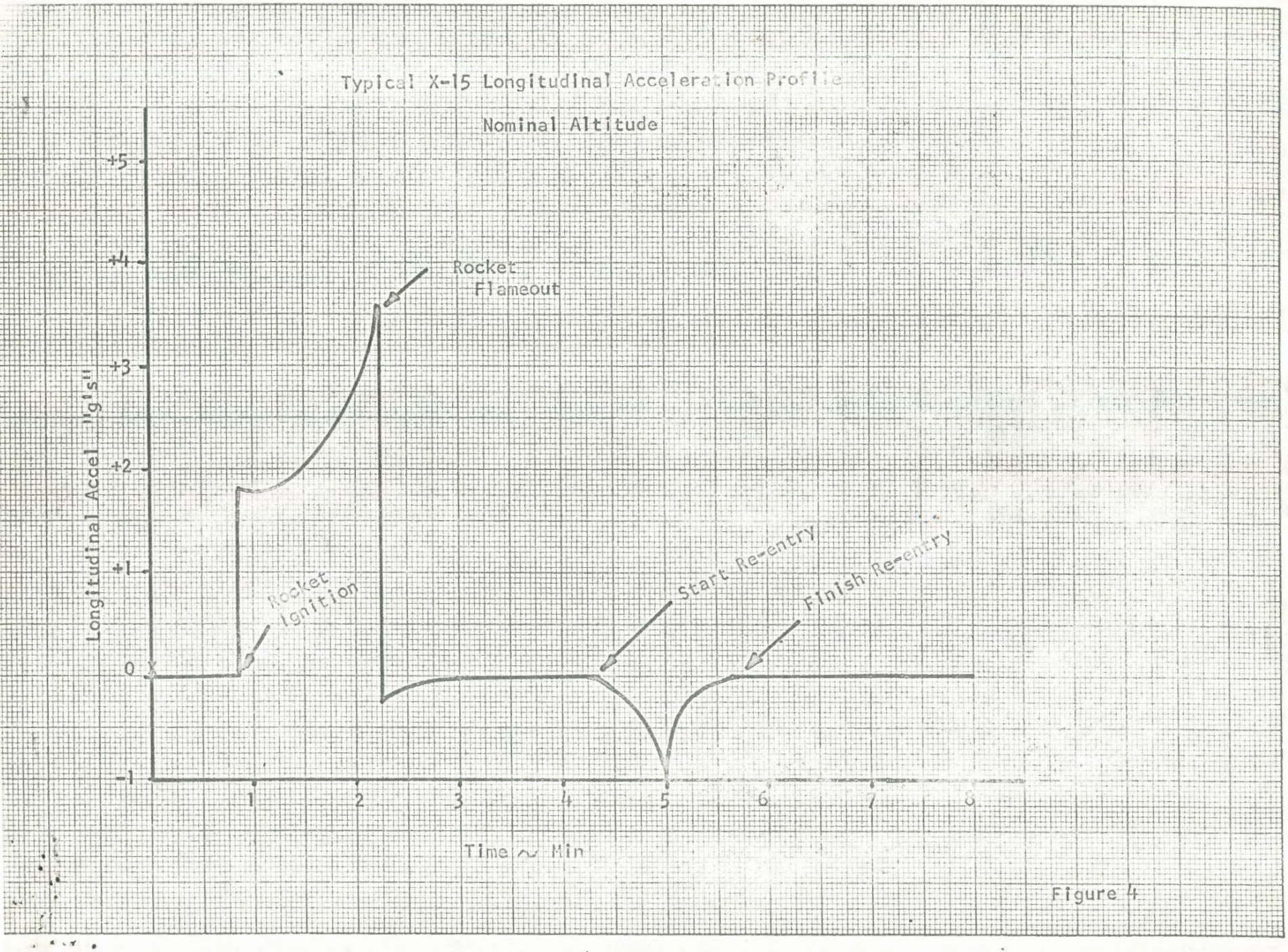

NF-104 Aerospace Trainer
NOMINAL TRAJECTORY
J79-3B Engine
Initial Wt = 16,850 lb.
Rocket Burn Time = 70 Sec.
Altitude
Load Factor
Mach
Load Factor
MACH NUMBER
LOAD FACTOR
ALTITUDE, 1000 ft
Time, Sec
0
20
40
60
80
100
120
140
160
180
.8
1.2
1.6
2.0
1
2
3

Figure 3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2
3
4
5
6
7
8
Time ~ Min

Figure 4

23 AUG 1963

SCPTP

Qualitative Operational Requirement, Aerospace Trainer

SCPT
SCP
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4. Two companies and possibly a third have been working on the aerospace trainer concept at their own respective expense. The time has come to either develop a firm AFSC position regarding its further development or to run the risk of falling behind in terms of the future competency of our Aerospace Research Pilot School type graduates. Industry will have difficulty in selling the Aerospace Trainer as merely an Aerospace Research Pilot School-use aircraft.

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RICHARD G. HORNE, Captain, USAF
Chief, Career Programs
Personnel Plans & Training
DCS/Personnel

2 Atch
1. 1st Ind, AFFTC (FTO), dtd 12 Aug 63
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23 AUG 1963
DCS/PERSONNEL
MAIL & RECORDS
HQ AFSC
DETACHED

NAME, GRADE OR TITLE & OFFICE SYMBOL OF ORIGINATOR	DATE	TELEPHONE NUMBER	TYPIST INITIALS
Capt Horne/SCPTP	21Aug63	2322	LLC

AFSC HQ FORM JUN 63 16 AFSC (AAFB) 1963 COORDINATION SHEET

PREVIOUS EDITION OF THIS FORM MAY BE USED.

