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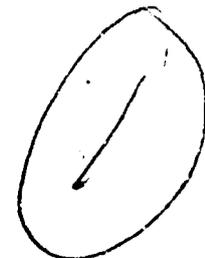
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Pres (F)

FINAL REPORT on

TAC MISSION ~~FF~~ FF 857,

AIR COMBAT TACTICS EVALUATION

F-100 F-104 F-105 F-4C

Vs

MIG-15/17 TYPE A/C (F-86H) (U)

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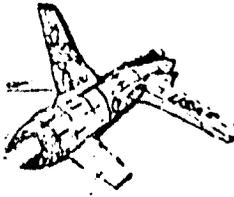
10 James C. Hare; Michael S. Muskat
is Jake D. Williams

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FOREWORD

TAC directed the USAF Fighter Weapons School, Nellis AFB, Nevada, to conduct an evaluation to determine the most suitable offensive and defensive maneuvers for the F-100, F-104, F-105 and F-4C versus MIG 15/17 type aircraft.

Colonel James C. Hare, Commandant, Fighter Weapons School, was designated project officer. Authority for the conduct of the test was TAC message C-0054, 28 April 1965 (SECRET). This report is submitted in accordance with TACR 80-1.

Assistant project officers were designated for each type of participating aircraft. F-86H, F-104 and F-4C team commanders were so designated for their respective types of aircraft.

- F-86H - Lt Col Joseph J. Maisch, Jr.
175 TFG, Md ANG
- F-100D - Capt Zeke D. Williams
USAF FWS
- F-104C - Capt Philip E. Smith
479 TFW, George AFB, Calif
- F-105D - Capt Michael S. Muskat
USAF FWS
- F-4C - Lt Col Ralph S. Parr, Jr.
4453 CCTW, Davis Monthan AFB, Ariz

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FINAL REPORT

AIR COMBAT TACTICS EVALUATION

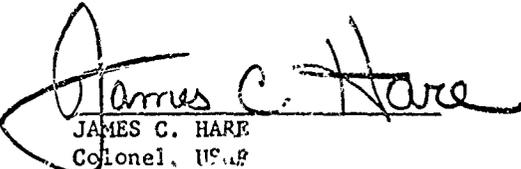
TAC MISSION FF-857

26 APR - 7 MAY 1965

This report was prepared by personnel of the USAF Fighter Weapons School, Nellis AFB, Nevada. Comments should be directed to Hq Tactical Air Command (DO) with info to USAF FWS.

Report prepared by:

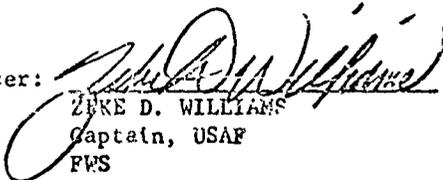
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Colonel, USAF
Commandant, FWS

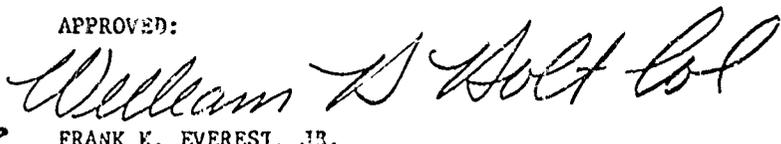
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ABSTRACT

The objectives of the Evaluation (TAC Mission FF-857) were to determine the most suitable offensive and defensive maneuvers for the F-100, F-104, F-105 and F-4C versus MIG 15/17 type aircraft. Energy maneuverability diagrams were used to substantiate conclusions and recommendations. Use of energy maneuverability concept for planning was limited; however, because necessary energy maneuverability diagrams were not available for the F-86H aircraft, which simulated the MIG 15/ MIG 17 types.

It was determined that the F-100, F-104, F-105 and F-4C should avoid co-speed, high angle of attack engagements with the MIG 15/17 type aircraft. On the offensive, a speed advantage should be maintained. On the defensive, maneuvering in an attempt to cause an overshoot will probably be unsuccessful. Therefore, an attempt to disengage should be made by reducing the angle of attack and using max power to move out of the attacker's range, maneuvering as necessary to spoil a tracking solution until well outside gun and/or missile range.

Performance data obtained in this test is in agreement with data obtained from energy maneuverability diagrams.

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TABLE OF CONTENTS

<u>PARAGRAPH</u>	<u>PAGE</u>
1. INTRODUCTION	1
2. DESCRIPTION OF TEST ITEMS	1
3. PURPOSE OF TEST	1
4. OBJECTIVES OF TEST	1
5. CONCLUSIONS	2
6. RECOMMENDATIONS	5
7. DEFICIENCIES	6
8. TEST ENVIRONMENT AND PROCEDURES	6
9. TEST RESULTS AND DISCUSSION	9
10. MAINTENANCE RESULTS	24
11. TRAINING REQUIREMENTS	25

ANNEXES

- A - MISSION SUMMARIES
- B - TEST DATA CARDS
- C - PILOT EXPERIENCE LEVEL
- D - F-105 ACCELERATION COMPUTATION
- E - PARTICIPATING TEAM POST MISSION SUMMARIES
- F - ACT MANEUVER DIAGRAMS
- G - ENERGY MANEUVERABILITY DATA
- H - AIM-9/B MANEUVERING ENVELOPES

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1. INTRODUCTION: In Southeast Asia our supersonic F-100s, F-105s and F-4s have engaged or been engaged by subsonic MIG 15s and MIG 17s.

The results of these engagements indicate an urgent need to determine the most suitable offensive and defensive maneuvers to be employed against the MIG 15/17s. The F-100, F-104, F-105 and F-4C were evaluated in simulated air-to-air combat using the F-86H as MIG 15/17 comparable aircraft.

2. DESCRIPTION OF TEST ITEMS: Refer to flight handbooks for information on the following types of aircraft used in the test.

- a. Three F-100Ds provided by the 4520th CCr Tng Wg.
- b. Three F-104Cs provided by the 479th Tac Ftr Wg.
- c. Five F-105D/Fs provided by the 4520th CCr Tng Wg.
- d. Three F-4Cs provided by the 4453rd CCr Tng Wg.
- e. Five F-86Hs provided by the Maryland and the New York Air National Guard.

For purposes of the evaluation, all aircraft were considered to be equipped with 20mm cannon, either M-39 or M-61, and with AIM-9/R missiles. This assumption was made in view of pending F-4C gun installation.

3. PURPOSE OF TEST: To determine the best offensive and defensive maneuvers to be employed against MIG 15/17 type aircraft and to verify through flight test certain data and conclusions obtained from energy maneuverability diagrams.

4. OBJECTIVES OF TEST: The objectives of this evaluation were to determine the following:

- a. Most suitable offensive maneuvers.

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- b. Most suitable defensive maneuvers.
- c. Most suitable element tactics.
- d. Verify certain energy maneuverability data.

5. CONCLUSIONS:

a. General:

(1) If F-100, F-104, F-105 or F-4C cruising at .9 mach or below are engaged by MIG 15/17 type aircraft, executing .95 mach attacks from the rear hemisphere, the best course of action is to employ a maximum power acceleration to supersonic speed for separation rather than employing defensive maneuvers designed to force an overshoot.

(2) If such attacks are detected within minimum separation range (3000-4000' for F-4C, 4000-5000' for F-104, 5000-7000' for F-100 and F-105), an accelerating diving spiral, max power escape is recommended.

(3) If such attacks are detected at attacker gun fire range, a break followed immediately by the diving spiral must be attempted.

(4) For offensive use during a maneuvering fight, the AIM-9/B is severely limited in that the launch capability is restricted by low angle off and G limitations.

(5) Evaluation of TAC fighter maneuvering flight capabilities at low altitude (2000'-15,000') was not analyzed due to the imposed 10,000' AGL minimum altitude restriction. Such capability is predicted by current energy maneuverability data to be greater than at higher altitudes.

2
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(6) According to participating F-4C aircrews, opportunities were presented for employment of AIM-7 and particularly AIM-7E missiles; however, live testing against maneuvering targets is required immediately to verify predicted capabilities.

b. F-100D:

(1) Defensive employment of descending hard turns is recommended to defeat AIM-9B type missile attacks. F-100 mach should be maintained at .9 or higher.

(2) Defensive employment of breaks is recommended to defeat gun attacks detected within or slightly outside gun firing range. Breaks should be continued to a diving separation maneuver if an offensive position is not achieved by a break maneuver.

(3) Use of high G rolls or scissors maneuvers to gain an offensive position is not recommended against F-86H type aircraft.

(4) F-100 attacks should be initiated with a high energy level (approximately mach 1) to enable closure to firing range prior to excessive speed loss in attempting to track defending F-86H type aircraft through turns. The $\frac{1}{2}$ roll away and down is normally the best disengagement method following such attack.

c. F-104C and F-4C:

(1) Defensive employment of descending hard turns is recommended to defeat AIM-9/B type missile attacks. Mach number of approximately .9 or higher should be maintained.

3
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(2) Defensive employment of breaks is recommended to defeat gun attacks detected within or slightly outside gun fire range. Breaks should be continued to a diving separation maneuver if an offensive position is not achieved.

(3) Use of high G rolls or scissors maneuvers to gain an offensive position is not recommended against F-86H type aircraft.

(4) F-104 and F-4C attacks should be initiated at a high energy level (1.2 mach or higher) to enable closure prior to excessive loss of airspeed in attempting to track defending F-86 type aircraft through turns. The $\frac{1}{2}$ roll away and down is the best disengagement method following such attack.

(5) If a gun attack is detected at approximately 4000' or greater range, a 0 to 1C max power dive for separation employing sporadic rolling maneuvers is recommended.

d. F-105D:

(1) Defensive employment of descending hard turns is recommended to defeat AIM-9/B type missile attacks. F-105 mach should be maintained at .9 or better to conserve maneuvering potential.

(2) Defensive employment of breaks is recommended to defeat gun attacks detected within or slightly outside of gun fire range. Breaks should be continued immediately to a diving spiral separation maneuver if not successful in forcing overshoot.

(3) Use of high G rolls over or scissors maneuvers to force overshoot and regain the offensive is not recommended against F-86H type aircraft. The use of a high G roll under will result in an

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attacker overshoot 3000-5000' above the defender, but leaves the F-105 with little maneuvering potential.

(4) F-105 attacks should be initiated with a high energy level (1.2 - 1.3 mach) to enable closure to firing range prior to excessive speed loss in attempting to track defending F-86 type aircraft through turns. The $\frac{1}{2}$ roll away and down is the best disengagement method following such attack.

6. RECOMMENDATIONS: The following actions are recommended:

a. Tactical fighter aircrews be provided the information in this report on an expeditious basis.

b. Tactical formations be utilized by TAC fighter flights that emphasize good lookout capability and mutual coverage, due to the necessity, as determined by this evaluation, to detect enemy MIG 15/17 type aircraft attacks at sufficient distance to gain separation and then re-engage at higher mach.

c. Fighter pilots and commanders should not consider ACT maneuvering obsolete as a result of this evaluation. The conclusions that accelerating separation maneuvers offer the best course of action is valid only against mach limited enemy fighters. Such maneuvers may not be possible if TAC fighters are attacked by MIG-21 or later type Soviet aircraft and a resort to overshoot forcing defensive maneuvers may be necessary.

d. To increase proficiency in flying widely spread tactical formations, the use during training of "route" formation should be minimized and maximum use be made of tactical formations.

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e. Realistic wing level Air Combat Tactics training programs should be conducted, to include flying clean aircraft, and to include minimum restriction on maneuvering other than flight handbook limitations.

f. In future procurement of air superiority fighters, consideration should be given to the desirability of high positive energy rate values while under G load (see Annex G). Without this characteristic, speed and altitude loss during high G maneuvering is rapid.

7. DEFICIENCIES:

a. Rearward lookout capability in F-105 and F-4C was found to be severely restricted. The presence of cockpit mirrors did not alleviate the problem.

b. AIM-9/B launch parameters of launch aircraft G load and angle off severely restrict the use of this missile in a maneuvering flight.

c. Specific F-4C deficiencies are as listed in Annex E, F-4C Team Summary.

8. TEST ENVIRONMENT AND PROCEDURES:

a. Test Environment:

(1) This evaluation was conducted by Tactics Development Division and Operations and Training Division, USAF Fighter Weapons School, Nellis AFB, Nevada.

(2) All physical testing was conducted in FAA Special Operating Areas within the Nellis local flying area from flight level 240 to 410, and in the underlying local flying area from 10,000' AGL to flight level 230.

6
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(3) Sorties were flown employing the F-86H versus F-100D, F-104C, F-105 and F-4C aircraft.

(4) All sorties were flown in a clean configuration with full internal fuel.

(5) Recovery distance was 60-100 NM, with normal initial approach fuel at "homeplate," with limited alternate allowance. Missions averaged 40-50 minutes in duration with sufficient fuel for 2 to 4 engagements totaling 20-30 minutes. Optimum return cruise and idle power descents were used frequently.

(6) The experience level of the majority of the 26 participating pilots was high, both in terms of jet and unit equipped aircraft, as indicated in Annex C.

b. Procedures:

(1) Emphasis was placed on one versus one sorties (one F-86H vs one F-100, one F-86H vs one F-105, etc.), to evaluate all appropriate offensive and defensive maneuvers. An attacker and defender were designated on each flight to provide equal sampling of offensive and defensive maneuvers. Initial engagement conditions were prebriefed to simulate either combat air patrol (.85 - .95 mach at 30 - 35M' depending on type aircraft) or low altitude approach to ground target (300 - 330 KCAS at 20M').

(2) Two missions of two-versus-two were scheduled for each TAC fighter to evaluate element tactics. TAC fighters were designated attackers on one two-versus-two mission and as defenders on the other.

7
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(3) Participants were briefed to obtain data on sustained "G" capability at various mach numbers and at 15M and 35M feet to verify energy maneuverability PsV diagrams.

(4) Test data cards were compiled during flight and in flight debriefing (see Annex B). The cards were then turned in to a project officer to be used in preparing the final report.

(a) Description of Test Data Cards (see Annex B):

1 Test Data 1 Card was used on ACT-1 (Air Combat Tactics 1), ACT-2, and ACT-X. On all ACT-1 flights the F-86H was designated the attacker and the TAC fighter was designated the defender. The F-86H was given an initial advantage of speed, altitude and position. As the F-86 closed for a gun attack, the defender countered with a prebriefed defensive maneuver, i.e., break, hard turn, scissors, high "G" barrel roll, etc. Engagements were terminated after desired evaluation of maneuvers was made. ACT-2 was identical to ACT-1 with the exception that the F-86 assumed an initial defensive role and the TAC fighter assumed an offensive role. ACT-X was used to repeat portions of ACT-1 or ACT-2 as deemed necessary for evaluation.

2 Test Data 2 Card (was used on ACT-3 and ACT-4 and ACT-X). This card is basically the same as Test Data 1 Card except both aircraft were equipped (simulated) with AIM-9/Bs in addition to guns. The attacker initially attempted to position for a missile launch, but once the missile attack was nullified a follow-up gun attack was attempted. On ACT-3, the F-86H was the attacker with the TAC fighter defending. The roles were reversed on ACT-4. ACT-X was used to repeat any portions of ACT-3 and ACT-4 deemed necessary for the evaluation.

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3 Test Data 3 Card was used on ACT-5, ACT-6 and ACT-X, to collect data on element tactics (2 vs 2). On ACT-5 the F-86H assumed the attacker roles, with the TAC fighters defending. The roles were switches on ACT-6. ACT-X was used to repeat portions of ACT-5 and ACT-6 as deemed necessary for the evaluation. Defensive splits, offensive counters to the split and the ability to lend mutual support were to be evaluated.

(5) Immediately following the evaluation, team leaders of the participating visiting teams (F-86H, F-4C and F-104) were asked to record their comments and conclusions for inclusion in this report. Although specific conclusions in some cases differ from those in this report, the team summaries are included in Annex E in an attempt to portray the diversity of thought on the subject of air combat tactics, and counter any possible bias on the part of the project officers.

9. TEST RESULTS AND DISCUSSION:

a. General: Although there are considerable differences in performance capabilities of the TAC fighters evaluated, they all share the same basic advantages and disadvantages when compared to an F-86H type aircraft. The F-100, F-104, F-105 and F-4C all have an advantage in top speed, all have a sustained G advantage at high mach numbers, and all have a disadvantage in sustained G at low mach numbers. When these facts are known, certain conclusions are obvious.

- (1) Take advantage of the superior speed of the TAC fighters.
- (2) Don't slow down and turn with F-86H type aircraft.
- (3) Employ "hit and run" tactics.

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Results of this evaluation strongly support these foregone conclusions. During the evaluation the following results were identified. It must be emphasized that the missions flown during this test were not "hassles" or "rat races". Prebriefed maneuvers were flown and evaluated, even though in some cases these maneuvers were known to be ineffective or foolhardy. In other words, the TAC fighters did not just play their game, but, for the purpose of this evaluation, slowed down and played the F-86's game.

A discussion of each of the TAC fighters versus the F-86H follows. First, defensive situations will be covered, analyzing effective and ineffective defensive courses of action. At the start of each engagement the TAC fighter defender used a relatively low mach number to allow the F-86H to close and although the attack was detected, did not attempt escape until the prebriefed defensive maneuver initiation range was reached by the attacker. Second, offensive situations will be discussed, covering not only how, but how not to maneuver on the offensive.

b. F-100 vs F-86H:

(1) F-100 Defender, F-86H Attacker:

(a) Maneuvering against a missile attack: A typical defensive engagement began with the F-86H at 5-7 o'clock high and approaching missile range. Assuming the attack was detected prior to launch, a hard turn into the attack placed the attacker outside the missile launch envelope. During this evaluation it was difficult to analyze maneuvering against a missile attack, because of the pilot's inability to judge angle-off, range, and rate of closure. It was

10
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considered, however, that a three-"G" turn into the attack would nullify the missile attack by placing the attacker outside angle-off launch parameters. As the attacker's range decreased, the 2 "G" launch limit was exceeded. Once the attacker gave up on the missile attack, a follow-up gun attack was initiated.

(b) Maneuvering against a gun attack: In maneuvering against a gun attack, the defender had two basic options:

1 Turn, in an attempt to cause an overshoot and subsequently gain an offensive position.

2 Out run the attacker and move outside gun/missile range.

When the turn option was selected, the F-100 played the turn with respect to the attacker's relative position. Max performance turning was approached only when the attacker closed to gun range. A mistake frequently made was to go to max performance maneuvering too soon, consequently losing airspeed and future maneuvering capability, placing the defender in a more vulnerable position. If max performance is achieved at the proper time (attacker inside gun range), and the attacker presses the attack in the plane of the defender's turn, a very rapid overshoot will occur and the attacker will slide out front. The reason this occurs is that at High "G" loads the F-100 loses airspeed so much faster than the F-36H type aircraft. In a hard turn, the F-100 airspeed can go from 300K to 140K in 90-120° of turn. Naturally the F-86 loses airspeed, also, but not nearly as rapidly.

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If the F-86 employed the high speed yo-yo he effectively countered the F-100's turn and maintained an offensive position. The F-86 pilot, recognizing an imminent overshoot, learned to discontinue the pass and pull up into the vertical plane. The F-86 attack normally had to be discontinued at extreme gun ranges (approximately 3500'). The exact range depended on angle-off and rate of closure. If the F-100 employed the hard turn properly, and forced the F-86 into a high speed yo-yo, the gun attack was only temporarily nullified. The F-86, following the yo-yo, was at six high, approximately co-speed. The turn required to force the yo-yo cost the F-100 most of his maneuvering airspeed. The F-86 was able to slide back down, or perform a roll-off back down to gun position. The F-100's subsequent defensive turn was completely ineffective because of its resulting loss of speed. If the F-100 took the fight down into the vertical plane, with the attacker at close range, an overshoot was more likely, since the attacker was less likely to employ the yo-yo type maneuver effectively. If an overshoot occurred, and the attacker had very little nose/tail separation, a vertical rolling scissors forced the F-86 into a 12 o'clock position. Reason: The F-100 was capable of achieving a very high angle-of-attack and lost energy (airspeed) faster than the F-86. If, on the overshoot, the F-86 had good nose/tail separation, it did not have to maneuver into a vertical rolling scissors. In those cases where the fight was going down and both aircraft had approximately 180K, the F-86 was able to roll wings level and zoom up into the vertical plane. If the F-100 attempted this, he was not able to match the attacker's rotation angle in the vertical plane. Therefore, the F-86 usually reached in the F-100's six o'clock

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high position, with the F-100 completely out of maneuvering airspeed. From this advantageous position, the F-86 was able to roll off into a gun position and achieve a gun kill. From this experience with the F-100's comparative turning capability, the obvious conclusion was: Don't try to turn with an F-86 type aircraft.

A second defensive option was also attempted, other than attempting to nullify missile/gun attack by turning. The second option was to use the F-100 speed advantage to move outside missile/gun range. Ideally all attacks would be detected outside missile/gun range, but for the purpose of this evaluation some attacks were allowed to reach closer ranges prior to defensive maneuvering. This was considered likely to occur at the lower speeds associated with ground attack missions, than at the higher speeds associated with combat air patrol. It was determined that if the F-100 pilot detected the attack outside missile/gun range, he should drop the nose and use AB as necessary to prevent the attacker from closing. The following courses of action were developed as a result of the evaluation: If the attacker is detected inside the missile envelope, the diving, max power separation is not feasible. If a three "G" defensive turn is initiated, the missile attack will be defeated, however, this will enable an F-86 type aircraft to cut off on the inside of turn and close. As his range is reduced, the F-100 must tighten the turn and eventually experience airspeed decay. To maneuver against a missile attack, a turn into the attack is necessary, however, the turn should be just hard enough to place the attacker outside the launch envelope. With only a .3 to .4 mach advantage, the F-100 will take an appreciable amount of time to move outside missile

13
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range, and any unnecessary turning will be to the attacker's advantage. If the attacker is equipped with gun only, an escape should still be attempted, initiated prior to the attacker reaching gun range. If the attacker is detected after reaching a gunfire position, a hard turn or break is advisable to spoil his tracking solution. This turn should be of short duration to prevent loss of airspeed. If the attacker overshoots, a reversal should be made, followed by a straightaway, max power, descending separation maneuver. If the attacker does not overshoot, a reversal, immediately followed by zero "G", frequently throws the attacker out of phase. If successful in placing the attacker out of phase, the F-100 has a few seconds of safe time in which to unload the wings (0 to 1G) and begin the separation maneuver. The defender should employ sporadic rolling or "S" type maneuvering to spoil a tracking solution until well outside gun range.

(2) F-100 Attacker, F-86H Defender:

(a) Maneuvering for a missile attack: When the attack was detected prior to launch the F-86 invariably nullified the attack with a defensive turn. In most cases the only chance for a successful launch appeared to be an undetected approach. A barrel-roll attack was effective in reducing angle-off, but if the defender maneuvered properly it was still impossible to reach the launch envelope, and a follow-up gun attack had to be initiated.

(b) Maneuvering for a gun attack: If the F-86 made a hard turn while the attacker was well outside gun range, a large angle-off resulted as the attacker approached gun range. Under these circumstances an overshoot was usually unavoidable. The resulting scissors

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maneuver then forced the F-100 out front. If the F-100 countered the overshoot with a high speed yo-yo, the F-86 effectively countered by pulling up into vertical plane, followed by a roll-off into the F-100's six o'clock position.

If the F-100 was allowed to reach gun range at a low angle-off an overshoot could be avoided, but at the expense of maneuvering airspeed. The F-86, out front, with an airspeed advantage, was able to pull up high into the vertical plane and roll in behind the F-100. The F-100, out of maneuvering airspeed, was an easy "kill".

To preclude the above situations from developing, the F-100 should employ "hit-and-run" tactics. A high mach number should be maintained at all times in a maneuvering fight. The exact minimum mach will vary with the attack conditions (defender's mach, altitude, etc.). A general rule of thumb is: Never slow down below best AB climb speed (92 true mach). If the defender counters properly, the attack will have to be discontinued at extreme gun range, or airspeed will be sacrificed. To break off the attack, reverse down and away from the defender and maneuver for separation.

(c) Two F-100s vs two F-86s (Element Tactics): Resources allowed only one partially effective mission to be flown and a meaningful evaluation could not be made. See Annex B, Card #67.

c. F-104C vs F-86H: The following results were identified:

(1) ACT-1: Thirteen .86 to .96 mach stern quarter gun attacks were completed by F-86H aircraft against F-104C aircraft. Of these attacks, seven were accomplished with the F-104 positioned at 35,000' at .85 - .9 mach, and six with the F-104 at 325-350 KIAS at 20,000-

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21,000'. Eight of these attacks resulted in F-86H gun kill assessment. F-104 hard turns and breaks were unsuccessful and the maneuvers were followed by the F-86H. The F-104 positive G accelerating diving spiral was successful in effecting five escapes; however, if the F-104 pulled up following diving escape, the F-86 could close the distance for a gun tracking position. In no case did the F-104 force an overshoot and regain the offensive.

(2) ACT-2: During 12 passes by F-104 aircraft against F-86H defenders, gun kills were assessed for the F-104 on six. In all cases the F-86H could force an F-104 overshoot, once it started a hard turn or break; however, on more than half of the passes the defending F-86 pilot had difficulty detecting the F-104 attack although he knew when and from where it was coming. Even when the attack was detected, defenders over estimated F-104 range due to its small size and delayed breaking until too late.

(3) ACT-3: During 16 F-86H .9 - .95 mach missile/gun stern quarter attacks, F-86 gun kills were assessed on 10 attacks. Again, F-104 level turns, breaks the hard pull ups were not effective. The diving spiral escape maneuver, if executed with a rapid roll entry, was effective in enabling F-104 escape. Only three opportunities occurred for possible AIM-9/B launch by F-86 aircraft following F-104 defensive maneuver initiation.

(4) ACT-4: During 11 F-104C .9 to 1.2 mach stern quarter missile/gun attacks, no gun kills were achieved due to F-86 forcing overshoot in all cases prior to gun range. (Malfunctioning F-104

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stick kicker onset at 2G degraded F-104 capability on four passes.)
In one F-104 gained a missile launch position using a barrel roll attack.

(5) ACT-5: During three element attacks by F-86H aircraft against a defending F-104 element, none of the attacks resulted in a sandwich by the defenders. The conclusion reached was that diving spiral separation was the better course of action for F-104 aircraft rather than attempt defensive split mutual support.

(6) ACT-6: During each of two element attacks by F-104 aircraft, gun kills were achieved on one F-86 defender due to loss of visual contact by the defenders with at least one of the attacking F-104s. Offensive fluid separation was effectively employed by the F-104s.

(7) F-104C Summary: As with the F-105, if a rear hemisphere missile/gun attack by MIG 15/17 type aircraft is observed by defending F-104 aircraft, max acceleration 0-1G diving separation is recommended. If the attack is observed too close for this type of separation, a diving accelerating spiral employing rapid roll rates is effective. The F-104 has an excellent chance to subsequently re-engage undetected visually by the enemy. If the attacking threat is carrying missiles, the accelerating dive, if delayed until missile launch range, must rapidly generate angle-off prior to attempting escape.

(a) The F-104 has little success in forcing overshoots through the use of breaks, hard turns, high G rolls, or scissors maneuvers.

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(b) In attacking with the F-104, an outstanding advantage is its small frontal silhouette. The F-104 attack should be pressed at supersonic speed, 1.1 - 1.3 mach, to insure closure before the defender's turn forces an overshoot.

(c) Both in attacking and defending with the F-104, once supersonic separation has been effected, initiation of climb must be delayed at least 1-2 miles to prevent MIG 15/17 type aircraft from cutting off in the vertical plane.

d. F-105 vs F-86H: During the evaluation the following results were identified when the missions were analyzed. It must be emphasized that instead of merely attempting missile or gun kill, or attempting escape, the participants were deliberately testing the effectiveness of prebriefed maneuvers.

(1) ACT-1: Ten .92 - .97 mach stern quarter gun attacks were completed by F-86H aircraft against F-105D aircraft. Of these, seven were accomplished with the F-105 positioned at 33,000-35,000' at .9 mach simulating typical combat air patrol cruise conditions. Three were accomplished with the F-105 at 20,000-25,000' at 330 KCAS, simulating typical medium altitude bomb mission cruise conditions during approach to the target. Five of these attacks resulted in F-86H gun kill assessment with F-105s attempting hard turns, breaks, High G rolls under and High G rolls over. Three successful escapes by F-105 resulted from separation maneuvers (one accelerating, descending hard turn; one break, followed by an immediate "Split S" AB escape; and one roll under, and accelerating dive). In no case did the F-105 force sufficient overshoot to gain the offensive.

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(2) ACT-2: Ten stern quarter or 6 o'clock attacks were completed by F-105D/Fs against F-86H aircraft. Of these, six were accomplished with the F-86 positioned at 35,000' and .85 mach and four were flown against the F-86 positioned at 20,000' at speeds of 330 KCAS or .85 mach. F-105 attack speeds varied from .98 to 1.25 mach. During these attacks, the F-105 achieved one gun kill, with one probable and one possible. The F-86H was able to effect escape in nine cases and was able on three of these cases to score a kill on the departing F-105. Generally, the F-86 used a hard turn, followed by a break when the F-105 closed to gun range, and forced an overshoot. If the F-105 yo-yoed high, the F-86 was able to reverse and accomplish a roll off with a higher apex into the F-105's 6 o'clock position.

(3) ACT-3: Four stern attacks were completed at .9 - .95 mach by F-86H aircraft against F-105D aircraft positioned for two attacks at 35,000', .85 - .9 mach and for two attacks at 20,000-22,000', 330 KCAS. During these attacks, F-105D defensive maneuvering was initiated at typical terminal AIM-9/B launch conditions (i.e., 5000-7000' range, 0-15° angle-off, less than 2G on launch aircraft). The attacking F-86 attempted to obtain a subsequent AIM-9/B missile launch position (less than 15° angle-off, less than 2G, 5000' range) and a follow-up gun kill position. In one case a subsequent missile launch position was obtained during the F-105 diving afterburner (AB) escape, and in three cases gun kills were obtained during F-105 evasive maneuvers (hard turn and diving spiral entries). During two head on engagements, with the F-86H possessing an airspeed advantage, high and low speed yo-yo maneuvering in AB was attempted by the F-105D. In the first case the F-86 scored a

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gun kill, in the second case the F-105 executed a separation maneuver after the F-86 reached a high side position. In the one case where the F-105D escaped from an F-86 stern quarter attack, the maneuvers were a descending hard turn (to deny subsequent missile launch positions), followed by a break when the F-86 closed to gun range, and an immediate entry into an AB accelerating vertical diving spiral with low altitude recovery at .98 mach. In one case after initiating the diving spiral escape maneuver, the F-105 pulled up hard into the F-86 and forced an overshoot, but as the F-105 attempted to reverse into the vertical rolling scissors to gain the offensive, it snap rolled twice at 250-300 KCAS. Recovery was immediate when controls were released.

(4) ACT-4: Three stern quarter attacks were completed by F-105 aircraft at .98 to 1.3 mach. Two of these resulted in gun kill assessment against the defending F-86H. Three head on attacks were completed by F-105s having initial speed and/or altitude advantage. In no case was a kill position achieved before the attack terminated.

(5) ACT-5 and 6: One mission combining both ACT-5 (F-105 defenders) and ACT-6 (F-105 attackers) was flown using an element of F-105s versus an element of F-86s. With the F-105s defending and attempting a defensive split, the low defender was "killed" before the high defender could effect a sandwich. When the attackers observed the high defender sliding toward 6 o'clock, they performed a break upward into the high defender, forcing the high defender to roll under and separate. With the F-105s attacking, a low defender kill was accomplished before the high defender could effect a sandwich, however, the trailing attacker was "killed" by the high defender before the attackers could separate.

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(6) F-105 Summary: With the F-105 in the defending role, if an attack is observed in the rear hemisphere, separation is the best course of action against F-86H type aircraft possessing good subsonic sustained turning capability. If the attack is observed within AIM-9/B type missile range, perform an immediate hard descending turn to acquire a minimum of 30 to 40° angle-off, maintaining or acquiring .9 - .95 mach through use of afterburner, then unload G and separate at supersonic speed. If the attack is detected approaching gun range execute a max performance break followed by an immediate roll in the direction of turn to the inverted position and execute an AB diving spiral escape maneuver. The effort here is to defeat tracking by combining moderate G with roll. As .95 mach is acquired, relax G and level off for separation. Regardless of the speed acquired, the F-105 pilot must not initiate a climb shortly after disengagement, or F-86H type aircraft will cut off and regain a firing position. The above measures assume an aggressively pressed attack by qualified enemy pilots.

(a) In attempting separation in F-105 aircraft as with the F-100, if the attack is detected at longer ranges (7000'+) the best method is a 0-to-1G push over into a dive with afterburner power, as is the case for the F-104 and F-4C; however, the acceleration is much slower than these latter aircraft (see Annex D), hence, the diving spiral escape may be needed to buy time to effect successful separation.

(b) With the F-105D in an attack role, attempt an afterburner stern attack at 1.2 to 1.3 mach. If the attack is detected and is countered by a hard turn, attempt tracking down to .95 mach and execute any yo-yos well astern of the defenders. Break off the attack

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at .95 mach with a half roll opposite the direction of the defender's turn and accomplish separation. If the attack is pressed below .9 mach, a defender high G roll can compromise F-105 separation.

(c) The above analysis places the F-105 in a poor position in terms of Air Combat Tactics maneuvering capability and confirms the results of TAC Test 63-4 Phase II. This is considered true in view of the high energy loss (speed and altitude) during maneuvering at medium and high altitude, predicted by Energy Maneuverability Theory. The F-105 is in severe trouble if forced to defend in the 250-200 KCAS region, therefore, every effort should be made to avoid this region and to separate and re-engage at .95 or higher mach.

e. F-4C vs F-86H:

(1) F-4C defender - F-86H attacker:

(a) Maneuvering against a missile attack: The F-86 was allowed to enter missile range from the stern quarter prior to any defensive maneuver on the part of the F-4C. When missile range was attained, the F-4C countered by executing a 3 "G" turn which in effect negated all missile attacks. Level turns, diving turns and slight climbing turns all proved successful. High "G" breaks and other high "G" maneuvers were also successful against a missile attack, but left the F-4C extremely vulnerable against a follow-on gun attack. The most successful procedure to utilize to defeat a missile attack with a follow-up gun attack was to execute a 3 "G" diving turn into the attacker, apply max power and execute a diving spiral. This maneuver achieved angle-off from the missile as well as adequate lateral separation to preclude the gun attack.

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(b) Maneuvering against a gun attack: All gun attacks were initiated at 3,000-4,000' range from the stern quarter with approximately a .10 mach advantage on the part of the attacker. To defeat a gun attack presented a slightly different problem than encountered with missiles. Maneuvers such as hard turns, breaks, split S, and other attempts to cause the attacker to overshoot were generally unsuccessful against the F-86H. At the speeds and altitudes flown during this evaluation, it was obvious that the F-86H had a decided maneuvering advantage. Two basic principles evolved as outgrowths of ACT-1 and -2.

1 It is pointless to attempt to out-turn a MIG 15/17 type aircraft with the F-4C.

2 When attacked, the F-4C should immediately strive for separation and re-enter the fight on its own terms.

If an attacker is first observed within gun range and has a .10 mach advantage, it was concluded that regardless of the defensive maneuver, the attacker will continue to close. Any defensive maneuvers where high "G" loads were attempted decreased range considerably and increased the kill potential of the attacker, as his maneuvering capability exceeded that of the F-4 to a great degree.