SCG
SCGE
SCGV
SCGC
SCGS
SCGM
SCGCA
SCGB
SCH
MSF
SPECIAL STAFF
SCA
SCD
SCE
SCI
SCJ
SCW
SCX
SCO
DEPUTY CHIEFS
SCC
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SCK
SCL
SCM
SCP
SCS
SCT
OTHER
SCQ

5. The life of the NF-104A is approximately 4-5 years. By 1968, a follow-on trainer or simply a better replacement appears to be a reasonable requirement.

6. My general comment is this: that the proposed true aerospace trainer is not a significant enough improvement over the NF-104A to be acquired for the school. Industry should be more visionary in developing an aerospace trainer. For example: the present apogee of the NF-104 will be approximately 122,000,000 feet and 1-2 minutes of weightlessness. If the Northrop, Lockheed and North American Aviation proposed trainer tripled this apogee and the minutes of weightlessness (Zero "G") this is not progress enough. I would think that increasing the apogee/weightlessness by ten-fold would be the objective for tomorrow's trainer. To be useful in space, man must be exposed to extended periods of weightlessness, variety of re-entry problems and a broad spectrum of activity. An extension of the NF-104A aircraft is not, in my judgement, the way to proceed. I believe that future aerospace craft must be as different in character, use and power as the atomic bomb was to the TNT "blockbuster." Finally, too much time is spent in launch and recovery of the present and proposed trainers as compared to the time actually spent (or proposed) experiencing ballistic controls, utilization and the effects of Zero "G."

7. The following is recommended:

a. Staff the QOR within the Headquarters.

b. Provide the Headquarters USAF Aerospace Research Pilot School OPR the AFSC position based upon the staff comments.

c. Subsequent to the Headquarters USAF review and direction either:

(1) Move forward with an aerospace trainer acquisition action.

(2) Maintain the aerospace trainer as an important part of the Aerospace Research Pilot School 5 Year Expansion Plan.

RICHARD G. HORNE, Captain, USAF
Chief, Career Programs
Personnel Plans & Training
DCS/Personnel

2 Atch
1. 1st Ind, AFFTC (FTO), dtd 12 Aug 63
2. Basic Ltr, AFFTC (FTT), dtd 7 Aug 63, w/4 atchs

Ltr, AFFTC (FTT) Edwards AFB, Calif, Subj: Qualitative Operational Requirement, Aerospace Trainer

1st Ind (FTO) 12 AUG 1963

Hq AFFTC, Edwards AFB, California

TO: AFSC (SCP)

1. The need for an Aerospace Trainer is a critical requirement for updating the capability of the Aerospace Research Pilot School. Acquisition of self-launched trainer with near-space capability is believed to be the most economical method of providing this training.

2. Recommend approval.

FOR THE COMMANDER

H. H. WITTROCK
Colonel, USAF
DCS/Plans & Operations

4 Atchs
n/c

SCP-63-1659

USAF
AEROSPACE RESEARCH PILOT SCHOOL
AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA

REPLY TO ATTN OF: FTT

SUBJECT: Qualitative Operational Requirement, Aerospace Trainer 7 AUG 1963

TO: FTO

1. The following information is submitted in accordance with procedures outlined in AFR 57-3, 4 June 1963.

2. The USAF space mission is becoming more clearly defined each day. That the USAF will have operational manned space systems and vehicles within the next decade is now a foregone conclusion even though a great deal of controversy is currently associated with this premise. The USAF transition into the space era is requiring and will continue to require completely new research and operational space equipment. It follows therefore, that the need for space research pilots trained in the most modern equipment available will continue to be an essential part of the overall program.

To accomplish this training objective, a singularly important consideration is clear. Continued reliance on high performance modified and unmodified turbojet aircraft to accomplish this type training will result in the USAF falling considerably short of providing that degree of research pilot experience considered necessary. The readily identifiable deficiencies in current equipment include:

a. Serious deficiencies in required training capability.

b. A decrease in suitable high performance turbojet inventory during the next decade with no known plans for a follow-on procurement. Suitable high performance turbojets in this instance are aircraft that can be feasibly modified to incorporate supplemental rocket power.

Due to lack of developed rocket engines suitable for installation and use in turbojet aircraft, the number of operational turbojet types that can be classified as "suitable", are restricted to one aircraft, the F-104, because a flight qualified rocket engine (6000 pound thrust) is available for use in the F-104. F-101, F-102, F-105, F-106, F-110 and TFX aircraft are unsuitable due to their weight. To provide appreciable performance gains for these aircraft, a rocket engine capable of producing 10-15000 pound thrust is required. Unfortunately, there are no known rocket engines currently developed with a 10-15000 pound thrust capability although Rocketdyne Div., of NAA, Inc., has designed a 10-12000 pound thrust engine. This particular rocket engine is still in a design status, has not been test fired and no plans have been made for continued development effort due to lack of DOD interest and company funds.

A training concept that has important ramifications when considering a flight aerospace trainer is the training role of ground based simulators. Although ground based trainers have provided invaluable assistance in training programs, this type of trainer in no way can be considered more than an important supplement to a complete training program. The capability to expose a pilot to the actual environment in which tests are to be performed remains of cardinal importance.

In addition to the above required capabilities, it appears to be a valid assumption that other identifiable mission capabilities could be applied to this proposed aerospace trainer. These include, but are not necessarily limited to the following areas:

(1) Special high altitude research programs could be examined by substituting a sensor package for one of the crew positions. It is visualized that this Research Bay could be used to investigate various types of sensors, their applications, limitations and operational effectiveness.