It was determined that the basic aim of the F-4 was to immediately strive for separation from an attacker by the use of the excess power available. This proved successful against a highly maneuverable but mach-limited type aircraft such as the F-86H.

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The most consistently successful escape was achieved by unloading to 0 to 1/4 G and simultaneously advancing to max power. This resulted in a rapid acceleration to co-air speed during which time the attacker closed an additional 1000-1200'. F-4C acceleration then permitted rapid separation to well outside of effective gun range. While the attacker is in gun range, it is imperative that the defender make the attacker's tracking problem as difficult as possible. This can be accomplished by "jinking" (sporadic rolling and yawing at low G) until out of gun range. It was determined after discussions with the F-86 pilots that it was much more difficult to track the F-4C when viewed from astern than when observed from a position which affords a plan view of the aircraft in a hard turn.

10. MAINTENANCE RESULTS: During the evaluation participating aircraft flew a total of 124 sorties broken down as follows:

<u>Number of A/C</u>	<u>Type A/C</u>	<u>Dates</u>	<u>Sorties</u>
5	F-86H	26 Apr - 7 May 65	63
3	F-100	26 Apr - 30 Apr 65	14
5	F-105D/F	26 Apr - 30 Apr 65	13
3	F-104C	3 May - 7 May 65	18
3	F-4C	3 May - 7 May 65	16

In commission records of the F-104, F-4C and particularly the F-86H aircraft were especially noteworthy. Only two malfunctions contributed to loss of sortie effectiveness

a. F-86H - One engine shroud binding during shutdown following an ACT sortie, necessitating engine change.

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b. F-104C - One stick kicker malfunction, reducing maximum G capability on two sorties.

11. TRAINING REQUIREMENTS: Recommend the following:

a. Continued command emphasis on realistic ACT training with a minimum of restrictions imposed above normal flight handbook limits for applicable aircraft.

b. Dissemination of the results of this report to all TAC, PACAF, and USAF fighter units.

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ANNEX A

MISSION SUMMARIES

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F-86H versus F-100D

TAC Mission FF-857 ACT Evaluation - Summary

<u>Card #</u>	<u>Mission</u>	<u>Date</u>	<u>Attacker</u>	<u>A/C #</u>	<u>Type</u>	<u>Defender</u>	<u>A/C #</u>	<u>Type</u>	<u>T.O. Time</u>	<u>Fly Time</u>
60	ACT-1	28 Apr	A	113	86	J	099	100	1300	0:45
61	ACT-1	29 Apr	F	294	86	J	099	100	0930	0:45
62	ACT-1	29 Apr	A	113	86	K	130	100	0930	0:45
63	ACT-2	29 Apr	J	099	100	E	738	86	1300	0:45
64	ACT-2	29 Apr	K	130	100	F	294	86	1300	0:40
65	ACT-3	30 Apr	F	294	86	I	099	100	0925	0:45
66	ACT-4	30 Apr	K	110	100	G	255	86	0940	0:45
67	ACT-5,6	30 Apr	F - G	294-255	86	I - K	110-099	100	1400	0:45

NOTE: Letters refer to "attacker" or "defender" pilot who flew the mission. See Annex C.

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F-86H versus F-104C

TAC Mission FF-857 - ACT Evaluation - Summary

<u>Card #</u>	<u>Mission</u>	<u>Date</u>	<u>Attacker</u>	<u>A/C #</u>	<u>Type</u>	<u>Defender</u>	<u>A/C #</u>	<u>Type</u>	<u>T.O. Time</u>	<u>Fly Time</u>
20	ACT-1	3 May	B	1255	86	R	891	104	0910	0:50
21	ACT-1	3 May	D	1294	86	S	892	104	0910	0:50
22	ACT-1	3 May	C	5738	86	R	891	104	1200	0:50
23	ACT-2	3 May	T	892	104	B	1255	86	1200	0:50
24	ACT-2	4 May	R	883	104	H	1231	86	1240	0:40
25	ACT-2	4 May	T	891	104	A	2113	86	1240	0:50
26	ACT-3	4 May	A	2113	86	T	891	104	1640	0:50
27	ACT-3	4 May	C	738	86	S	883	104	1640	0:50
28	ACT-3	5 May	A	113	86	S	892	104	1045	0:45
29	ACT-4	5 May	T	883	104	C	738	86	1045	0:45
30	ACT-4	5 May	R	892	104	A	113	86	1340	0:40
31	ACT-4	5 May	S	883	104	C	738	86	1345	0:45
32	ACT-5	6 May	B	255	86	U	891	104	1000	0:30
33	ACT-1	6 May	D	231	86	T	892	104	0930	0:40
34	ACT-5	6 May	B - D	255-231	86	R - S	891-892	104	1320	0:50
35	ACT-6	7 May	T - S	883-891	104	C - D	738-113	86	1000	0:45

A-2

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F-86H versus F-105D/F

TAC Mission FF-857 ACT Evaluation - Summary

<u>Card #</u>	<u>Mission</u>	<u>Date</u>	<u>Attacker</u>	<u>A/C #</u>	<u>Type</u>	<u>Defender</u>	<u>A/C #</u>	<u>Type</u>	<u>T.O. Time</u>	<u>Fly Time</u>
40	ACT-1	26 Apr	G	225	86H	Q	531	105D	1350	0:45
41	ACT-1	26 Apr	E	738	86H	M	530	105D	1350	0:45
42	ACT-1	28 Apr	F	294	86H	N	530	105D	1420	0:50
43	ACT-2	28 Apr	M	531	105D	H	231	86H	1430	0:50
44	ACT-2	29 Apr	O	525	105D	G	225	86H	1420	0:45
45	ACT-2	29 Apr	N	338	105F	H	231	86H	1400	0:40
46	ACT-3	30 Apr	A	113	86H	N	531	105D	0900	0:50
47	ACT-3	30 Apr	E	738	86H	P	525	105D	0900	0:40
48	ACT-4	30 Apr	P	525	105D	H	231	86H	1200	0:50
49	ACT-4	30 Apr	N	531	105D	E	738	86H	1200	0:45
50	ACT-5,6	30 Apr	M	338	105F	A	113	86H	1500	0:50
			L	525	105D	R	231	86H		

A-3

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F-86H versus F-4C

TAC MISSION FF-857 ACT Evaluation - Summary

<u>Card #</u>	<u>Mission</u>	<u>Date</u>	<u>Attacker</u>	<u>A/C #</u>	<u>Type</u>	<u>Defender</u>	<u>A/C #</u>	<u>Type</u>	<u>T.O. Time</u>	<u>Fly Time</u>
1	ACT-1	3 May	A	113	86	V	435	4	0830	0:50
2	ACT-1	3 May	H	231	86	W	512	4	0830	0:45
3	ACT-1	3 May	A	113	86	Z	625	4	1120	0:50
4	ACT-2	3 May	V	435	4	H	231	86	1120	0:50
5	ACT-2	4 May	Y - V	512	4	D	294	86	1200	0:50
6	ACT-2	4 May	W	435	4	B	255	86	1200	0:50
7	ACT-3	4 May	B	255	86	X	625	4	1600	0:50
8	ACT-3	4 May	D	231	86	Y - V	512	4	1600	0:50
9	ACT-3	4 May	B	255	86	W	625	4	1005	0:50
10	ACT-4	5 May	V	435	4	H	231	86	1005	0:50
11	ACT-4	5 May	V	225	4	B	512	86	1305	0:50
12	ACT-4	5 May	W	625	4	D	231	36	1310	0:50
13	ACT-3	6 May	C	238	86	W	512	4	1005	0:50
14	ACT-1	6 May	A	113	86	Z	435	4	1010	0:45
15*	ACT-5	7 May	B - AA	255-231	86	V - X	512-435	4		
16*	ACT-6	7 May	V - X	512-435	4	B - AA	255-231	86	0920	0:50

* NOTE: #15 and #16 flown on same mission.

A-4

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ANNEX B
TEST DATA CARDS

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INT. DATA - SAC MISSION 837 - 451 2, 3
(Fill in blank; cross out inapplicable entries)

Pilot: _____ A/C Type: F-86h Date: _____ TO TIME: _____ Fly Time: _____

Attacker: F-86h

Defender: F-4C

Number of: _____

Engagement #

1.	2.	3.	4.	5.
5/44	6/44	5/44		
85/35	85/38	85/38		
91/35	91/35	92/35		
No	No	No		
No	No	No		
No	No	No		
No	No	No		
88/55	86/35	87/37		
No	No	No		
No	No	No		
No	No	No		
No	No	No		
No	No	No		
Yes	Yes	Yes		
No	No	No		

1. Attacker
Type Aircraft
Initial Speed/Altitude
Terminal (3000') Speed/Altitude
High Speed Yo-Yo
Roll Off
Low Speed Yo-Yo
Gun Kill?

2. Defender (Initial Speed/Altitude)
Break
Accelerator Over Speed
Speed/Altitude
Scales, # Instruments
Light G Roll Over
Recovery Speed/Altitude
High G Roll Under
Recovery Speed/Altitude
Escape Achieved?
Gun Kill?

3. E.H. Turner
Peak Altitude _____ Mach _____ Level Max G _____ A/C _____

NOTE: Describe key factors for each engagement.

Attacker's Comments: #1 F-86 started attack from 5 o'clock high. Max attainable speed was .92. Approached from 6 o'clock slightly low. Our take speed was not enough. F-4 could not see F-86. Range was called at 1 mile. 4000-3000. At 3000 ft. F-4 started climbing left turn in AB and separated.

#2 Same as above to 3000 ft range. Then F-4 did an unloading right roll under with main gear separated.

#3 Same as #1 to 3000 ft range. Then F-4 did unloading roll under and reversed and separated in diving spiral. F-4 could not track due to wing roll at .91-.96.

Defender's Comments: #1 Unloaded a/c - accelerated to 92 in lazy climbing turn. Then accelerated to 100. Good separation - No Kill.

#2 Slicing roll to right - roll under to left - 5 G turn to right at 11 M. Good separation - No Kill.

#3 - Made slicing turn to left - unloaded a/c. Main gear roll to left going down uncocked at 11 M roll to right - straight wings level pullout - No Kill.

(F-4C needs gear view mirrors in back cockpit. Front cockpit mirrors need repositioning)

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TEST PAGE 1 - PAC MISSION 857 - ACT 1, 2, 3
(Fill in blanks; cross out inapplicable entries)

3. E.M. TIME _____ Pool Remains _____ Altitude _____ Mach _____ Level Max G _____ A/C _____

Pilot _____ A/C Type _____ A/C # _____ Date _____ TO Time _____ Fly Time _____
Attacker _____ F4U
Defender _____ F4C

Maneuver Log

1. Attacker	2	3	4	5
Type Attack	6/44	6/44	6/44	6/44
Initial Speed/Altitude	75/40,75/40	7/30	17/30	17/30
Terminal (300%) Speed/Altitude	21/105/33	10/14/25	10/14/25	10/14/25
High Speed Y0-Y0	No	No	No	No
Roll Off	No	No	No	No
Low Speed Y0-Y0	No	No	No	No
Gun Kill?	No	No	No	No
2. Ejection (Initial Speed Altitude)	55/30	185/100	170/50	50/30
Free	No	No	No	No
Attacker Over Shoot	No	No	No	No
Speed/Altitude	-	-	-	-
Scissors, & Reversals	-	-	-	-
High G Roll Over	No	No	No	No
Recovery Speed/Altitude	-	-	-	-
High G Roll Under	No	No	No	No
Recovery Speed/Altitude	-	-	-	-
Escape Achieved?	Yes	Yes	Yes	Yes
Gun Kill?	No	No	No	No

NOTES: Describe key factors for each engagement.

Defender Comments:
 #1 - When attacker was at 2 miles defender went to V/C AB and accelerated. Achieved Mach 1.0 in 10 sec.
 #2 - Same except attacker came into 1 mile before was increased air speed.
 #3 - When attacker was at 1 mile, defender unloaded A/C, then hardturned into attacker and picked up #1, then climbed at .9
 #4 - Same.
 Note: Visibility in aft quarter of F4 is very poor in fact Nil. Once an engagement is begun, it will be almost impossible to keep tabs on an attacker between 5-7 clock, and very difficult past 8 o'clock.
 Attacker Comments:
 On all attacks as soon as defender started separation maneuver, separation began to increase. In each case attacker did not maintain a closing advantage. When defender started climbing spiral

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INT. DATA - SAC MISSION 837 - 451-2-X
 (Fill in blanks; cross out inapplicable entries)

3. **L.M. Turner**

Pilot	A/C Type	Date	To Home	Fly Time	Altitude	Max	Level Max G	A/C
Attacker	F-26A							
Defender	F-4C							

Notes: Describe key factors for each engagement.

Defender Comments: #1 - @ 2500' attacker range, entered hard turn, max AB, accelerated to 9, pulled max, 9, G keeping 9, attacker closed to 2400', tracked & achieved gun kill. Attacker could not get closer than 2400'. #2 - Same as #1.

#2 - @ 3000' - 4000' attacker range, entered hard turn, max AB, accelerated slowly to 9 & converted turn to climb. Attacker closed to 2500-2550'. Flocked, achieved gun kill.

#4 - Initially same as #2 but entered 4-59 diving roll, accelerated to 11 M. 16.0 climbed as period, but not before attacker achieved gun kill. Attacker Comments: #1 - Aircraft range, F-4 did hard left level turn. I had no problems tracking to 2400ft. Could not close to less than 2400 without doing a low speed yo-yo which did not seem necessary because tracking was so easy. #2 - Same as #1.

#3 - Started attack from 4 o'clock high. Closed faster and achieved gun kill in hard turn at 2400ft.

#4 - Same as #3 except that F-4 did diving logical type separation but did not demonstrate fast enough to preclude a gun kill at 2400ft.

Engagement #		1.	2.	3.	4.	5.
Type Attack	Initial Speed/Altitude	7/46	4/46	4/46	4/46	
Terminal: (3000') Speed/Altitude	High Speed Y-to	85/39	86/38	85/29	85/26	
Roll Off	Low Speed Y-to	92/35	92/35	92/25	87/25	
Gun Kill?	Speed	No	No	Yes	No	
Escape	Attacker Over Shoot	No	No	No	No	
Speed/Altitude	Separators, # 2, or 6	85/35	85/35	82/25	82/25	
High G Roll Over	Recovery Speed/Altitude	No	No	No	No	
Mid High G Roll Under	Recovery Speed/Altitude	-	-	-	-	
Recovery Speed/Altitude	Escape Achieved?	-	-	-	-	
Gun Kill?	Gun Kill?	No	No	No	No	

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4

ZENT BAZZ 1 - SAC MISSION 857 - ACT 2 (2) 3
(Fill in blanks; cross out inapplicable entries)

Pilot A/C Type F-4C

Defender F-86A

Maneuver Log

1. Altitude

Dive Attack

Initial Speed/Altitude

Terminal (300' by Speed/Altitude)

High Speed Yoyo

Roll Off

Low Speed Yoyo

Gun Kill?

2. Ejection (Initial Speed/Altitude)

3. Ejector Over Board

Speed/Altitude

4. Ejector Over Board

Recovery Speed/Altitude

5. Ejector Over Board

Recovery Speed/Altitude

Escape Achieved?

Gun Kill?

Have Turn

Altitude

Roll Off

Low Speed Yoyo

High Speed Yoyo

Roll Off

Low Speed Yoyo

Gun Kill?

Ejection (Initial Speed/Altitude)

Ejector Over Board

Speed/Altitude

Ejector Over Board

Recovery Speed/Altitude

Ejector Over Board

Recovery Speed/Altitude

Escape Achieved?

Gun Kill?

Have Turn

NOTE: Describe key factors for each engagement.

Attacker's Comments

1. Tracked to 2500' - 230° - 15° Roll off - Good separation.
Gun kill # 2 - Tracked from 5000' - 1200' - 40° - 30°
2. G's = 10-10 - gun kill. # 3 - Tracked from 5000' - 2000' - Hillslope - top at 32 minutes.
Turn in and bleed off - Standoff - Gun kill.
4 Barrel roll in to stern - tracked, topped at 4000' on 10-10 turn in. Standoff - Gun kill.
5 - Suppression. I seen press and tracked to 2500' - Roll in to 10-10. Good separation - Gun kill.
6 - Started out 10-10 track - tracked to 10-10 - 10-10 up.
7 - Turn in - Gun kill. Head on - Gun kill.
(Kept airspeed up at all times. Detail firing pass engaged was 51M to 12M which left plenty for subsequent maneuvering.)
Defender's Comments: Defender lost too much speed in causing overshoot, which caused him to have no advantage after overshoot due to low airspeed. Defender lost out in attempting to follow attacker in 10-10 maneuvers and on 6th pass he exceeded air speed and almost spun A/C

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TEST DATA - TAC REVISION 837 - ACT 1.2.3
(Fill in blanks; cross out inapplicable entries)

Attacker _____ A/C Type F-8C Date _____ Fly Time _____
Defender F-86H _____ TB Time _____

MANEUVER LOG

1. ATTACKER

Type Attack _____

Initial Speed/Altitude _____

Terminal (3200') Speed/Altitude _____

High Speed Y-to-Y _____

Roll Off _____

Low Speed Y-to-Y _____

Gun Miss? _____

2. ESCAPEE (Initial Speed _____)

Speed _____

Altitude Over Shot: _____

Speed/Altitude _____

Roll-off, & Inversions _____

High G Roll Over _____

Recovery Speed/Altitude _____

High G Roll Under _____

Recovery Speed/Altitude _____

Escape Achieved? _____

Gun Miss? _____

Engagement #	1.	2.	3.	4.	5.
1.	6/16/41				
2.	83/20				
3.	83/20				
4.	No				
5.	No				
6.	No				
7.	No				
8.	83/20				
9.	Yes				
10.	No				
11.	-				
12.	No				
13.	Pass				
14.	Pass				

NOTES: Describe key factors for each engagement.