(2) Maintenance of proficiency by active space pilots between space missions.

(3) Orientation/familiarization flights for non-pilot scientist crew members.

Since the requirements above are not specified as part of the Aerospace Research Pilot School mission responsibility, further definition and discussion concerning them will not be included in subsequent paragraphs. These requirements are indicated for the purpose of identifying possible applications in addition to the training requirement which is an integral part of the School curricula.

3. The mission of the USAF Aerospace Research Pilot School as stated in AFR 53-19, 1 May 1963, is: "The USAF Aerospace Research Pilot School trains selected officers to monitor or perform flight tests of research, experimental, or production type vehicles. These tests are made to determine flight characteristics, performance, stability, and functional utility, and to obtain technical information on serviceability and functioning of installed equipment and component parts".

4. The School's curriculum is segmented into four general areas which are:

a. Academic Training

b. Simulator Training

c. Bio-astronautics Training

d. Flying Training

This requirement is directly related to the flying training portion of the curriculum so the first three areas mentioned above will not be discussed further. At present, flying training is accomplished in operational high performance turbo-jet aircraft. These aircraft provide satisfactory training in all flying training areas except the broad areas directly pertaining to aerospace flight such as:

(1) Launch and ascent

(2) Operations in space

(3) Re-entry

(4) Recovery

To provide limited flying training in the areas above, a Class V modification project on three F-104A aircraft assigned to the School is currently being performed by Lockheed Aircraft Corporation. Each of these modified aircraft will have a 6000 pound liquid rocket engine for supplemental thrust, a reaction control system, an auxiliary cockpit pressurization system and other non-standard equipment such as special cockpit instrumentation and in-flight data recorders. Graphs showing predicted performance of these modified aircraft are attached. In addition, a Class V modification program on two F-106B aircraft assigned to the School has been approved and is currently in the initial stages of the procurement cycle. These two aircraft will be modified to incorporate a variable stability flight control system which will be capable of demonstrating normal and peculiar handling qualities of future aerospace vehicles during atmospheric flight. Completion of these two modification projects will greatly increase the School's ability to adequately train Aerospace Research Pilots, but their limitations, as discussed in the following paragraphs dictate a follow-on vehicle with a much greater capability.

5. The basic limitation in current or near term aerospace flying training equipment is lack of performance. Review of the predicted performance graphs (attached) for the modified NF-104A's, show the following primary performance limitations:

a. Dynamic pressure (q) below 12 psf - approximately 60 seconds during a maximum trajectory profile. Low dynamic pressures are required for effective training using reaction controls. Longer periods of reaction control training are highly desireable.

b. Peak Altitude - approximately 122,000 feet during maximum trajectory profile. High altitudes are required to place the trainee in a space environment. The modified NF-104A's perform considerably better than unmodified aircraft; however, 122,000 feet maximum altitude

is far short of a true space environment. Time above 100,000 feet (approximately 65 seconds) is also quite short.

c. Maximum Mach Number - 2.2. An important required pilot skill which has not received extensive publicity, is the ability to judge and plan the terminal portion of a flight while approaching the terminal point at extremely high velocities and altitudes. This pilot skill becomes increasingly important in vehicles such as the X-15 with a no-go-around capability. The comparatively slow approach speeds of the modified NF-104A's with their go-around capability allows very limited training in this area.

d. High Longitudinal Acceleration Effects. Although not included in the attached graphs, since it is negligible in the modified NF-104A's, longitudinal acceleration during rocket boost phases of flight is considered to be an important training area. X-15 pilot experience has shown head movements during periods of high longitudinal acceleration create sensory illusions which can be quite serious unless properly understood and compensated for. The low longitudinal acceleration capability in the modified NF-104A's offers extremely limited training in this area.

e. Re-entry. Training in re-entry piloting techniques and procedures is essential for the successful completion of any space mission. Studies of the re-entry vehicle profile and its related problems regarding acceleration forces, heating, and vehicle dynamics, have proven that this portion of the flight is most critical and particularly sensitive to pilot control techniques. These control techniques involve piloting the vehicle with regard to limits as defined by a particular re-entry corridor. Knowledge of re-entry corridor parameters and the method of maintaining a desired equilibrium glide path by controlling these parameters is essential for application of proper control procedures.

The NF-104A does not provide us with acceleration limits, heating limits, and because of the nature of its trajectory, does not afford sufficient variables to approach a re-entry corridor of significant dimensions.

6. The overall performance capabilities of the proposed aerospace trainer must, to the maximum degree practical, present significant environmental conditions and piloting tasks encountered during boost, space operations, re-entry, and recovery. The environmental conditions and piloting tasks need not duplicate those of actual orbital spacecraft, but should cover in type and relative severity, those phases of space flight which make the greatest demands on the pilot's judgement, endurance, and piloting skills.

Design philosophy must be based on maximum operating flexibility, high use rate, low operating costs and levels of performance that provide

adequate training in the four phases of space flight mentioned previously. A vehicle which has these ground handling and operating characteristics will not have the performance of an orbital vehicle and will therefore be a compromise between a high performance turbojet and an orbital vehicle.

More specific performance capabilities are discussed below:

A. BOOST PERFORMANCE

The unusual environmental conditions associated with boost are:

(1) High longitudinal accelerations:

Boost accelerations of typical sub-orbital and orbital vehicles range from +4 to +10G's over time intervals of up to one minute. A typical X-15 longitudinal acceleration profile is shown in the attached graphs. The acceleration profile of an Atlas launched Mercury is not included since it is classified, however, its profile is considerably more severe and would represent one extreme of the range of possible longitudinal acceleration profiles.