#1 - Target started evasive action at 1 mile with loss of visual contact. Rejoin was accomplished with time for one effective pass.

2000 ft. Co-alt Co-air speed (83) 2000 ft by F-86 hard turn forced lateral separation and F-86 assessed turn with more precision. Followed by nose low roll, accelerating dive away for successful escape.

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REF ID: A66232 - THE HISTORY OF - AC-119G (K) (All in black; some are illegible)

Altitude	A/C Type	Base	TO Time	BY Time
	F-86H			
	F4C			

Altitude	A/C Type	Base	TO Time	BY Time
741	6/44	6/44	6/44	6/44
85/10	8/39	8/39	8/39	7/27
92/10	92/15	92/15		
N/A	N/A	N/A	N/A	N/A
50/10	50/15	N/A	Yes	Yes
-	-	-	-	-
-	-	-	N/A	N/A
-	-	-	N/A	N/A
-	-	-	N/A	N/A
N/A	N/A	N/A	Yes	Yes
85/30	85/35	85/35	75/20	82/20
Yes	Yes	Yes	Yes	Yes
N/A	N/A	Yes	N/A	N/A
Yes	Yes	SP-15	N/A	N/A
N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A
N/A	TR-10	Yes	N/A	N/A
N/A	N/A	N/A	N/A	N/A

NOTES: Describe key factors for each engagement.

#1 - Defender entered head descending turn when attacker at 2-2 1/2 miles. Attacker closed by cutting across circle - possible missile - N/G. #2 - Defender based diving turn when attacker entered. Miss. G's slightly steeper dive used. Attacker could streak at less steep 2'G. For initial 20-30' of turn, then G' increased as range shortened to 500'. IE defender tried to translate diving spiral to climbing spiral. Attacker could cut across circle - low angle range. #3 - Defender - spiral's attacker's attack range. Initial missile given escape achieved by pulling attacker G' at 7T. If defender continues to rise more, attacker cuts across circle. It would probably achieve a missile attack with in proximity. Caused by the delay in defender's Mx before achieving 2-3 mile separation. #4 - 1-2 attacks by F-86 Defender. 12 to 12. In these attacks defender was unable to accelerate out of missile or gun range. Defender attacker from positioning for gun kill. Defender did not attempt a diving deceleration maneuver for the purpose of low alt. simulation. Question on successful missile attack: Could attacker discriminate IR tone against a ground background.

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REF ID: A66666 - SAC MISSION 837 - ACT 2
 (Fill in blanks; cross out empty/licable entries)

Pilot: E-16H A/C Type: E-16H Date: 7/11/65 TO Time: 20:00 Fly Time: 20:00

Attacker: E-16H

Defender: E-16H

Remarks: See notes

Measurement	1	2	3	4	5
1. AIRCRAFT					
Type Attack	5/11	6/11	7/11		
Initial Speed/Altitude	84/10	84/30	86/35		
Terminal (Missile) Speed/Angle Off	40	20	20		
Barrel Roll Attack	N	N	N		
Missile Kill? Range & Angle Off	N	Yes	Yes		
Terminal: Gun Attack (3000 ft)	--	--	UNK		
High Speed Yo-Yo	No	No	No		
Roll Off	N	N	N		
Low Speed Yo-Yo	N	N	N		
Gun Kill?	N	N	N		
2. DEFENSE - Initial Speed/Altitude	88/10	82/30	88/20		
Hard Turn/Maneuver	Yes	Yes	Yes		
Missile Attack Deflected	Yes	Yes	Yes		
Striving Spiral	Yes	Yes	Yes		
Vertical Rolling Scissors	N	N	N		
Accelerator Over Shock? Speed/Altitude	N	N	N		
Escape Achieved?	Yes	Yes	UNK		
Gun Kill?	N	N	UNK		

Notes: Descriptive key factors for each engagement.

Defender's Comments:
 2-1st attack initiated at 35M. Attacker in blind area. Evade maneuver successfully by max gun diving (3 to 6) turn to 130. 14 Mpxt. G. roll moderate but not enough to prevent successful attack. Attacker was observed 25 to 30° ← 055 min range 4500 ft. in first third of maneuver. 1st attack in blind & deflected at 20M-max gun fired to 130° for about 100 at 94 then nose low (25 to 6) acceleration to 13 Mpxt. in sustained turn. Turn was started 7-8 Mpxt. range. Attacker was not observed at all. Attacker's Comments:
 #1-Attack started at 40M with defender at 35M-observable to reach high enough to close properly and ended in a tail chase. When at 7000 ft. defender turned and would not permit a shot in the 20° zone with less than 40's. Defender called enemy prior to close to gain range.
 #2-Attack started at 38M with defender at 35M. When at 7000 ft. defender pitched a missile shot with less than 20°. Missiles subsequently shot at max gun range.
 #3-Attack started at 25M with defender at 20M. Defender notes: 20° zone when I was in missile range at 2000 ft.

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REF. NO. 2 - SAC MISSION 837 - ACS 2-2
(Fill in blanks; cross out inapplicable entries)

3. B.M. FORM

Fuel Remains _____ Altitude _____ Mach _____ Level/Max G _____ A/G _____

Pilot _____ A/G Type _____ Date _____ 30 Time _____ Fly Time _____

Attacker _____ F-4C
Defender _____ F-4E

Attacker	Defender	Altitude	Mach	Level/Max G	A/G
1. AIRSIGHT	2.	3.	4.	5.	6.
Type Attack	4/4	4/4	4/4	4/4	4/4
Initial Speed/Altitude	9/40	11/35	11/27	12/21	11/30
Turnout: (On-axis) Speed/Angle Off	1.3	1.1	.95	.9	.92
Barrel Roll Attack	No	No	No	No	No
Missile Kill? Range & Angle Off	20-30	20-30	20-30	20-30	20-30
Turnout: On-Axis? (-300 ft)	Yes	Yes	Yes	Yes	Yes
High Speed Yo-Yo	Yes	Yes	Yes	Yes	Yes
Roll Off	Yes	Yes	No	No	No
Low Speed Yo-Yo	No	No	No	No	No
Gun Kill?	No	No	Yes	No	No
2. Refunder - Initial Speed/Altitude	9/15	8/35	75/30	75/20	75/30
Hard Turn/Break	Yes	Yes	Yes	Yes	Yes
Missile Attack Deflected GWR	Yes	Yes	Yes	Yes	Yes
Diving Spiral	No	No	No	No	No
Vertical Rolling Scissors	No	No	No	No	No
Attacker Over Shoot Speed/Altitude	55/37	6/31	7/28	7/26	7/24
Range Achieved?	No	No	No	No	No
Gun Kill?	No	No	No	No	No

Notes: Describe key factors for each engagement.

Defender's Comments:
 #1 - After break and observing overshoot did not have any opportunity to get into gun or missile position.
 #2 - Same as #1, however as attacker came out of yo-yo was able to reverse and fall into six o'clock about 3000-4000 feet at about 20-30 degree off, 20's.
 #3 - Never did have attacker in sight until he called soon set and tracking. This was after defeating initial missile.
 #4 - Same as #1.
 #5 - Attacker tried to turn (after initial overshoot) with maneuver out to a climb, however could not climb as eyes maintain angle off while attempt to gain advantage. ATTACKER'S COMMENTS:
 GWR attack was detected and passes recognition and position. Successive attacks were excellent for sparrow kill. Shoulder braces being frequently crossed loss of visual sighting. Instrument hood should be removed for better rear vision. Emphasis was placed on retaining missile envelope position best turning trail. On third attack the yo-yo fall off allowed 30 degree deflection shot tracking more low than 2000 ft to lose it with waste clearance. Speed on attacker different launch angle. Strep during test tracks at high Mach were completely unsuccessful due to difficulty in late recovery. Would be extremely useful as an escape maneuver.

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14

REF: DATA 2 - SAC MEMPHIS 857 - 457 2 5 2
Call in blinding cases not identifiable cases)

Plane	A/C Type	A/C #	Date	30 Min	60 Min	90 Min
Attacker	2-86					
Defender	2-4					
MANEUVER LOG						
1. AIRCRAFT						
Type Aircraft	U.S. Side	U.S. Side	U.S. Side	U.S. Side	U.S. Side	U.S. Side
Tactical Speed/Altitude	8/25	8/26	8/25	8/25	8/25	8/25
Turns: (Direction) Speed/Angle 0-90			180°	180°	180°	180°
Barrel Roll Attack	No	No	No	No	No	No
Missile Kill? Range & Angle 0-90	No	No	No	No	No	No
Terrain: Gun Attack (3000') ²	No	No	No	No	No	No
High Speed Yo-Yo	No	No	No	No	No	No
Roll Off	No	No	No	No	No	No
Low Speed Yo-Yo	No	No	No	No	No	No
Gun Kill?	No	No	No	No	No	No
2. AIRCRAFT - Tactical Speed/Altitude						
Hard Turn/Track	Not Feasible					
Missile Attack Defenses	Not Feasible					
Rolling Spiral	Not Feasible					
Vertical Rolling Defenses	Not Feasible					
Attacker Over Shoot: Speed/Altitude	Not Feasible					
Escape Altitude?	Not Feasible					
Gun Kill?	Not Feasible					

1. E.R. JAMES
Fuel Events Altitude Mach Level/Max C A/C

NOTE: Describe key factors for each engagement.

Abductor's Comments:

#1 2-4 west-south-west, 6° E above 2-86, 4500 ft - with 20° nose low - a straight away wide roll was initiated with 6 inches of wing from 2-4 to 6 - but 2-86 was to roll to above 10,000 ft at 13. Max G = 6.

#2 Same as #1 but with in opposite direction. Max G = 5.

#3 2-4 was on 2-86 to 2-86 nose low - an other initiating roll with 6 inches building to 5 G and roll to 180 - maneuver initiated at 1000 ft range with good rate of closure.

#4 2-4 was on 2-86 to 2-86 nose low 2-86 roll 180° in a slight 2-86 roll 180° roll under - transitioning to 13 and range 1000 ft (sum to 2-86 700 to 1000 ft) Altitude's Comments:

#1 2-4 started 2-86 to 6 pushover and roll to opposite. Discovered at 3500' range. 2-86 pushover caught me off guard temporarily. I rolled over but 2-4 separated and I never got close. Then about 3500' the pushover and rolling several maneuvers and another transition of 180° if not impossible.

#2 Same as #1 except that 2-86 did opposite direction, uncocked and opposite while changing roll rate and for duration of roll.

#3 Same as #2 to 3000' but this time I rolled immediately with 6 inches above 2-86. 2-86 rolled the 2-4 stopped his roll at 4000' altitude and shot a gun. I hit at 1000-1500 ft.

#4 Same as #3 but 2-86 in rolling low which put me straight down at 1000' estimated a maneuver which did not happen and I had to pull back from dice.

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REF ID: A62837 - (2) 3
(All data herein are unclassified)

2. E.M. JUNE

Full Name: _____ Altitude: _____ Mph: _____ Level/Unit: 6 A/E

Attacker 1. _____ Alt: 7990 Date: _____ 20 Time: _____ 21.7 Time: _____

Attacker 2. _____ Alt: _____ Date: _____ 20 Time: _____ 21.7 Time: _____

Defender 1. _____ Alt: _____ Date: _____ 20 Time: _____ 21.7 Time: _____

Defender 2. _____ Alt: _____ Date: _____ 20 Time: _____ 21.7 Time: _____

Maneuver Log _____

1. Altitude _____

Terminal (Altitude) Speed/Angle Off _____

Missile Kill #, Range, & Angle Off _____

Terminal: On Attack (2000?) _____

High Alt/Field Separation _____

High Speed/Low Speed 30-70 _____

On Kill # _____

2. Defenses: Terminal Speed/Altitude _____

Hard Turn/Quick _____

Maneuver: On Attack Defenses? _____

Defensive Split _____

Terminal (Altitude/Time) _____

Subsides/Escape Achieved _____

On Kill # _____

Notes: Describe key factors for each engagement.

Attackers Comments - #1 - Attackers on D-2 - D-2 made Pt turn. A-1+2 stayed on D-2 until D-1 started attack and A1+2 turned into D-1 making D-1 escape. A1+2 made successful escape with Def. split between. Def. made successful escape with AB power attack (Speed). #2. A-1+2 made overhead vertical pass picking out D-2 - D-2 made a left turn with A1+2 pressing in for a Prob. Gun kill. D-1 made attack on A1+2 causing A1+2 to break off D-2 but not before A1 was shot down by D1. A-2 did not make D1 range quick enough to call break. Defenses Comments: #1 - A1 on D2 (outer side) D1-2 accelerated to kill closure rate at 4200' range. Pt turn by D1+2 with D1 on outside called hi and in on A1 forcing A1 to break off D2 and break into D1 - with no offensive positioning until. D1+2 effectively broke off engagement and away. #2 - A1+2 hi rate of closure on D2 off left side at 4500-5000 D1+2 asked to kill closure rate and D2 made left turn to decim off A1+2 + effect defensive split. D1 when ahead A1+2 - head on collision behind D2 with 1050' D1+2 Closing 3-5 sec tracking shot to 2500' Good snap shot plan view. 500' with slow cross over - Escape successful for D1+2 as a unit.

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TEST DATA 2 - TAG MISSION 157 - ACT 2, 0, 2
(Fill in blanks; cross out inapplicable entries)

2. 24 JUNE Level/Time 8 A/C

Pilot A/C Type A/C # Data TO Time Fly Time
 Attacker 1. F-4C
 2. F-16A
 Defender 1.
 2.

Maneuver Log	1.	2.	3.	4.	5.
1. Attacker	6/4c				
Type Attack					
Terrain (Missile) Speed/Angle Off					
Missile Kill #, Range, C, Angle Off	No	No			
Terrain: Gun Attack (3000')	-	105%			
High Man/Field Separation	No	No			
High Speed/Low Speed Ye-Ye	No	No			
Gun Kill #	-	-			
Defenses: Initial Speed/Altitude	No	Yes			
Hard Turn/Track	90/135	75/20			
Missile Attack Defeated?	Yes	Yes			
Defensive Split	-	-			
Reversal (Under/Over)	No	Yes			
Switch/Escape Achieved	No	Yes			
Gun Kill #	No	No			

NOTE: Describe key factors for each engagement.

Defender's Comments:
 #1-Defender #102 made hard left turn at about 7000'.
 Attacker #102 could not track or get into position.
 #2-Attacker 102 pulled off high. Defender #102
 achieved escape. Att could not take in hard reversal.
 #2-Slight FBK pass on defender #1 then switched
 to defender #2. Victim #2 made a break to late causing
 a gun kill on him by attacker #1. Attacker #1 turned into
 attacker #102 head on pass but was unable to
 cross. With energy much to do any good.
 Attacker's Comments:
 #1-Attacker #102 submarine attempted pass on
 Defender #2 (right side). Defender 102 left
 break at 35M, 7000ft. (obs) range. Brake off
 #2-Attacker 102 from quartering stern.
 dropped down-closing in at 105-105-en
 die back to 102. Attacker #2
 as break to right was initiated - gun kill.

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TEST DATA - 206 MISSION 007 - 001 (1) (2) (3)
(Fill in blanks across one legible mission)

Pilot _____ A/C # _____ Date _____ 20 Time _____ Fly Time _____
Attacker _____ F-86H
Defender _____ F-104C

Statement of _____

1.	2.	3.	4.
6/44	6/44		
A/40	89/38		
90/35	9/33		
No	No		
No	No		
No	No		
Yes	Yes		
9/35	85/36		
No	No		
No	No		
-	-		
No	No		
No	No		
-	-		
No	No		
-	-		
Yes	No		
No	No		

1. Altitude
Type / attack
Initial Speed/Altitude
Terminal (2000') Speed/Altitude
High Speed Turn
Roll off
Low end Turn
Gun hit
2. Distance (Initial Speed/Altitude)
Break
Altitude Over Shoot
Speed/Altitude
Sightings, # Acrobatics
High G Roll Over
Recovery Speed/Altitude
High G Roll Under
Recovery Speed/Altitude
Fr. 470 achieved?
Gun kill?

3. 2.2.2001
Peak Altitude _____ Altitude _____ Level 1000' _____ A/C _____
2300 _____ 35 _____ 90 _____ F-86H
2200 _____ 30 _____ 183 _____ F-104
UNK _____ 35 _____ 8 _____ F-86
3.5 _____ F-86

NOTE: Describe key factors for each engagement.
F-104 unable to cause overshoot on any turn. Tried level climb + descending at 3000' range. F104 entered light diving spiral. F86 pulled to left - unable to track - F104 escaped during diving spiral.
F-104 unsuccessful in climbing spiral escape.

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21
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TEST RESULT - THE MISSION IS - AC (2) 2 1
(Fill in blanks; cross out inappropriate entries)

3. Alt. Time
Fuel: 5000 Altitude: 10000 Mach: 0.8 0.8

Pilot: F-86H A/C Type: F-86H Date: 7/14/46 To Time: 4:14 Fly Time: 5
Defender: F-104C

1. Altitude

1.	2.	3.	4.	5.
7/14	7/14	4/14		
9/6/40	9/3/37	8/6/25		
9/2/28	9/3/27	7/3/18		
No	No	Yes		
No	No	No		
No	Yes	No		
Yes	Yes	Yes		
9/1/35	9/1/36	8/1/20		
Yes	Yes	Yes		
No	No	No		
-	-	-		
No	No	No		
No	No	No		
No	No	No		
No	No	No		
No	No	No		
No	No	No		

2. Altitude (Initial Speed)

Attacker Over Shoot: Yes
Speed/Altitude: Yes
Sights, & Evid: Yes
High G Man: Yes
Recovery Speed/Altitude: Yes
High G Man: Yes
Recovery Speed/Altitude: Yes
Escape Achieved: Yes
Can Kill: Yes

NOTES: Describe key factors for each engagement.
 Attacker Comments: #1 Attacker started down from 4000 and had no trouble staying in the beam at all times ranging down to ground level position. #2 Started from 3700 and speed and then stayed with him throughout downward turn. #3 - Started at 2500 and #1. Overshot and high bid on outside. Defender turned toward me & climbed in AB then called over to the right. My turn to follow him down. Presented no problems.
 Defender Comments:
 #1 Level break 5000' land flaps. Unable to get F-86 to overshoot.
 #2 Break 5000' High G diving - No acceleration. Unable to get overshoot.
 #3 Break 4000' Climbing high G. No overshoot - then called over to F-86 for escape maneuver but was too late to be effective.