The combination of control demands, acceleration, and other stresses placed on the pilot simultaneously are of more significance than the severity of the control problems or stresses alone. In this vehicle the boost accelerations will begin with the takeoff roll and continue through the transition from horizontal to near-vertical flight. Therefore, peak longitudinal accelerations of +3G's and burn times exceeding 90 seconds will present a combination of longitudinal acceleration, rapid attitude change, and control problems that will require precision control and rapid responses comparable to that of a boosting orbital vehicle.

(2) Rapid attitude changes and steep climb angles:

Rapid attitude changes during boost are inherent in a vehicle that takes off or launches from a horizontal attitude and transitions into vertical or near vertical climb angles. Boost performance should be such that altitudes of 200,000 to 300,000 feet can be attained, using 70° to 90° climb angles. Shallower climb angles (25° to 45°) to intermediate altitudes with dynamic pressures near the apex that will afford use of reaction controls should also be possible. Performance in these ranges will give satisfactory approximation to boost trajectories of vertically boosted vehicles. In addition, while in boost environment, the pilot will be required to precisely control:

(a) Attitude

(b) Flight path

(c) Thrust

1 Thrust level

2 Burn time

(c) Thrust

1 Thrust level

2 Burn time

(d) Velocity Profile

(e) Test instrumentation and data recording equipment.

(3) Control during boost:

Precision thrust variation to afford accurate control of velocity and cut-off should be possible. Flight instrumentation, using both airborne and ground inputs, should allow the pilot to fly a precise flight profile. This will require altitude, attitude, space position, and velocity indications with near zero lag.

B. SPACE OPERATIONS

(1) Unusual environmental conditions, piloting tasks, and special equipment associated with space operations include:

(a) Low dynamic pressure: The trainer should be capable of profiles that provide dynamic pressures less than 10 psf at altitudes between 200,000 and 400,000 feet for periods exceeding two minutes. This will provide adequate time for use of reaction controls to practice various maneuvers and establish re-entry attitude. Except for vehicle velocity relative to the earth, a 300,000 foot maximum altitude places the vehicle in a space environment closely approximating an orbital vehicle. The reaction control system must be capable of manual control with and without automatic stability augmentation in all 3 axes. Various roll, pitch and yaw rates should be capable of being preset on the ground.

(b) Life Support Systems: Since the vehicle will operate in space, space type life support equipment will be required to provide student familiarization with important life support equipment operation and design. The life support system should be capable of providing a shirt-sleeve environment with full pressure suit backup for safety.

(c) Maneuvering in Space: Ideally the vehicle should provide the capability of changing its position relative to another vehicle or frame of reference while in the space environment. However, this capability would require a store of rocket fuel very much in excess of that needed to achieve the desired sub-orbital profile. The initial and operating costs for this type vehicle would be prohibitive for a training operation. Therefore, this particular feature is not considered a mandatory requirement.

C. RE-ENTRY

(1) Unusual environmental and piloting tasks associated with re-entry are:

(a) Longitudinal and normal g forces. Depending on re-entry angle and type of vehicle, orbital re-entry "g" forces vary from approximately 1 "g" to in excess of 10 "g's". Considering pilot tolerance, practical maximum "g" loads are: "10 g's" eyeballs in; 3-5 "g's" eyeballs out and 5 "g's" eyeballs down.

The "g" forces during re-entry of the proposed trainer will be determined by its boost performance. A vehicle with longitudinal accelerations of 2 to 4 g's and exit angles 70 to 90 degrees during boost will reproduce re-entry "g" loads of from -1 to -3.5 longitudinally and from 4.75 to 5.5 in a normal direction. The duration of the "g" forces in re-entry will only be a fraction of that for actual orbital re-entry. However, in keeping with the basic idea of heavy training operations at minimum costs, adequate coverage rather than duplication will be satisfactory.

(b) Control during re-entry: An ideal re-entry trainer would be capable of being inserted into orbital re-entry profiles along a corridor ranging from very shallow to relatively steep paths of several degrees. However, such a capability would require velocity and altitude performance approaching orbital flight. To keep initial and operating costs low and provide high use rates, re-entry performance for the proposed trainer should be limited to that which is compatible with the boost performance previously described. This necessarily restricts re-entry velocities and angles to a narrow range. They will generally be steep (70-90°) and comparatively slow. Although the re-entry profile will be considerably different from that of an actual orbital re-entry vehicle, the piloting tasks confronting the pilot will be approximately the same and of the same order of difficulty as those encountered in an orbital re-entry vehicle. These re-entry tasks will include:

1 Precise vehicle attitude control longitudinally and laterally in response to an energy management and vehicle heating display.

2 Relying on and following directions from ground stations.

3 Monitoring and controlling test instrumentation and data recording equipment.

4 Doing all of the above with decreased cockpit visibility because of heat shielding required during re-entry.

D. RECOVERY

The recovery phase is essentially an energy management problem involving an unpowered landing. The performance of the proposed trainer must permit recovery from the point of completion of the re-entry phase to the initial takeoff point. There must be sufficient margin in altitude at the landing site following a non-optimum recovery to compensate for reasonable errors in energy management on the part of the pilot. Although not mandatory, a sustainer type jet engine to compensate for such errors is desirable.

E. SUMMARY OF MANDATORY DESIGN FEATURES AND PERFORMANCE REQUIREMENTS

(1) Two-place vehicle (controllable from both cockpits)

(2) Capable of sustained flight rate of ten flights per trainer per month.

(3) Launch and recovery at the same site.

(4) Longitudinal "g" forces during boost to reach at least 3 "g's".

(5) Horizontal takeoff and landing from lakebed or runway. Air launch capability optional.