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23

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101.82.1 - SAC MISSION 107 - ACT 1.2.1
(Fill in blanks; cross out inapplicable entries)

File # _____ A/C Type F-104C Date _____ TO Time _____ Fly Home _____

Attacker _____
Defender F-104C
Maneuver Log F-86H

Equipment #	1.	2.	3.	4.	5.
1. Altitude					
Dye Altitude	3/11	6 km/level			
Initial Speed/Altitude	9/50	7/50	70/50		
Turns: (30°/s) Speed/Altitude	14/55	12/50	11/22		
High Speed Turns	7/0	7/0	9/0		
Roll Off	9/0	9/0	7/0		
Low Speed Turns	7/0	7/0	7/0		
Out Limit	7/0	7/0	9/0		
2. Radar (Initial: Speed'Altitude)	85/55	85/35	85/20		
Maneuver Log	9/0	9/0	9/0		
Altitude Over Shot	9/0	9/0	9/0		
Speed'Altitude	14/55	12/50	85/20		
Subsonic, # Acrosals	7/0	7/0	7/0		
High G Roll Over	7/0	7/0	7/0		
Autotry Speed'Altitude	-	-	-		
High G Roll Under	7/0	7/0	7/0		
Autotry Speed'Altitude	-	-	-		
Escape Achieved?	Yes	No	No		
Gun Kill?	No	No	No		

23

3. I.M. DATA
Pool Remarks _____ Altitude _____ Mach _____ Level Max G _____ A/G _____

NOTES: Describe key factors for each engagement.
Attacker's Comment:
Defender's Comment:
I-104. Reason for I-104 because of specific chosen route of I-104. Reason for the production because of inability to see I-104 starting making pass. Range estimation by I-104 pilot per actual range was always much greater than estimated. I-104 did not see any pass by I-104 except engagement #2 action initiated by I-104. Then making possible kill from rear. There was no initial positioning for I-104 to provide better visual contact.
Attacker's Comment:
I-104. The defender was unable to keep the attacker in sight on any of the passes partly due to the inability of the attacker to accurately assess the range at onset of attack and during the pass.

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24.

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24.
REF: 24 - THE MISSION IS - ACT 10 X
(Fill in blank; cross out inapplicable entries)

Altitude: 10000
Rate: 1000
Fly Time: 30

Altitude	Rate	Fly Time
10000	1000	30
9000	1000	30
8000	1000	30
7000	1000	30
6000	1000	30
5000	1000	30
4000	1000	30
3000	1000	30
2000	1000	30
1000	1000	30
0	1000	30

1. Altitude: 10000
 Rate: 1000
 Fly Time: 30

2. Altitude: 10000
 Rate: 1000
 Fly Time: 30

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3. L.A. Data
Foot Remains Altitude Rate Level Mass of A/C

NOTES: Describe key factors for each engagement.

Attacker's Comments:

#1 Attacker appeared to be tracking with defender in lead turn. Difficult to judge distance because of size of 3rd. Thought attacker was out of range when actually he was 200-300 feet. Counsel overheard still using hard turn but was unable to close to less than 400 feet.

#2 Could not see attacker. Attacker called back, caused our short subculture gain advantage.

#3 Did not turn to rear overcut. Still could not gain advantage with trying to follow high speed on me.

#4 Did not turn but still could not gain advantage. That evening, under I could have scored about all felt. Expected to judge 1st surge.

Attacker's Comments:

#1 I did start hard turn at 5000 ft range. 1st attack speed 12 at 3000 ft alt to track for 3 seconds then overcut. Under down into diving spiral and escaped.

#2 Chas at 10000 called dependent by at 10000. Altitude 10000.

#3 After this I would go back up to 30000 and escape.

#4 The preferred hard turn at 4000' would be to track within in your range. He did escape on.

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27.

TEST DATA 2 - SAC MESSINS 037 - ACFT 2
CRUISE IN DURING CROSS-CUT (applicable entries)

Altitude _____ A/C Type _____ Date _____ TO Time _____ Fly Time _____
Attacker _____ F-8H
Defender _____ E-105C

MEASUREMENTS

	1.	2.	3.	4.	5.
1. Altitude	5H	5H	7H		
2. Altitude	90/37	80/35			
3. Altitude	93				
4. Altitude	No	No	No		
5. Altitude	50/50	No	No		
6. Altitude	5/25	No	No		
7. Altitude	No	No	No		
8. Altitude	No	No	No		
9. Altitude	No	No	No		
10. Altitude	Yes	No	No		
11. Altitude	8/25	8/25	8/20		
12. Altitude	No	Yes	No		
13. Altitude	No	Yes	Yes		
14. Altitude	No	Yes	Yes		
15. Altitude	No	No	No		
16. Altitude	No	No	No		
17. Altitude	No	Yes	Yes		
18. Altitude	Yes	No	No		

2. Altitude - Initial Speed/altitude

3. Altitude - Initial Speed/altitude

4. Altitude - Initial Speed/altitude

5. Altitude - Initial Speed/altitude

6. Altitude - Initial Speed/altitude

7. Altitude - Initial Speed/altitude

8. Altitude - Initial Speed/altitude

9. Altitude - Initial Speed/altitude

10. Altitude - Initial Speed/altitude

11. Altitude - Initial Speed/altitude

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NOTE: Describe key factors for each engagement.

#1 - level turn when attacker was within 1000' maintaining
mach 1.50. When within gun range started a diving
spiral at 1200' it became effective
#2 - Diving spiral when at 1000' level at 10,000'
#3 - Diving spiral to the left. Attacker came
in at high angle off (50°).

3. E.M. DATA

Fuel Remains _____ Mach _____ Level/Max G _____ A/S _____

Altitude _____

30. CONFIDENTIAL

REF ID: A62302
 (Fill in blank areas not applicable entries)

2. S.M. DATA

Pilot Name Altitude Mach Level/Num G A/C

Pilot A/C Type Date TO Time FLY TIME

Attacker F-104
 Defender F-104

Item	1.	2.	3.
1. Altitude	614	514	614
Type Attack	9139	9140	9135
Initial Speed/Altitude	No	No	No
Terminal (Missile) Speed/Angle Off	No	No	No
Barrel Roll Attack	No	No	No
Missile Kill: Range 6 Mile Off	No	Yes	No
Terminal: Gun Attack (.50")	No	No	No
High Speed To-70	No	No	No
Back off	No	No	No
Low Speed To-70	No	No	No
Gun Kill?	8535	8535	8520
2. Defenses - Initial Speed/Altitude	Yes	Yes	Yes
Head Turn/Track	Yes	Yes	Yes
Missile Accns Defused	No	No	No
Diving Spiral	No	No	No
Vertical Rolling Scissors	8335	8337	8320
Attacker Over Enemy Speed/Altitude	Yes	Yes	Yes
Target Acknowled	No	No	No
Gun Kill?			

NOTES: Describe key factors for each engagement.

#1. F-104 at 3300 + 15 Mach. F-104 attacked at 3300. Pilot achieved 12 dead astern of defender start hard turn at 5000 ft. Reached 4 track by 4 while in 70 degree. Attacker achieved 12 dead astern of defender start hard turn at 5000 ft.

#2. F-104 at 3500 + 15 Mach. 1000 ft. quarter steep turn at 4500 ft. 90. Attacker started 12 dead astern of defender. Attacker unable to track F-104 due to speed brakes. Attacker reduced power and speed brakes. Defender and defender reversed - set 10 seconds of reversals. F-104 maneuvered 5000 and showed away. F-104 could have obtained favorable gun position if F-104 had continued with lateral reversals.

#3. Started break at 5000 ft. F-104 unable to track while in gun range. - we shot and engaged with diving spiral.

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32

32

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REF: DATA 2 - THE REFERENCE 817 - ACT 3, 4, 5
(Fill in blanks; cross out (applicable section))

Pilot: _____ A/C # _____ Date: _____ TO Time: _____ BY Name: _____
 Attacker: 286
 Defender: 210A

NOTES: Describe key factors for each engagement.

Refueler Comments:
 #1 F-86 called 5000 range I lost. Left and down podded inside, complete 360-
 degree roll over speed pod off but about 1000 ft. Altitude assumed
 rapidly. 20 pull out, made F-86 track, successful during pull out. May 65. 5. 10. 1
 #2 F-86 lost and had to hit a jet over down - did not see speed walking
 capability of airplane to rotation. F-86 was tracking with radar. In 1000 ft. 6. 5.
 #3 F-86 did not see so much contact as expected. Pilot who might be
 greater capability. No engagement could be compared to a pilot who might be
 placed into contact with minimum provisions.
 #4 F-86 was tracked called debris over. 2 mi. - F-86 made head bump. F-86
 #5 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #6 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #7 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #8 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #9 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #10 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #11 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #12 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #13 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #14 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #15 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #16 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #17 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #18 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #19 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
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 #99 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.
 #100 F-86 was 5000 ft. and fell to earth - two vertical - contact lost in contact.

Engagement #	1	2	3	4	5
Speed	8/25	8/25	8/25	8/25	8/25
Altitude	5110'	70'	70'	70'	70'
Roll	Yes	Yes	Yes	Yes	Yes
Missile Kill?	No	No	No	No	No
Terminal: Gun Attack (3000')	Yes	Yes	Yes	Yes	Yes
High Speed Yo-Yo	No	No	No	No	No
Roll Off	No	No	No	No	No
Low Speed Yo-Yo	Yes	Yes	Yes	Yes	Yes
Gun Kill?	8/20	8/20	8/20	8/20	8/20
2. Defense - Tactical Speed/Altitude	Break	Break	Break	Break	Break
Head Turn/Break	Yes	Yes	Yes	Yes	Yes
Missile Attack Defeated	No	No	No	No	No
Rolling Spiral	No	No	No	No	No
Vertical Rolling Sissors	No	No	No	No	No
Attacker Over Short: Speed/Altitude	Yes	Yes	Yes	Yes	Yes
Escape achieved?	No	No	No	No	No
Gun Kill?	No	No	No	No	No

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REF ID: A6 26 MARCH 197 - 450 2. 3
(Fill in blanks; cross out inapplicable entries)

File: A/C Type: J-55A Date: 7/11/51 TO TIME: 7/11/51 FLY TIME: 3.0
Attacker: J-55A
Defender: J-104C

Maneuver Log

1.	2.	3.	4.	5.	6.	7.
Type Attack	7/11	8/11	5/11	7/11	7/11	3.
Initial Speed/Altitude	26/25	26/25	26/25	26/25	26/25	
Formation: (300') Speed/Altitude	26/20	24/20	26/20	26/20	26/20	
High Speed Y-to-Y	No	No	Yes	No	No	
Roll Off	No	No	Yes	No	No	
Low Speed Y-to-Y	No	No	No	No	No	
Gun Kill?	Not	No	Yes	No	No	
2. Ejector (Initial: Speed/Altitude)	350/60	350/60	325/12	350/21	350/21	
Break	No	No	Yes	No	No	
Attacker Over Board	-	-	-	-	-	
Speed/Altitude	-	-	240/15	-	-	
Subsides, & Reverts	-	-	25/11	-	-	
W/C Roll Over	No	No	No	No	No	
Recovery Speed/Altitude	-	-	-	-	-	
High Altitude Along Spiral	No	Yes	No	Yes	Yes	
Recovery Speed/Altitude	13/1511	12/1511	25/11	20/11	20/11	
Escape Achieved?	Yes	Yes	No	Yes	Yes	
Gun Kill?	No	No	No	No	No	

3. J.M. FURB
Pool-Emits Altitude Mach Level Max G A/C

NOTE: Describe key factors for each engagement.

Attacker's Comments:

#1: Attacker came in about 20' off the tail. At 5000' range I tried a reg. G-quarter roll straight away escape. Attacker tracked in to 2200' prior to my separation.

#2: Same as #1. Lost at 3000' range. Dropped flaps, rolled back, 110' and spiralled away. Lost the attacker immediately.

#3: At about 3000' range I broke up and into the attack. Attacker tracked from feet decends then overbroke and yo-yed high for re-attack. No contact.

#4: Same as 3. Only spiraled down and away and had no problem with this escape.

Attacker's Comments:

#1: Was able to track and get to within 2000' just before before reaction. G's proved difficult to keep tracking.

#2: Lost at 3000' range and target started right turn and spiral down. My action prevented any track or shot at any time.

#3: Called at 3000' and target tried to pull up and into attacker and reverse - this maneuver prevented me with a 1600' range and good target tracking.

#4: Called at 3000' range and target broke down and away. I was unable to track or close.

40 CONFIDENTIAL

40

REF ID: A66666 - SAC WISCONSIN 837 - 40-133-1
 (Fill in blanks; cross out inapplicable entries)

Pilot _____ A/C Type E-66H Date _____ TO Time _____ Fly Time _____
 Altitude _____ Level Max G _____ A/C _____
 Defender _____ A/C # E-105D

1. ALTITUDE

Type Attack	1.	2.	3.	4.	5.	6.
Initial Speed/Altitude	4/41	4/41	5/41	7/41		
Terminal (3200') Speed/Altitude	8/40	75/38	75/38	78/30		
High Speed Tests	9/30/35	8/35	7/35	6/35		
Roll Off	Yes	No	Yes	Yes	Yes	Yes
Low Speed Tests	No	No	Yes	Yes	Yes	Yes
Gun R...?	No	Yes	Yes	Yes	Yes	Yes

2. ESCAPE (Initial Speed/Altitude)

Speed	1.	2.	3.	4.	5.	6.
Attacker Over Shot	No	Yes	Yes	Yes	Yes	Yes
Speed/Altitude	No	No	No	No	No	No
Escape, # Turns	-	-	-	-	-	-
High G Roll Over	No	No	Yes	Yes	No	No
Low G Roll Under	-	-	200/30	-	-	-
Escape achieved?	Yes	No	No	No	No	No
gun still?	No	No	No	No	No	No

NOTE: Describe key factors for each engagement.

#1 - Defender started turn @ approx 6-7000' High. Y-96 initiated but defender left over & cancelled off pass.

#2 - Just a tracking situation - Slight G-90's used. Nose up and down approximately 30°. Some tracking pass to cut off defender. Kill would be a probable. Range estimation 3000-2500' with defender increasing range.

#3 - Both Hi speed & speed utilized. When defender started a "Roll over" Power was reduced, nose raised and a long tracking situation occurred. Range 1500-1000'.

#4 - Same as above except @ lower alt. and lower A/S. Both Hi & Lo speed to be utilized. Defender rolled under thru the vertical. But as he slowed down a good tracking situation developed. Range 1500-1000'.

Note: Defender shot wrong A/C until approx 2000' range.

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41

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2025 RELEASE UNDER E.O. 14176
(This in whole or in part may be inapplicable matter)

Pilot: _____ Altitude: _____ Mach: _____ Level Max G: _____ A/C: _____
 Attacker: _____
 Defender: _____
 Maneuver Log: _____
 1. Altitude: _____
 Type Aircraft: _____
 Initial Speed/Altitude: _____
 Terminal (120°) Speed/Altitude: _____
 High Speed To-Go: _____
 Roll Off: _____
 Low Speed To-Go: _____
 Gun Altitude: _____
 2. Radar (Initial Speed): _____
 Area: _____

Engagement #	1	2	3	4	5	6	7	8
Altitude	7140	5145	7150					
Initial Speed/Altitude	98/40	88/40	86/24					
Terminal (120°) Speed/Altitude	97/58	96/59	95/59					
High Speed To-Go	Yes	Yes	No					
Roll Off	Yes	Yes	Yes					
Low Speed To-Go	No	No	Yes					
Gun Altitude	Yes	No	Yes					
Radar (Initial Speed)	9/35	9/35	330/28					
Area	9/35	95/33	Discarded 320					
Altitude Over 5000	No	Yes	Engagement					
Speed/Altitude	-	350/28						
Roll Off & Inverts	No	No						
High G Roll Over	No	No						
Recovery Speed/Altitude	-	-						
High G Roll Under	Yes	Yes						
Recovery Speed/Altitude	200/22	10/15						
Escape Achieved?	No	Yes						
Gun Kill?	No	No						
	No	No	FB					

3. Talk Data
 Fuel Remains _____ Altitude _____ Mach _____ Level Max G _____ A/C _____
 Remarks: Describe key factors for each engagement.
 Defenders Comments: #1 - Made slight nose-low base roll down to 250k, then hard roll undermeat. He came up beside me after roll out but I had 200k - He then quit. I did not use FB #2. Got burner 200k into 4th attack, then came out of FB + gave max performance "stop", he came up beside me so I turned into + under him, got burner at Spitfire's away getting good separation. He said I was making a very good turn. Then I pulled up into the sun, 45° FB climb from mesh at about 15M - He came up well behind me, I zoomed max performance, turned back down to him but he cut me off easily. #3 Did not have time to complete, it looks a lot better. I got down to 5000 lbs - loaded with 4000 lbs.

Attacker Comments: In second engagement target successfully evaded gun pass and proceeded to unload, however for purposes of further evaluation started vertical recovery maneuver and gun kill was obtained after an even-top maneuver. Max G during flight 6.25 + at 1.0. Usually 2-4 G's never exceeded wing roll (which 1.97) thrust speed approx. 140 IAS.

I feel that a minor overshoot can be turned to the advantage of the F-86 by getting the target A/C to commit to a split and the attacker using a vertical roll maneuver.

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42.

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2. 2-316 - SAC MESSIAH 837 - 45 2 2 2
 (Fill in blanks; cross out inappropriate entries)

Pilot _____ A/C # _____ Date _____ TO Date _____ 717 Date _____
 Attacker _____ A/C # 2-316
 Defender _____ 2-1051D

Encounters: 0

1.	2.	3.	4.	5.
5/1/11	7/1/11	7/1/11	5/1/11	
9/1/98	85/57	530/26	550/25	
9/1/52	90/25	330/20	350/20	
2/10/1	2/10/1	No	2/10/1	
No	2/10/1	No	No	
No	No	No	No	
No	2/10/1	2/10/1	2/10/1	
9/1/35	9/1/35	350/20	350/20	
2/10/1	2/10/1	2/10/1	2/10/1	
No	No	No	No	
—	—	—	—	
No	2/10/1	2/10/1	No	
No	2/10/1	No	No	
—	—	—	—	
2/10/1	No	No	2/10/1	
2/10/1	9/1/5	9/1/5	2/10/1	
No	2/10/1	No	No	
No	No	No	No	

1. Altitude
 Type aircraft
 Initial Speed/Altitude
 Terminal (250'±) Speed/Altitude
 High Speed Yes/No
 Roll Off
 Low Speed Yes/No
 Gun Kill
 Gun Miss

2. Initial (Initial Speed/Altitude)
 Break
 Attacker Over Speed
 Speed/Altitude
 Screens, # In-Action
 Wgt & Roll Upcr
 Recovery Speed/Altitude
 High & Low Altitude
 Recovery Speed/Altitude
 Escape Altitude
 Gun Kill

NOTE: Describe key factors for each engagement.

- #1. Altitude - Altitude was a critical factor in this case. The attacker was at a high altitude and the defender was at a low altitude. The defender was unable to track the attacker due to the high altitude.
- #2. Roll Off - The defender rolled off the defender's roll rate, which allowed the attacker to maintain a high roll rate and avoid the defender's roll rate.
- #3. Low Speed - The defender was at a low speed and the attacker was at a high speed. The attacker was able to maintain a high speed and avoid the defender's low speed.
- #4. Gun Kill - The defender was unable to kill the attacker due to the high altitude and the attacker's roll rate.
- #5. Gun Miss - The defender was unable to hit the attacker due to the high altitude and the attacker's roll rate.

The defender was unable to track the attacker due to the high altitude and the attacker's roll rate. The defender was unable to hit the attacker due to the high altitude and the attacker's roll rate. The defender was unable to kill the attacker due to the high altitude and the attacker's roll rate.

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413

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413

INTERNAL - SAC MEMO 817 - 452 1-2
CRIT (in blanks; cross out inapplicable entries)

3. E.M. DATA

Pool Name: Altitude: Max: Level Max 6 A/C

Attacker: A/C # 1 A/E # Date 20 Time 7:15 Time
Defender: A/C # 2 A/E # Date 20 Time 7:15 Time
Remarks: 105

1.	2.	3.	4.	5.	6.	7.
Type Aircraft	1111	1111	3/12/1	3/12/1		
Initial Speed/Altitude	1115/35	1115/35	1115/35	1115/35		
Terminal (3000') Speed/Altitude	1101/35	1101/35	1101/35	1101/35		
High Speed Y-to-Y	Zoom	Yes	Yes	Yes		
Roll off	Yes	Yes	50°	50°		
Low Speed Y-to-Y	No	Yes	-	-		
Gun Kill	No	No	No	No		
2. ESCAPE (Initial Speed/Altitude)	55/35	33/20	33/20	33/20		
3. Status	Yes	Yes	Yes	Yes		
Attacker Gun Shot	Yes	Yes	Yes	Yes		
Speed/Altitude	-/40	-/23	33/20	33/20		
4. Gun Kill Over	Yes	Yes	Yes	Yes		
Altitude Speed/Altitude	Yes	-	-	-		
High Gun Kill: Under	No	No	No	No		
Altitude Speed/Altitude	-	-	-	-		
Escape Altitude:	Yes	-	-	-		
Gun Kill:	Retard	Yes	No	No		

* Gun kill but only because the defender mis-judged attacker's range before "breaking" to counter the attack.

NOTES: Describe key factors for each engagement.

- #1 Attacker zoomed off too late after attempting to track. Defender could not zoom as high but forced attacker to dump it and run. Before the runway, the attacker was forced to roll under the defensive almost got a kill before the 105 ran away.
 - #2 Pressed the attack pulling to G's but couldn't track even 6 G's so I up'd high at about 11M. The 86 did a roll right in behind me & got a kill (I could have probably gotten away but I did not run & the 86 got me).
 - #3 The 105 attacker pulled off earlier in the course of pursuit & tried one Ye-Ye then ran & easily got away by not staying longer in the 86's envelope.
- Remarks: 105 attacker didn't get 12M but got close enough to it to see what we still cannot track him in the break, it was cannot press the attack at all if we are to get away safely after giving up on the attack.

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CONFIDENTIAL - See Mission 287 - 457 100
(Fill in blanks across out (applicable entries))

Pilot A/C Type Date TO TIME FLY TIME
Attacker 31052
Defender 2-86
Remarks

1. Altitude	2.	3.	4.	5.
Type Attack	6/Head	6/Head	6/Head	6/Head
Initial Speed/Altitude	9/38	9/24	9/40	9/25
Terminal (320') Speed/Altitude	135	98/20	1335	98/20
High Speed Yes/No	Yes	No	No	No
Roll Off	No	Yes	Yes	Yes
Low Speed Yes/No	No	No	No	No
Gun Kill?	No	Pass	Shot	Yes
2. Ejector (Initial Speed/Altitude)	35/85	20/330	35/85	20/330
Break	Yes	Yes	Yes	Yes
Altitude Over Shot	Yes	Yes	Yes	Yes
Speed/Altitude	Yes	Yes	Yes	Yes
Distance, # Targets	1	1	1	1
High G Roll Over	Yes	Yes	Yes	Yes
Recovery Speed/Altitude	Yes	Yes	Yes	Yes
High G Roll Under	No	No	No	No
Recovery Speed/Altitude	No	No	No	No
Engage Achieved?	Yes	Yes	Yes	Yes
Gun Kill?	Yes	No	Yes	No

AA.

3. E.M. DATA
Pool Name
Altitude
Mach
Level Max G
A/G

NOTES: Describe key features for each engagement.

Attacker's Comments:

1. High G - No - Jan late and not effective. F-86 reversed abt got behind.

2. Sharp abt - fall off. F-86 could not follow in losing range.

3. Three seconds of tracking. Then overshoot followed with a Hi G roll which killed exposed. F-86 closed into range and got shot.

4. Good tracking - would have made hit-up load and fall off at 19 m - Hit. 99 immediately. F-86 had overshoot but was not closing.

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45.

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3. E.N. NICH Pool Name: Altitude: Month: Level Max G: A/C:

TABLE 1 - THE MIXER 837 - ACT 1 (2) I
(Fill in blanks; cross out inapplicable entries)

Attacker: _____ A/C Type: 2105E A/C #: _____ Date: _____ TB Test: _____ Fly Time: _____

Defender: _____ A/C #: 286

MANEUVER LOG

1. ALTITUDE

Type Altitude

Initial Speed/Altitude

Terminal (3XG's) Speed/Altitude

High Speed To-Go

Roll-off Position

Low Speed To-Go

Gun Kill?

2. ESCAPE (Initial Speed/Altitude)

and Head Down

Attacker Over Shoot

Speed/Altitude

Escape, & Re-escape

High G Roll Over

Recovery Speed/Altitude

High G Roll Under

Recovery Speed/Altitude

Escape Aborted?

Gun Kill?

1.	2.	3.	4.	5.
60/1000	60/1000	60/1000	60/1000	60/1000
100/1500	100/1500	100/1500	100/1500	100/1500
100/1500	100/1500	100/1500	100/1500	100/1500
Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes
No	No	No	No	No
85/35	85/35	85/30	85/30	85/30
Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes
67	67	67	67	67
Yes	Yes	Yes	Yes	Yes
No	No	No	No	No
No	No	No	No	No
Yes	Yes	Yes	Yes	Yes
No	No	No	No	No
Yes	Yes	Yes	Yes	Yes
No	No	No	No	No

NOTE: Describe key factors for each engagement.

Attacker's Comments:

1. Had look over but did not get into position via ramp before
 to drop off. Reported hitting close L side and a few
 getting some separation around and spread to try for another
 shot. He indicated about 450 km had over but had to turn
 2. Attempted to track a little longer but could not get
 close enough. Again went for separation and attempted
 to turn into attack, however, not at proper about 450 km from
 and engage, but had much better view.
 3. Tried to track into his position. Used 5.5 Gs but could
 not track. Both off and attempted a several with
 defender. No success, so I made.

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REF ID: A66222 - THE MESSIAH - AC-119G
 (List in Member area and Supplemental material)

Altitude: _____
 Fuel Status: _____
 Mach: _____
 Altitude: _____
 Mach: _____

1. AIRCRAFT

Type Aircraft: E-10H

Initial Speed/Altitude: _____

Terminal: (Missile) Speed/Angle Off: _____

Barrel Roll Attack: _____

Missile Kill: Range & Angle Off: _____

Terminal: Gun Attack (2000'±): _____

High Speed Y-to-Y: _____

Roll Off: _____

Low Speed Y-to-Y: _____

Gun Kill: _____

2. DEFENDER - Initial Speed/Altitude: _____

Hard Turn/Track: _____

Missile Attack Defenses: _____

Rolling Spiral: _____

Vertical Rolling Maneuver: _____

Accelerator Over Speed/Altitude: _____

Scrape Maneuver: _____

Gun Kill: _____

NOTES: Describe key factors for each engagement

Attacker Comments: #1 Missile was at 1000' altitude & out of turn & got a gun kill from a missile killing the Def. escape maneuver. #2 - I launched from 5000' high in about 10' due to 1000' range. Def. made hard diving turn left & again I closed in & cut off & got a gun kill. #3 - I closed in & cut off & was shot in the vent. seissors & Def. slid to my forehead but could not hear tracked & he snapped due to subverse flow. #3 Head on at 2200'. I did hard climbing but he was above. Def. he crossed below me so I rolled into his forehead & got a gun kill. Note: Target ID was just about impossible on all attacks until inside missile launch range.

Defenders Comments: #1 - Started into defensive turn ending in diving squeal with Burner escape. #2 - Started with defensive turn into diving spiral. Pulled up into a VERT seissors & Flashed F&B cut front. In attempt to track A/C entered a partial snap underneath & so had to release carbons & try a diving burner escape which was effective. #3 - Dived within 15' of 1000' but burner pulled up to turn into attacker. I could have kept going in burner & escaped however attempted another 1000' & did nothing but enable Attacker to do a roll off into attack position.

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50. CONFIDENTIAL

TEXT PAGE 2 - SAC KESION 857 - ACT 8
 (Fill in blanks; cross out inapplicable entries)

File # _____ A/C Type _____ Date _____ 2D Time _____ Fly Time _____
 Pilot _____ Altitude _____ Mach _____ Level/Num G _____ A/C _____

Attacker 1. _____
 2. _____
 Defender 1. _____
 2. _____

Maneuver Log
 1. Altitude _____
 Type Attack _____
 Terminal (Missile) Speed/Angle Off _____

 Missile Kill? #, Long, G, Angle Off _____
 Terminal: Own Attack (2000') _____
 High Num/Tim's Separation _____
 High Speed/low Speed Turn _____

Own Kill? # _____
 2. References: Initial Speed/Altitude _____
 Hard Turn/Break _____
 Missile Attack Reference? _____
 Definitive Split _____
 Inversion (Under/Over) _____
 Switch/Escape Aborted _____
 Own Kill? # _____

Attachment #	1	2	3	4	5
6H	6/10				
12/15	9/20				
	10/20	9/28			
	Yes	No			
	No	No			
	Yes	Yes			
	8/35	8/30			
	Yes	Yes			
	Yes	Yes			
	No	No			
	No	Yes			
	Yes	No			

NOTES: Describe key factors for each engagement.

F-86 Comments:
 #1 - F-86H wingman saw F-105's too late and the hard turn did not force overshoot of #2. F-105 Defensive split then forced overshoot with #2 on inside of turn. #1 F-86 would then slide behind #1 F-105 and achieved kill at 2000-1500 ft. #2 F-86 got to 6000 ft on #2 F-105 - did not get a kill because of wing roll (95) even though he was in 3000-2000'.
 #2 - #2 F-105 started left turn and #1 F-86 cut off for a kill with #2 F-86 in trail. #2 F-86 called a left break because #2 F-105 was maneuvering to my back. I broke up left. #2 F-105 unbalanced and separated.
 F-105 Comments: Good 105 missile attack at 6266 mach. I did a hard turn but not hard enough. #2 closed to a kill on #1. Then #1 closed to get a kill on #4. #2 rolled down. The point is that we could not switch from 4 to 3 on the attack because #2 was heading #4. The sandwich works well though on #2 staying right on the #4 & switching from down to a split of a kill on #1. The sandwich occurs fast & was easy to perform. #5 the defender makes a hard turn. Not a break. We (105's) could not switch as listed because #3 separated from #4, so we had to stay after #1 & #4.

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60
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TEST DATA - SAC MISSION 857 - 45703 I
 (Fill in blanks; cross out inapplicable markers)

Pilot: _____ A/C Type: F-86H / F-100D Pool Number: _____ Altitude: _____ Mach: _____ Level Man G: A/C

Engagement #

1. Attacker	2. 86H	3. 100D	4.
Type Aircraft	5/41	5/41	5/41
Initial Speed/Altitude	85/30	85/30	90/30
Terminal (300°) Speed/Altitude	30M	25M	—
High Speed Y-to-Y	Yes	Yes	Yes
Roll Off	Yes	Yes	No
Low Speed Y-to-Y	Yes	Yes	No
Gun Alt.?	Yes	Yes	No
2. Escaper (Initial Speed/Altitude)	85/30	85/30	85/30
Speed	Yes	Yes	Yes
Altitude Over Shot	Yes	Yes	No
Speed/Altitude	300/30	300/30	—
Roll-off, & Reversals	Yes	Yes	No
High G Roll-over	No	No	No
Recovery Speed/Altitude	—	—	—
High G Roll-over	No	No	No
Recovery Speed/Altitude	—	—	—
Escape Achieved	No	No	Yes
Gun Kill?	No	No	No

NOTE: Describe key factors for each engagement.

1 - Able to Force F-86H to Overhoot in vertical plane, but F-86 pulled up out of fight & rolled off behind F-100.

2 - Ditto

3 - Hi Speed 120 lb attempted when F-100 unable to stay in F-86H plane of flight. F-86 able to pull up and resist zoom. F-100 then roll-off to a position behind F-100. F-100 made 95 diving spiral for separation.

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62. CONFIDENTIAL

INT. AREA - THE MISSION IS - ACT 1.2.1
 (Fill in blanks; cross out inapplicable entries)

2. E.M. NAME

Pool Name: _____ Mach: _____ Level/Flts: 4/8

Pilot: _____ A/C Type: F-16 Date: _____ TO Time: _____ Fly Time: _____

Attacker: _____
 Defender: F-16

Engagement #

1.	2.	3.	4.	5.
5/11	5/11	6/10	6/10	6/10
7/24	7/24	7/24	7/24	7/24
9	9/25	9/25	9/25	9/25
No	Yes	Yes	Yes	Yes
No	No	No	No	No
No	No	No	No	No
No	No	No	No	Yes
8/30	8/25	8/25	8/25	8/25
Yes	Yes	Yes	Yes	Yes
Yes	Yes	No	Yes	Yes
NOPE	NOPE	-	UNK	UNK
Yes	Yes	No	Yes	Yes
No	No	No	No	No
Yes	No	No	No	No
Yes	No	No	No	No
Yes	Yes	Yes	Yes	No
No	No	No	No	No

NOTE: Describe key factors for each engagement.

#1 - Attacker did not attempt to yo-yo but maintained plane of turn - defender rolled on outside turn - attacker rolled and half rolled into attacker, hit burner at 10' C and achieved 6-8 sec separation.

#2 - Attacker yo-yo'd when he saw he was going to overheat. Defender carried him into vertical and achieved an overheat in vertical. Done two vertical cells were seen - pilot for repositioning that he was for separation. It appeared that if the line for separation is maintained with both at max committed nose load that F-16 will stay with the F-10 for initial separation. Vertical during separation and attacker was unable to track.

#3 - Attacker started burner at 6000 ft to defend. Attacker rolled yo-yo'd but he did not overheat. Attacker bumbled but lost track - attacker defender achieved separation.

#4 - Attacker started 3000' at low - defender did a roll - defender rolled over to 6000' to start separation. Separation was not achieved and all during low roll. Defender subsequently pulled up to 6000'. At 4000' pitch, defender did a high G roll going up and attacker overshot him - we quit there because of low fuel.

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63

63

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INT. DATA - DCS VERSION 217 - ACT 1.2.3
(Fill in blanks; stress out (applicable entries))

3. E.M. DATA

Popl Remains Altitude No. Level Max G A/C

Time A/C Type A/C # Time TO TIME 217 TIME

Attacker F-100D
Defender F-105

1.	2.	3.	4.	5.	6.
5/14	6/14	5/14	6/14	6/14	6/14
08/35	10/30	10/30	08/30	08/30	08/30
08/37	05/52	08/35	08/26	08/50	09/24
Yes	No	No	No	No	No
No	No	No	No	Yes	No
No	No	No	No	Yes	Yes
No	No	No	Yes	No	No
08/35	08/30	08/30	08/30	08/30	08/30
Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes
11/37	07/34	05/26	07/27	20/35	08/20
No	No	No	No	Yes	No
No	No	No	No	No	No
No	No	No	No	No	No
No	No	No	No	No	No
Yes	Yes	Yes	No	Yes	No
No	No	No	No	Yes	No

NOTE: Describe key factors for each engagement.