(6) Altitude capability in excess of fifty miles.

(7) Capability for boost trajectories (25° to 45°) to intermediate altitudes with dynamic pressures less than 10 psf at apex.

(8) Other:

(a) Aerodynamic control

(b) Reaction controls

(c) Stability augmentation for both types of flight controls

(d) Throttleable thrust control 50% to 100% range.

(e) Instrument display that will allow precise pilot control during all phases of flight.

7. If an advanced aerospace trainer were available now, it could be effectively utilized to provide training for Gemini, and X-20 crews. However, due to lead time considerations, this vehicle's future use should be considered to be for post X-20 projects. Useful life is estimated to be ten years since it will be capable of providing training that is appropriate for near term aerospace vehicles. In other words,

manned space vehicles within the next 10-15 years will have the same general propulsion, control, instrument display, and life support systems that current space vehicles have and will have generally the same type flight limitations and problems.

8. This vehicle will initially be employed by the USAF Aerospace Research Pilot School to train Aerospace Research Pilots for future aerospace research vehicles. If the demand for operational space pilots ultimately requires an operational space pilot training program, a follow-on procurement of this vehicle for the Air Training Command might be considered if it is still considered to be suitable for aerospace vehicle crew training.

The trainer should be procured as a complete system to include all peculiar support equipment and facilities. Since Edwards AFB has extensive facilities for this type vehicle, facilities costs should be considerably less for the initial procurement. These facilities include exotic fuels storage and servicing equipment, high pressure gas generating, storing and servicing equipment, rocket engine maintenance and overhaul facilities, a large fully instrumented range with numerous emergency landing fields and a terminal landing area complex that is more than adequate.

Quantities required will be dependent on the following general considerations:

a. Number of trainees and number of flights per trainee. Number of trainees will be estimated by USAF requirements while number of flights per trainee will be dependent on the School's curriculum. The curriculum will be developed basically on the vehicle's training capability per flight.

b. The vehicle's predicted utilization rate.

c. Attrition estimates

Once a specific aerospace trainer concept is approved, more definitive quantity estimates can be made.

9. Two contractors are currently investigating the feasibility of modifying operational high-performance turbojets (T-38's and F-104's) to an aerospace trainer configuration. This approach, should it prove feasible, will undoubtedly decrease initial procurement costs since much of their basic aerodynamic, design and structural data will be applicable. However, it should be noted that the modified vehicles will have to incorporate extensive system changes such as propulsion, fuel, auxiliary power, flight control, life support and cockpit display.

in addition, extensive structural and materiel changes will be required.

Another possible solution is procurement of modified X-15's. This solution will also require thorough investigation into feasibility.

In the event the solutions mentioned above prove unsuitable, a completely new specifically designed vehicle will be required.

CHARLES E. YEAGER, Colonel, USAF
Commandant

4 atchs
1. Design Trajectory, J79-3B Engine (Fig. 1)
2. Design Trajectory, J79-3B Engine (Fig. 2)
3. Nominal Trajectory (Fig. 3)
4. X-15 Long. Accel Profile (Fig. 4)

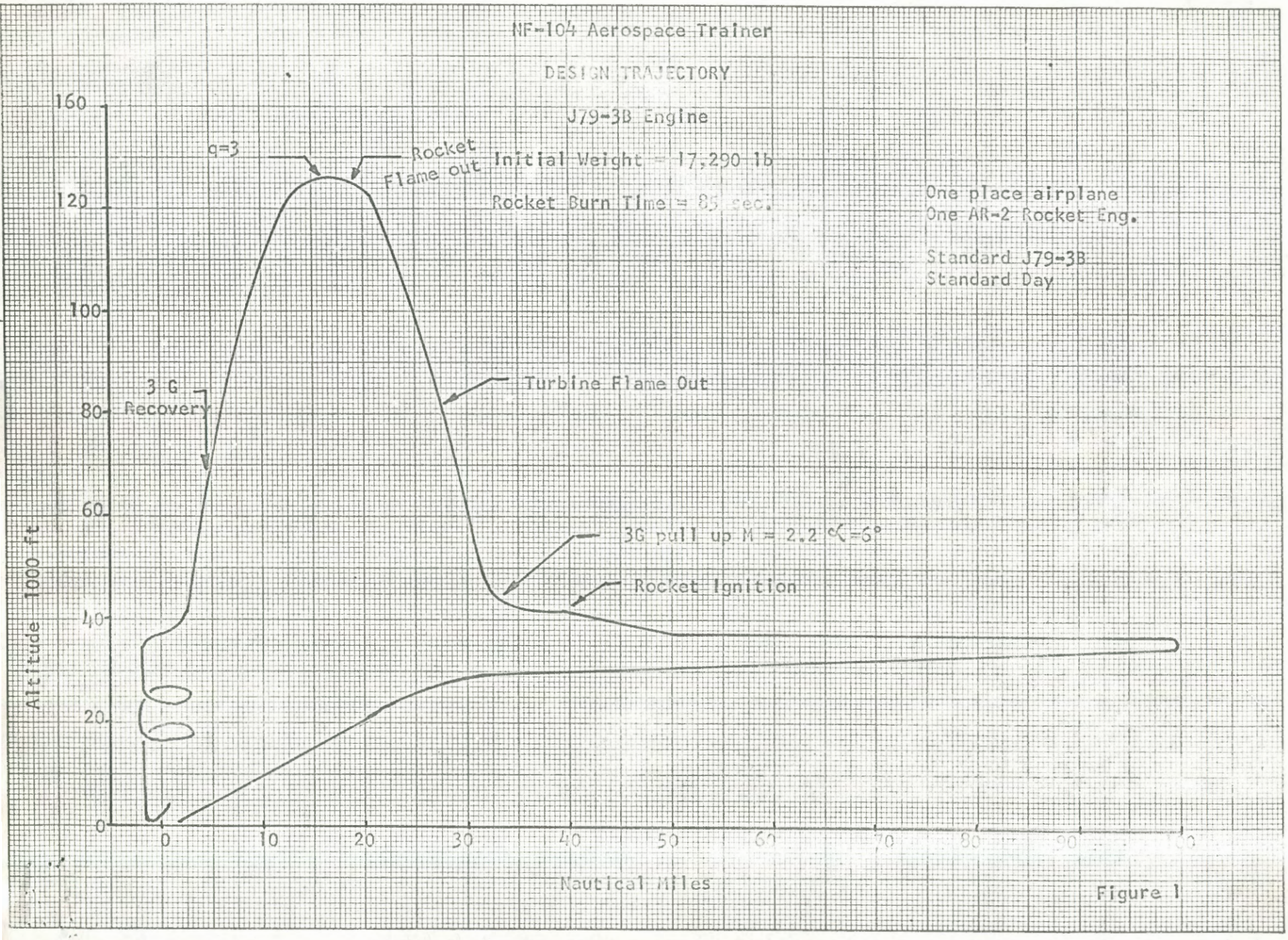
NF-104 Aerospace Trainer
DESIGN TRAJECTORY
J79-3B Engine
Initial Weight = 17,290 lb
Rocket Burn Time = 85 sec.
One place airplane
One AR-2 Rocket Eng.
Standard J79-3B
Standard Day
g=3
Rocket Flame out
3 G Recovery
Turbine Flame Out
3G pull up M = 2.2 α=6°
Rocket Ignition
Altitude 1000 ft
Nautical Miles
0
20
40
60
80
100
120
160
0
10
20
30
40
50
60
70
80
90
100