- #1 Brake off attack & climbed away when unable to track.
- #2 Unable to track - F86 brake left.
- #3 Snapshot when F86 brake.
- #4 Tracked to 2000' in hard turn - then F86 brake.
- #5 - Pulled up & rolled off about 100' behind. Sl6 = Sl6 pulled 100 into west. Rolled scissors 100 dove away starting at 2000'. Sl6 able to achieve gun kill then Sl6 brake harder.
- NOTE: in dive away 100 waggled wings & fishtailed which frustrated Sl6 from tracking.

2. Emission (Initial Speed/Altitude)

Speed/TURN
Speed Altitude
Scissors, & ...
Activity Speed/Altitude
Escape maneuver
Can miss?

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65

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ZENT MAIL - MC MISSILE 057 - A/C 3 2
(fill in blanks once not applicable, asterisk)

Attacker: _____ A/C Type: F-86H Base: _____ Altitude: _____ Mach: _____ Level/Num: _____ A/C: _____

Defender: F-100D

Notes: Descriptive key factors for each engagement.

Defenses: #1 - Defender did not attempt to achieve the mach advantage. #2 - F-86 attack qualified - 15723 causing attacker to exceed angle off 1 shift then G limit. #3 - Attacker is detected inside max range, escape will be difficult. #4 - F-100 turns with max mach, 80% can cut off + prevent F-100 from achieving separation. #5 - Straight ahead segment is attempted, this will increase chances of missile kill. #6 - Follow-up gun attack - Attacker tracked from 3000 - 800'. Consecutively overshoot slightly with defender @ 1000'. Defender unable bring pipper up to target because air speed had dropped into 100 kts. #7 - Start same as #1 - but Df had 92 M. Attacker took longer to close. Following gun attack successful. #8 - Attacker overshoot @ 800'. Defender into stall, attempted banking scissors, when def disengaged attempted to achieve longit. separation however shot down again. #9 - Attacker overshoot + 1000' alt. #10 - Attacker overshoot + 1000' alt. #11 - Attacker overshoot + 1000' alt. #12 - Attacker overshoot + 1000' alt. #13 - Attacker overshoot + 1000' alt. #14 - Attacker overshoot + 1000' alt. #15 - Attacker overshoot + 1000' alt. #16 - Attacker overshoot + 1000' alt. #17 - Attacker overshoot + 1000' alt. #18 - Attacker overshoot + 1000' alt. #19 - Attacker overshoot + 1000' alt. #20 - Attacker overshoot + 1000' alt. #21 - Attacker overshoot + 1000' alt. #22 - Attacker overshoot + 1000' alt. #23 - Attacker overshoot + 1000' alt. #24 - Attacker overshoot + 1000' alt. #25 - Attacker overshoot + 1000' alt. #26 - Attacker overshoot + 1000' alt. #27 - Attacker overshoot + 1000' alt. #28 - Attacker overshoot + 1000' alt. #29 - Attacker overshoot + 1000' alt. #30 - Attacker overshoot + 1000' alt. #31 - Attacker overshoot + 1000' alt. #32 - Attacker overshoot + 1000' alt. #33 - Attacker overshoot + 1000' alt. #34 - Attacker overshoot + 1000' alt. #35 - Attacker overshoot + 1000' alt. #36 - Attacker overshoot + 1000' alt. #37 - Attacker overshoot + 1000' alt. #38 - Attacker overshoot + 1000' alt. #39 - Attacker overshoot + 1000' alt. #40 - Attacker overshoot + 1000' alt. #41 - Attacker overshoot + 1000' alt. #42 - Attacker overshoot + 1000' alt. #43 - Attacker overshoot + 1000' alt. #44 - Attacker overshoot + 1000' alt. #45 - Attacker overshoot + 1000' alt. #46 - Attacker overshoot + 1000' alt. #47 - Attacker overshoot + 1000' alt. #48 - Attacker overshoot + 1000' alt. #49 - Attacker overshoot + 1000' alt. #50 - Attacker overshoot + 1000' alt. #51 - Attacker overshoot + 1000' alt. #52 - Attacker overshoot + 1000' alt. #53 - Attacker overshoot + 1000' alt. #54 - Attacker overshoot + 1000' alt. #55 - Attacker overshoot + 1000' alt. #56 - Attacker overshoot + 1000' alt. #57 - Attacker overshoot + 1000' alt. #58 - Attacker overshoot + 1000' alt. #59 - Attacker overshoot + 1000' alt. #60 - Attacker overshoot + 1000' alt. #61 - Attacker overshoot + 1000' alt. #62 - Attacker overshoot + 1000' alt. #63 - Attacker overshoot + 1000' alt. #64 - Attacker overshoot + 1000' alt. #65 - Attacker overshoot + 1000' alt. #66 - Attacker overshoot + 1000' alt. #67 - Attacker overshoot + 1000' alt. #68 - Attacker overshoot + 1000' alt. #69 - Attacker overshoot + 1000' alt. #70 - Attacker overshoot + 1000' alt. #71 - Attacker overshoot + 1000' alt. #72 - Attacker overshoot + 1000' alt. #73 - Attacker overshoot + 1000' alt. #74 - Attacker overshoot + 1000' alt. #75 - Attacker overshoot + 1000' alt. #76 - Attacker overshoot + 1000' alt. #77 - Attacker overshoot + 1000' alt. #78 - Attacker overshoot + 1000' alt. #79 - Attacker overshoot + 1000' alt. #80 - Attacker overshoot + 1000' alt. #81 - Attacker overshoot + 1000' alt. #82 - Attacker overshoot + 1000' alt. #83 - Attacker overshoot + 1000' alt. #84 - Attacker overshoot + 1000' alt. #85 - Attacker overshoot + 1000' alt. #86 - Attacker overshoot + 1000' alt. #87 - Attacker overshoot + 1000' alt. #88 - Attacker overshoot + 1000' alt. #89 - Attacker overshoot + 1000' alt. #90 - Attacker overshoot + 1000' alt. #91 - Attacker overshoot + 1000' alt. #92 - Attacker overshoot + 1000' alt. #93 - Attacker overshoot + 1000' alt. #94 - Attacker overshoot + 1000' alt. #95 - Attacker overshoot + 1000' alt. #96 - Attacker overshoot + 1000' alt. #97 - Attacker overshoot + 1000' alt. #98 - Attacker overshoot + 1000' alt. #99 - Attacker overshoot + 1000' alt. #100 - Attacker overshoot + 1000' alt.

1.	2.	3.	4.	5.	6.
6/14	5/14	6/14			
8/29	8/29	9/5/71			
9/20	9/20	9/5/71			
Yes	No	No			
No	No	No			
Weak	Weak	Weak			
No	No	No			
No	No	No			
No	No	No			
Yes	Yes	Yes			
8/26	9/21	9/1/73			
Yes	Yes	Yes			
Yes	Yes	Yes			
No	No	No			
No	Yes	No			
20/22	20/22	N/A			
N/A	No	N/A			
No	No	No			

- Altitude: _____

Speed/Altitude: _____

Turn Rate: (Missile) Speed/Altitude: _____

Barrel Roll Attack: _____

Missile Kill? Range @ Max. G: _____

Turn Rate: Gun Attack (3000') _____

High Speed Turn: _____

Roll off: _____

Low Speed Turn: _____

Gun Kill? _____
- Altitude: _____

Speed/Altitude: _____

Turn Rate: _____

Barrel Roll Attack: _____

Missile Kill? Range @ Max. G: _____

Turn Rate: Gun Attack (3000') _____

High Speed Turn: _____

Roll off: _____

Low Speed Turn: _____

Gun Kill? _____

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TEST DATA 2 - THE MISSION 037 - ACT 2 (S) 2
(Fill in blanks; cross out inapplicable entries)

PLANE	A/C TYPE	A/C #	MODE	TO TIME	FLY TIME
Attacker	F100D				
Defender	F-86H				
MANEUVER LOG					
1. Attacker					
Type Attack					
Initial Speed/Altitude	1/10	6/10			
Terminal: (Missile) Speed/Angle Off	95/40	3/25			
Barral Ball Attack	1/5	1/0			
Missile Kill: Range G Angle Off	Yes	No			
Terminal: Attack (7000'N)	No	No			
High Speed Ye-Ye		No			
Roll Off	No	No			
Low Speed Ye-Ye	No	No			
Gun Kill	No	No			
2. Defender - Initial Speed/Altitude					
Used Turn/Break	26/37	80/26			
Missile Attack Defaced	Yes	Yes			
Maneuver Spiral	Yes	No			
Vertical Rolling Scissors	No	No			
Attacker Over Shoot: Speed/Altitude	No	Yes			
Escape Achieved	Yes	Yes			
Own Kill	Yes	Yes			

NOTE: Describe key factors for each engagement.

- # 1. Attacker lost sight of defender during diving spiral due to low viz.
- # 2. Attacker unable to assess or missile attack - Pressed for gun attack - unable to track - over shot Defender broke hard, did a high barrel roll and maneuvered to low and achieved a gun kill.

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ANNEX C

PILOT FLYING EXPERIENCE

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PILOT FLYING EXPERIENCE

<u>PILOT</u>	<u>AIRCRAFT</u>	<u>TOTAL TIME</u>	<u>TOTAL JET</u>	<u>TOTAL UE AIRCRAFT</u>
A	F-86H	4870	2179	1329
B	F-86H	4786	1729	1121
C	F-86H	2493	1386	1059
D	F-86H	2687	1287	987
E	F-86H	3211	1829	1061
F	F-86H	3958	2948	1014
G	F-86H	2624	2184	996
H	F-86H	1083	837	684
AA	F-86H	Unknown	Unknown	Unknown
I	F-100	2674	2334	1936
J	F-100	2786	2505	1313
K	F-100	2088	1838	1695
L	F-105	5097	4142	320
M	F-105	3083	2779	271
N	F-105	2353	2059	272
O	F-105	2708	2450	500
P	F-105	3010	2600	570
Q	F-105	2054	1800	652
R	F-104	2000	1750	750
S	F-104	1600	1500	1100
T	F-104	1500	1400	625
U	F-104	Unknown	Unknown	Unknown
V	F-4C	6300	4000	530
W	F-4C	4600	4100	250
X	F-4C	3600	3000	170
Y	F-4C	4500	3500	600
Z	F-4C	3100	3000	550

C-1

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ANNEX D
F-105 ACCELERATION COMPUTATION

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F-105 ACCELERATION COMPUTATION

Using energy maneuverability terms and P_s values obtained from current P_s - V diagrams (APGC-TDR-64-35 & 38) the acceleration times can be approximated in the following manner. The F-105D is shown in the sample computation.

Terms are as follows:

P_s = Energy rate = specific excess power in ft/sec.

E_s = Specific energy in feet.

H = Altitude in feet. $\frac{dh}{dt}$ = rate of climb (ft per sec)

V = Velocity in feet per second.

$\frac{dv}{dt} = a$ = Acceleration in feet per second per second.

g = Gravitational constant.

From energy maneuverability theory:

$$E_s = \frac{V^2}{2g} + H$$

differentiating with respect to time (T)

$$\frac{dE_s}{dt} = \frac{V}{g} \left(\frac{dV}{dt} \right) + \frac{dh}{dt} = P_s$$

$$\text{or } \frac{dV}{dt} = a = \frac{g}{V} \left(P_s - \frac{dh}{dt} \right)$$

assuming an average acceleration:

$$V = V_0 + at \text{ or } t = \frac{V - V_0}{a}$$

For the first case, assume a .95 mach (1010'/sec) attacker detected by an F-105 at 15,000' and 330 KCAS (.665 mach or 706'/sec). Assuming the attacker has no further mach capability, the F-105 will begin to separate when its velocity has reached .95 mach. We'll assume that the F-105 uses

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a level A.B. acceleration in level flight. Ps values for the F-105 (clean, 5000# fuel remaining) in this area average 300 ft/sec. The average velocity during this acceleration is .8 mach. At 13,000' this is 505 KTAS or 854'/sec.

$$\text{then: } a = \frac{32.2}{854} (300-0) = 11.3'/\text{sec}^2$$

the time to accelerate to .95 is then:

$$t = \frac{V - V_0}{a} = \frac{1010 - 706}{11.3} = 27 \text{ seconds}$$

If the attacker's average rate of closure during this time (t) is .15 mach (.95 - .8) or 156' per second, the attacker covers 4210' during this 27 seconds. Closure at a rate of .285 mach (304'/sec) should also be added for at least 3 seconds to allow for F-105 afterburner light time, allowing the attacker to cover an additional 912'. Hence, if the attacker is to be maintained at a minimum distance of 3000', a level A. B. acceleration must be begun under these conditions before the attacker has closed to 8100'. A $\frac{1}{2}$ G diving acceleration can be analyzed in the same fashion. Assume an average descent during the acceleration of 6000' per minute (-100'/second). The average Ps for the above conditions under $\frac{1}{2}$ G loading is approximately 320, hence $a = \frac{32.2}{854} (320 + 100) = 15.8'/\text{sec}^2$

$$\text{and } t = \frac{1010 - 706}{15.8} = 19.2 \text{ seconds.}$$

During this time, the attacker would close 2990'. Adding the 912' of closure during 3 second A. B. light time, if the attacker is to be maintained at a minimum distance of 3000' then the $\frac{1}{2}$ G diving acceleration must be begun before the attacker has closed to 7000' range.

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ANNEX E
PARTICIPATING TEAM
POST MISSION SUMMARIES

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F-86H TEAM SUMMARY OF MISSION FF-857

WRITTEN BY LT/COL JOSEPH J. MAISCH, JR.

1. The F-86H can successfully defend against both missile (AIM-9) and gun attacks by the F-100, F-105, F-104 and F-4 as long as he is aware of their presence before they reach effective firing range. After defending against this gun attack from within 3000 ft range, the F-86H will probably get a gun kill on the F-100 or F-105 (unless the F-105 has .95 mach or better). The F-104 and F-4 can escape in the reversal if their speed is .9 or higher, otherwise, the F-86H stands a chance of a quick gun kill during the F-104 or F-4 separation maneuver. The F-86H has a better chance for a kill if coached, on when to reverse, by a properly positioned wingman (4000 to 5000 abreast or slightly aft).
2. Of the four century types, only the F-100 has any chance at all of escaping the F-86H when fighting the obsolescent ACM game; and this F-100 pilot must be of FWS instructor caliber.
3. The F-100 and F-105 have not been successful in escaping from an F-86H gun attack when the evasive maneuvering was started at 4500 feet or less range. The F-104 and F-4 can escape this attack from as close as 3000 ft range, but only if they start the separation maneuver immediately. The only successful separation maneuver is the one whereby they start an unloaded (+1/4 to 0 G) quarter descending roll, attempting to spoil the attacker's tracking problem by reversing roll direction in the descending plane and using minimum positive G while separating at the maximum possible rate. The F-86H will normally decrease the range by 1000 - 1500 ft while the F-104 or F-4 is performing the initial part

E-1

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of the separation maneuver, but will be unable to track if the defender performs properly.

4. The F-104 has a definite advantage in that he is very difficult to acquire visually due to small profile, and once acquired difficult to keep in sight. Also, when the 104 rolls into a bank it is very difficult to determine the direction in which he is turning or will turn. The 104 is extremely difficult to see when making a head-on pass.

5. The F-100 and at times the F-105 can cause the F-86H to overshoot from a stern type pass. The amount of overshoot is of course determined by the closure rate. This overshoot however, is merely a delaying action because the F-86 can yo-yo high, watch the next move by the defender and then either roll over the top or slide down into the 6 o'clock. The F-4 and F-104 cannot normally cause the F-86 to overshoot.

6. The F-86H is capable of pulling up into a "whifferdill" type maneuver to almost zero airspeed without snap type maneuvers resulting, and will then accelerate very well in the downhill run.

7. The F-86H has one very definite limitation in the .91 to .96 range and that is its tendency to roll to the right. This makes rolling to the left very difficult, and tracking during this wing roll is just about impossible.

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F-104 TEAM EVALUATION OF F-104 VERSUS F-86H

1. F-104 Defender, F-86H Attacker:

a. At almost any range and any reasonable cruise airspeed for that altitude, the F-104 can escape if he does it correctly (regardless of the attacker's range).

b. Never pull up into the attack or try to break or hard turn level as a defensive maneuver.

c. A flaps up, full afterburner, diving low G spiral is an almost fool-proof escape maneuver. It is extremely difficult to track and lateral separation is rapidly attained.

d. If the attacker has closed into 1500 feet and, for some reason, has "missed," he can be forced into an overshoot if he has any appreciable overtake speed. The F-104 will decelerate faster but the overshoot is only momentary and at best gives an opportunity to break down and away as the attacker rolls over the top for repositioning. (Not a useful maneuver in any but a super last ditch attempt to get away from an attacker who has run out of ammo!)

e. Starting a mission at the same time, the F-104 can spar with an F-86H attacker in the trans-sonic region and run the attacker out of fuel.

f. In rolling down and away for separation from an F-86H, it is best to go to the left as this amplifies the attacker's wing roll tendencies and complicates his tracking problem at higher mach numbers (.92+).