Figure 1

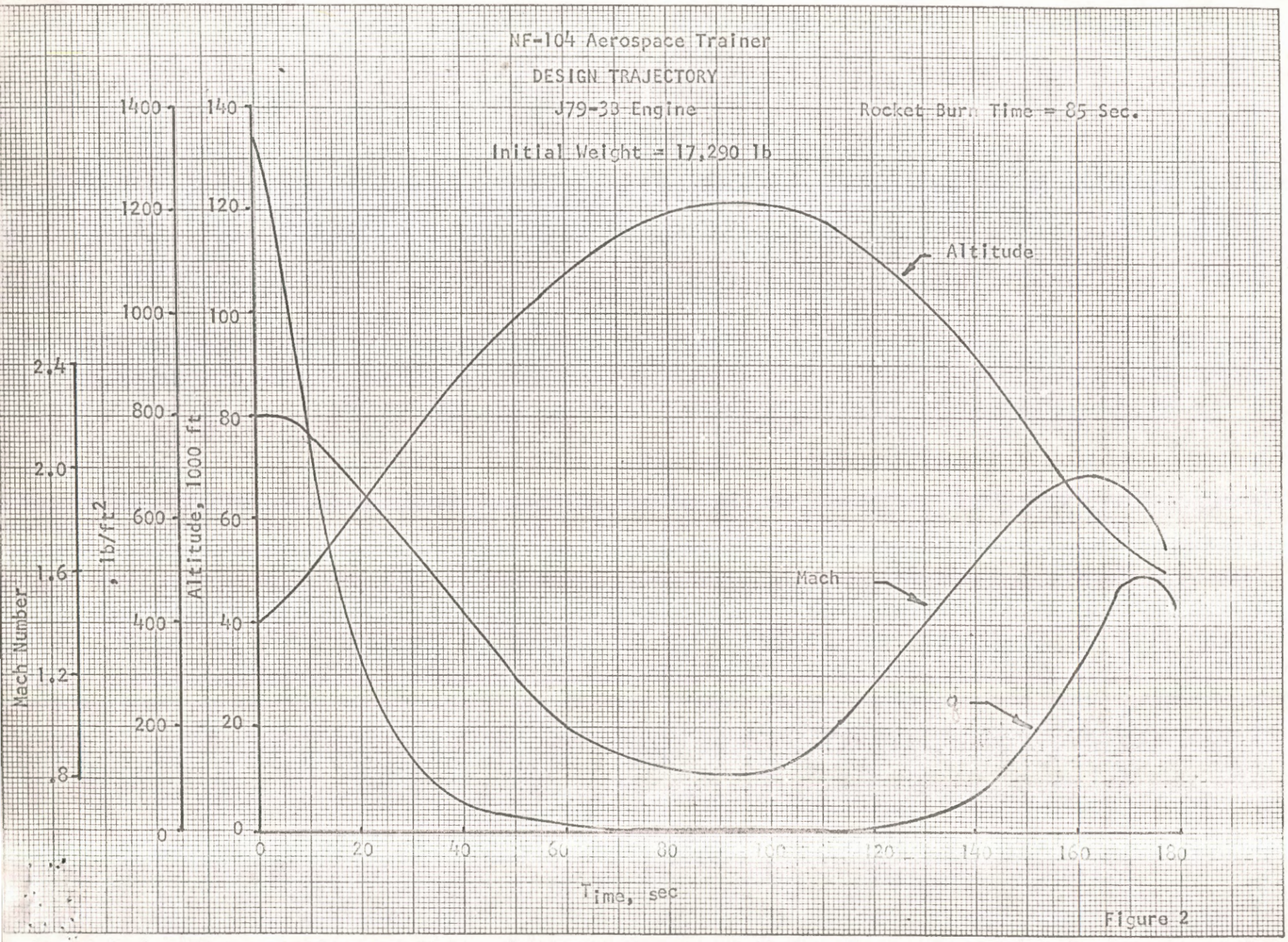
NF-104 Aerospace Trainer
DESIGN TRAJECTORY
J79-3B Engine
Rocket Burn Time = 85 Sec.
Initial Weight = 17,290 lb
Altitude
Mach
q
Mach Number
q, lb/ft^2
Altitude, 1000 ft
Time, sec
2.4
2.0
1.6
1.2
.8
1400
1200
1000
800
600
400
200
0
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180

Figure 2

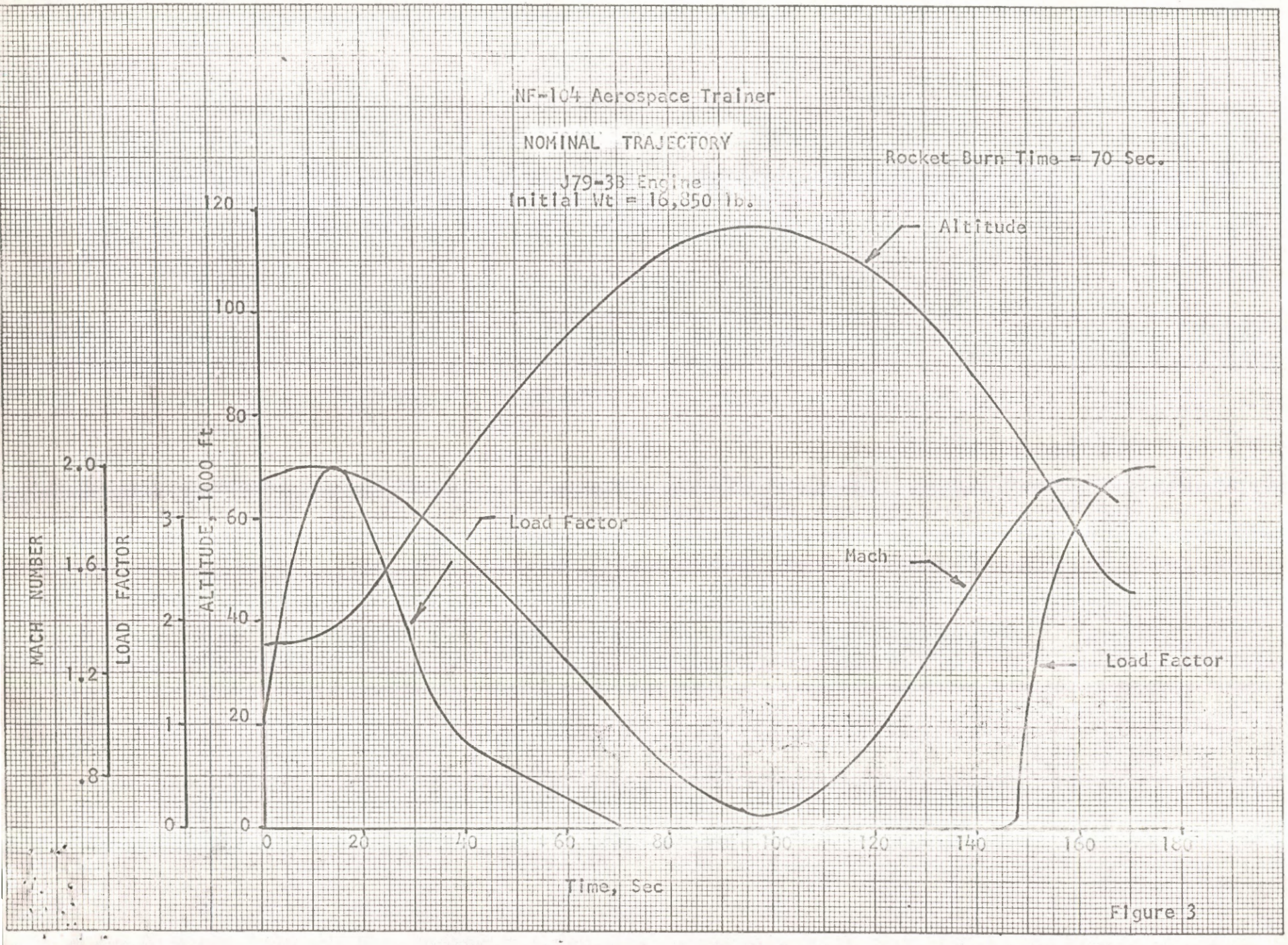
NF-104 Aerospace Trainer
NOMINAL TRAJECTORY
J79-3B Engine
Initial Wt = 16,850 lb.
Rocket Burn Time = 70 Sec.
Altitude
Load Factor
Mach
Load Factor
MACH NUMBER
LOAD FACTOR
ALTITUDE, 1000 ft
Time, Sec
0
20
40
60
80
100
120
140
160
180
.8
1.2
1.6
2.0
1
2
3

Figure 3

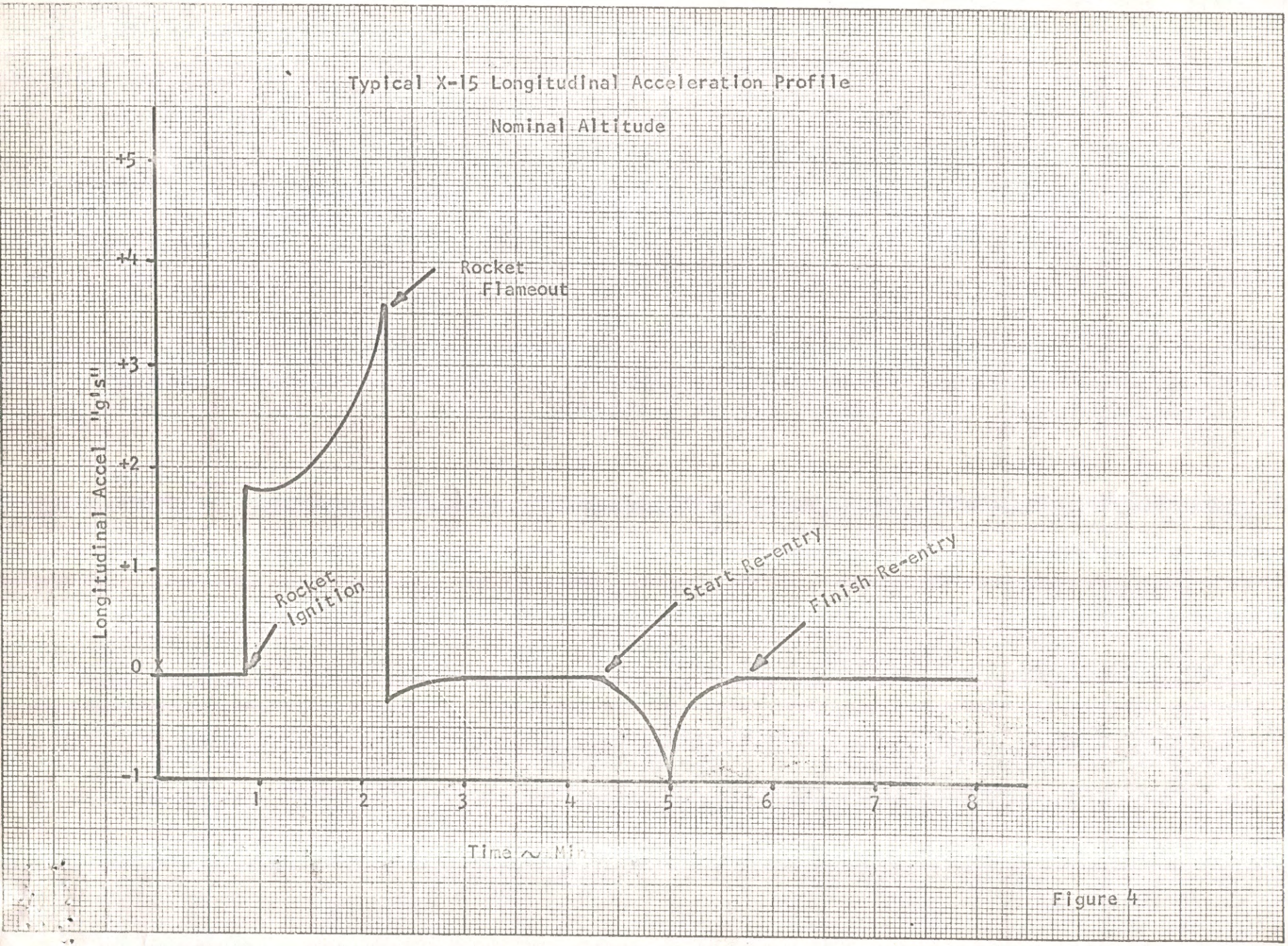
Typical X-15 Longitudinal Acceleration Profile
Nominal Altitude
Longitudinal Accel "g's"
+5
+4
+3
+2
+1
0
-1
Rocket Flameout
Rocket Ignition
Start Re-entry
Finish Re-entry
1
2
3
4
5
6
7
8
Time ~ Min

Figure 4

Chrono: File

SCGC

1. The QOR for the Aerospace Trainer was not endorsed for adoption by the Hq AFSC staff.

2. The coordinated position, however, of all interested staff agencies is that the QOR should be included in our basic plan (ARPS Expansion Plan) to be reviewed and up-dated on an annual basis.

3. The present NF104A rocket modified trainer will be included in the curriculum soon for the seeable future. A follow-on or true Aerospace Trainer, as proposed in the QOR, might be considered for inclusion in the curriculum at a future date depending upon known requirements, and most importantly, a more clearly defined military man in space mission.

4. In view of the above, it is recommended that the basic letter outlining the Hq AFSC position be resubmitted to the Vice-Commander for signature. It is felt that HQ USAF should have the opportunity to approve our "watch and wait" position regarding a future aerospace trainer and to review the QOR itself.

Capt Horne 26 Sep 63

LC

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
ANDREWS AIR FORCE BASE
WASHINGTON 25, D. C.

SCGV

Qualitative Operational Requirement (QOR), Aerospace Trainer

HQ USAF (AFRSTC)

1. The USAF Aerospace Research Pilot School has prepared a QOR on an Aerospace Trainer. (Atch 1)

2. The QOR has been staffed at this Headquarters and, subject to your concurrence, the following course of action is proposed:

a. The Aerospace Trainer QOR be included in the ARPS Expansion Plan to be reviewed and updated annually (reference SCP letter, subject: Requirements for, and Utilization of, Aerospace Research Pilot School Graduates, dated 11 Sep 63).

b. Evaluate the utilization, competency gained and projected life of the rocket modified NF104A.

c. Anticipate a probable requirement for a true Aerospace Trainer based upon a clearly defined military man in space mission.

d. Initiate a formal procurement cycle for an Aerospace Trainer at your direction or as a requirement becomes more definitive.

Read File

1 Atch
Ltr, ARPS (FTT), 7 Aug 63,
subject as above, w/4 atchs
and 1st Ind, AFFTC (FTO)
12 Aug 63