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2. F-104 Attacker, F-86H Defender:

a. In attacking with the F-104 the only real offensive strength other than the superior speed is the fact that the F-104 is difficult to see (especially in the headon profile) and it is difficult to judge range and closure rate.

b. If the defender makes a hard turn at ranges of 5000 feet or less the F-104 can make a gun kill before sufficient angle off is generated by the defender. This is providing the attacker is supersonic. At subsonic speeds the attacker is able to track longer but is not able to close into gun range before the large angles off are generated. It is therefore no advantage to slow down to enhance turn radius and tracking time. The escape is about the same since at higher overtake speeds, the defender has generated less turn prior to his reversal; on the lower speed pass, the defender has turned farther so has less airspeed himself and has a larger angle to reverse through before he poses a threat to the attacker.

c. If the defender breaks into the attack at ranges outside of 4000 feet it is not possible to track for a gun kill. The escape is no problem since the defender has lost all airspeed and has generated great angles off.

d. At low altitudes the F-104 can zoom away from any subsequent gun attack after the overshoot but is in a position for a possible missile attack by the defender.

e. If the F-104 does not have to defend against missile attack, it can stay in the combat area and spar with the F-86 making high speed

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attacks against the defender and possibly get a successful gun attack or a surprise deep six attack, if the F-86 loses sight of his attacker. In any case the F-86 could be kept engaged until fuel considerations required the F-104 to leave the fight.

3. (ACT-5) F-104 Defending Element versus F-86H Attacking Element:

The F-104 performed defensive split with the F-86 closing from a stern quartering attack. The defensive split was only effective in that it delayed the final positioning of the F-86. In order for either F-104 to escape both must perform the diving spiral type of escape. The defensive split is not an effective maneuver to perform against the F-86H. If the F-104 defenders are fortunate enough to spoil the attackers at a mile, it is mandatory to immediately dive out of the fight rather than attempt any other maneuver, and then attempt to engage on more favorable terms.

4. F-104 Attacking Element versus F-86H Defending Element:

On ACT-6 we had time for two passes and both passes were run under the same parameters. F-86H at 35000 feet and .88 mach, the F-104 at 35000 feet and .90 mach. The attack was initiated from 4 o'clock position about five miles out.

We discounted the value of element close formation tactics so on the initiation of the attack the wingman slid out about 30 degrees from the lead and did a max acceleration low G run on this heading. The lead attacker began a slow turn flying a pursuit curve and accelerated to .98. As the lead closed in to about a mile the number two attacker commenced his turn in. Shortly thereafter the defenders did a defensive split.

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They performed it perfectly with the #2 defender calling the reversal as the attacker overshot. Since the wingman was obviously pulling less G's he was tracked for a few moments before the F-104 was forced to break off in the overshoot. The lead defender immediately reversed and the wingman rolled under but the attacking F-104, with approximately .95 mach, spiraled down and to the left with no real difficulty in achieving separation. About this time the #2 attacker made his tracking pass and had a clear shot at either defender. He then pulled off and rejoined lead.

During this attack the defenders were unable to pick up the attacking lead until he was in about one mile. He therefore called off his range and angle off. They never did pick up the number two man.

After the breakaway the lead F-104 pulled up sharply about a mile ahead of the pursuing F-86's and at 1.3 mach. Within 30 seconds the F-86's were in gun range and tracking on the zooming F-104. This confirmed earlier findings that after accomplishing a successful escape maneuver it is unwise to zoom up and try to return immediately to the combat area.

On the second pass the same results were achieved, however, the attackers did not get enough lateral separation and the #2 attacker was in the attack too early and had little time to track, if any. He did distract the defenders and caused them to lose sight of the lead attacker who had commenced his dive for separation. On observing the defenders' reverse back after the #2 attacker, the lead rolled out and zoomed back

E-6

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up immediately into the six o'clock of the defending flight. As he was completely unobserved he had no evasive action to contend with at this time.

On both attacks the attack would have been enhanced had the lead attacker accelerated to 1.05 or 1.1. A speed differential of .35 between the two attackers is just a little too much and a supersonic pass from any quarter was found earlier to be most advantageous for the attacker.

E-7

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SUMMARY OF THE F-4C PORTION OF TAC MISSION FF-857

Program FF-857 was established to determine optimum offensive and defensive tactics for the F-4C when confronted with highly maneuverable, but subsonic aircraft of the MIG 15/17 type. Air National Guard F-86Hs were the closest available approximations to the desired maneuvering and performance characteristics and were used as adversaries throughout the evaluation. The specifics of the program were defined by the USAF Fighter Weapons School, under the direct supervision of Colonel James C. Hare, Commandant, with Captains Muskat and Williams as project officers. Three F-4Cs with five pilots, one maintenance officer, and fourteen maintenance support personnel were provided by the 4453 CCTW for the period 2 May - 7 May at Nellis AFB, Nevada. Lt Colonel R. S. Parr commanded the F-4C detachment and functioned as F-4C project liaison with the Fighter Weapons School.

The Evaluation as planned by the fighter weapons project officers required sixteen flights, broken down as follows:

- | | |
|-------------------------------------|---|
| Air Combat Tactics I
(3 Sorties) | - F-86H vs F-4C (Gun Attack) |
| ACT
(3 Sorties) | II - F-4C vs F-86H (Gun Attack) |
| ACT
(3 Sorties) | III - F-86H vs F-4C (Missile Attack with Follow-up Gun Attack) |
| ACT
(3 Sorties) | IV - F-4C vs F-86H (Missile Attack with Follow-up Gun Attack) |
| ACT
(2 Sorties) | V - 2 F-86H vs 2 F-4C (Evaluate Element Defensive Tactics against Gun Attack) |
| ACT
(2 Sorties) | VI - 2 F-4C vs 2 F-86H (Evaluate Element Offensive Tactics for a Gun Attack) |

R-8

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There was allowance for additional sorties, if needed, to further validate or investigate findings on any of the previously flown sorties.

As flown the project required eighteen sorties, the two additional flights were to further substantiate the findings on ACT I and ACT III. ACT V and VI were combined and accomplished on the final flight because the F-86s were forced to air abort on ACT V when one of their aircraft experienced a minor emergency on climb out.

SUMMARY BY MISSION TYPE

ACT I:

a. With the F-4C simulating Combat Air Patrol at 35,000', .85M, the attacker closes to approximately 4,000-5,000 feet, 10°-15° angle-off, at .94-.97M prior to any defensive maneuvers by the F-4C.

(1) The most consistently successful escape was achieved by pushing to approximately 0 to $\frac{1}{2}$ "G", simultaneously advancing to maximum power while rolling approximately 60° bank angle into the attacker. This resulted in a rapid acceleration to co-speed while the attacker closed an additional 1,000' to 1,200' then an ever increasing separation to well out of effective gun range. The length of time at 0 to $\frac{1}{2}$ "G", thus allowing maximum acceleration, is a function of aircraft limitations, attacker range at initiation and attacker closing rate.

b. F-4C simulating cruise with load at 20,000', .78M, otherwise same as previous encounter.

(1) Essentially the same as 35,000', but it is imperative that any high drag/heavyweight stores should be dropped immediately. Additional measures such as rolling or "jinking" while separating from attacker would severely limit his ability to track at long range.

E-9
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ACT II:

a. F-86H at 35,000', .83M, F-4C initiates stern quarter gun attack, F-86 commences evasive maneuvers at 4,000-5,000' attacker range.

(1) Although the F-4Cs were on the offensive for this mission, the F-86s were tasked with: 1. escaping, and 2. attempting a gun or heat missile attack when and if the F-4Cs overshoot.

If the F-86s initiated proper evasive maneuvering well prior to F-4C gun range they invariably escaped. If they misjudged closure rates and delayed their evasive maneuvering or reversed too soon on anticipated overshoot, they could be tracked and probably destroyed. It was imperative for the F-4s to keep their mach up throughout the attack to achieve escape after overshooting. If the F-4 slowed and attempted to maneuver with the F-86, they were extremely vulnerable. The optimum mach for the F-4s appeared to be approximately 1.0-1.1M. This kept closure rates to a reasonable value, and still allowed either a successful maximum afterburner climbing departure or quarter roll descending break when tracking was no longer practical. In this phase, mach must not be sacrificed in attempts to out-maneuver the adversary.

b. F-86 at 20,000', .8M, F-4C initiates stern quarter gun attack. F-86 commences evasive maneuvering at 4,000-5,000' attacker range.

(1) Same comments as above.

ACT III:

a. F-4C at 35,000', .85M simulating CAP. F-86H initiates stern quarter heat missile and follow-up gun attack. F-4C defensive maneuvering starts when attacker at 6,000-7,000 foot range.

**E-10
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(1) This is by far the most difficult attack to thwart. To defeat the missile attack it is necessary to turn into the opponent, to defeat the gun attack requires separation. A level, or nose high, maximum afterburner, hard turn into the attackers would preclude a successful missile attack but would permit closure and a successful gun attack. The optimum defensive tactic appeared to be an immediate, nose low, maximum afterburner turn into the attacker. Approximately 30° nose down with not more than three "G" initially would allow acceleration, but still shrink the missile envelope enough to defeat the missile attack, while the acceleration effectively separated from the F-86 and precluded a successful gun attack. A further roll reversal underneath achieved maximum separation rate, but did not seem to be necessary. Premature zooms, after initially escaping, would probably result in a successful missile or gun kill by the opponent if he pressed the attack.

b. F-4C at 20,000', .78M simulating heavyweight cruise. F-86 initiates stern quarter heat missile and follow-up gun attack.

(1) Same as above, but the reduced altitude preclude any steep accelerating, moderate "G" roll unders after the initial phase.

ACT IV:

a. F-86 at 35,000', .82M, F-4C initiates heat missile attack from stern quarter with follow-up gun attack.

(1) Essentially the same as ACT II. Barrel roll attacks for an optimum heat missile launch were attempted, but the superior maneuverability of the F-86, and the extremely limited capabilities of the Sidewinder against a maneuvering target precluded success.

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ACT V:

a. Two F-4s simulating CAP at 35,000', .86M; two F-86s initiate stern quarter gun attack. F-4s commence defensive maneuvering at approximately 4,000-5,000'.

(1) For adequate mutual support it is essential for the defenders to maintain line abreast. Early recognition of the attackers as to type, range and closure rate allowed adequate defensive maneuvering to preclude a successful gun attack.

ACT VI:

a. Two F-86s simulating cruise at 35,000', .82M; two F-4s attack from stern quarter.

(1) Essentially the same as ACT II. Because of the mutual support aspect of this mission it is feasible to press the attack further. Optimum element tactics could not be established on the basis of a single flight.

GENERAL COMMENTS:

In preparation for the evaluation, the team leader initiated discussions among the F-4 pilots to establish principles and compare capabilities of the F-4 and F-86H. Although specific performance and maneuvering data were not available for the F-86H, experience verified by rough calculation immediately established the decided maneuvering advantage of the F-86 at indicated speeds of 400K and below, and at the altitudes to be used for the program this was the applicable envelope. This was translated into the first principle:

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(1) It is pointless to attempt outturning the F-86 with the F-4C as presently configured. It is conceivable, however, that a supplemental lift device could improve the F-4C's turn capability and make it competitive with the F-86.

Since the F-4C cannot out-maneuver the F-86, the second principle logically followed:

(2) When attacked, the F-4C should immediately strive for separation and re-enter the flight on its own terms.

The performance comparison included the obvious fact that the F-86 was mach limited to approximately 1.0, and then only in a steep dive. Further discussion and calculation indicated a decided advantage in thrust to weight ratio in favor of the F-4C. This fact has to be tempered with drag considerations, since excess thrust to weight ratio determines performance capabilities. This ratio is greatest at the best climb speed for any given altitude, which closely approximates .9M for the F-4C in the configuration and at the altitudes flown. In view of the drag characteristics associated with low aspect ratio, high wing loaded aircraft, any maneuver which increases lift greatly increases drag and therefore decreases excess thrust.

It logically follows that any actions which maximize excess thrust assist in achieving the desired separation. If the aircraft is "unloaded" to 0 to $\frac{1}{2}$ "G", drag is minimized, excess power increases and maximum separation rate is achieved. If it is essential to turn into the opponent to defeat a missile attack "G" must be applied sparingly and the nose allowed to drop (at medium and high altitudes) to

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allow acceleration and thus separation. Operation at M below that for best climb represent a loss in efficiency, allow the attacker to close further and increase the speed differential, thus time thru which the defender must accelerate. This leads to the last principle:

(3) Keep your mach up.

The higher your initial mach, the less closure rate for the attacker, and the more time available for sighting and/or maneuvering.

The flights conducted throughout the program indicated several areas for further development or investigation.

a. The Sidewinder (AIM-9/B) is severely limited when employed against a maneuvering target.

b. There is a definite need to develop Sparrow III employment tactics against maneuvering target without a GCI environment; the range capabilities of the missile greatly exceed the visual identification envelope.

c. Aft visibility from the F-4C is severely restricted by the "flush" canopy design. Removal of the aft cockpit instrument hood assists slightly, and the installation of mirrors in the aft cockpit also assists, but even with these changes it is still very poor.

d. A lift supplement, such as maneuvering flaps, could greatly increase the ACM potential for the F-4C.

e. The trim change gradient associated with airspeed changes, and the relatively slow trim response of the F-4 make maximum performance maneuvering difficult.

f. Currently established flight tactics should be thoroughly reviewed and validated.

E-14
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g. If the F-4 is to be employed as an air superiority weapon, a moduled gun and a pilot controlled computing sight are essential.

h. If the roll damper in the F-4 is not precisely adjusted, it can cause unnecessary tracking difficulties. A pilot selected roll damper would eliminate this limitation.

i. The automatic shoulder harness lock installed in the Martin Baker seat severely limits pilot mobility when maneuvering. Again, a selective cutout of this feature would be highly desirable.

j. The almost complete lack of a vigorous ACM program throughout the Air Force severely limits our potential. ACM takes practice and judgement, proficiency cannot be achieved by reading manuals and theorizing. The risks inherent in maximum performance maneuvering can be minimized by education and supervision. Unrealistic limitations would defeat the fundamental purpose.

k. The scope of TAC Program FF-857 was too limited. ACT against like aircraft, simulating MIG 19, MIG 21, etc. should have been included.

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ANNEX F

ACT MANEUVER DIAGRAMS
AND
EXPLANATION

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ACT MANEUVER DIAGRAMS AND EXPLANATION

1. HIGH SPEED YO-YO (Figure 1)

The high speed yo-yo is an offensive maneuver in which the attacker maneuvers through the vertical and horizontal planes to prevent an overshoot in the plane of the defender's turn. When an overshoot appears imminent, the attacker pulls up into vertical plane, so that nose tail separation can be maintained. Afterburner should be employed as required (especially in F-105) to maintain some closure. At the slower speed in the apex, a turn is made to realign with the defender's 6 o'clock position.

2. LOW SPEED YO-YO (Figure 2)

The low speed yo-yo is an offensive maneuver which provides turn cut-off and closure speed in a Lufberry turn, or increased closure rate in a running battle. To gain position quickly, with this maneuver, the attacker lights the afterburner and dives below and inside the defender's flight path, and then pulls up to zoom at the defender and either pulls into his turn, or executes a follow up high speed yo-yo if the angle off is too high.

3. THE SCISSORS MANEUVER (Figure 3)

The scissors is a defensive maneuver in which a series of turn reversals is executed in an attempt to achieve an offensive potential after an overshoot by an attacker. Success, when employing the scissors maneuver, depends on the defender's ability to achieve a lower velocity component in the direction of the flight, using a large amount of turning and rapid speed reduction.

F-1

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4. VERTICAL ROLLING SCISSORS (Figure 4)

The vertical rolling scissors is a defensive maneuver which is used when a defensive turn in the vertical plane causes the attacker to overshoot. The defender then reverses into the attacker, and continues a high G rolling maneuver to force the attacker out front.

5. BARREL-ROLL ATTACK (Figure 5)

This offensive maneuver can be effectively employed when approaching a defender at high angle off and long range. If a high speed yo-yo is employed under these circumstances, the attacker is forced to an extremely high apex in order to maintain nose-tail separation and stay inside the defender's turn radius. The barrel-roll attack allows the attacker to reduce his velocity, cut-off and turn inside the defender's turn, then regain velocity after angle off is diminished.

6. HIGH G BARREL-ROLL (Figure 5 & 6)

The high G barrel-roll is a "last ditch" defensive maneuver which is used to force the attacker out front. The maneuver is a max performance, vector roll designed to rapidly reduce aircraft indicated airspeed and vector velocity. The roll can be made in the direction of the turn (under) or following a reversal (over). The high G barrel-roll over the top is performed if an attacker is detected with low rate of closure at gun range, and the defender knows that a break would not be successful. The maneuver requires a high angle of attack capability at slow speed and is generally not suitable for F-104 type (high horizontal tail surface) aircraft. For the F-105, since control response is sluggish and airspeed bleed off rapid, the maneuver is not recommended. The high G roll under

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is performed if low airspeed does not permit execution over the top, and as a last ditch maneuver for F-105 aircraft. In the F-105 aircraft, rapid speed bleed off plus an approximate 5000' altitude loss will result. The high G roll under is entered with a rapid roll to the inverted position.

7. DIVING SPIRAL (Figure 8)

The diving spiral is performed as a last ditch maneuver designed to prevent gun or AIM-9/B type missile kill while the defender is gaining airspeed for separation, or to perform a reversal up into the attack. Entry to the diving spiral is similar to the high G roll under. From the inverted position the aircraft is pulled into a vertical spiral or a spiral with a lesser axis of descent, depending on altitude available. Max power is used and moderate G is combined with a rapid roll rate to defeat the attacker's tracking. The increasing airspeed will increase both acceleration and G capability. As airspeed builds, G is relaxed to allow further airspeed increase for separation.

8. DEFENSIVE SPLIT (Figure 9)

The defensive split is performed if an element is attacked and cannot achieve separation or turn to meet the attack. A defensive turn is held to defeat the AIM-9/B type missile attack. As the attacker(s) close for a gun attack, the defending element leader calls the split as the attackers approach gun range. The low defender continues a hard turn or increases to a break as required and the high defender slides high to acquire a line abreast position in the vertical and horizontal plans, with about 3000-4000' separation. The object is to force the attacker(s) to

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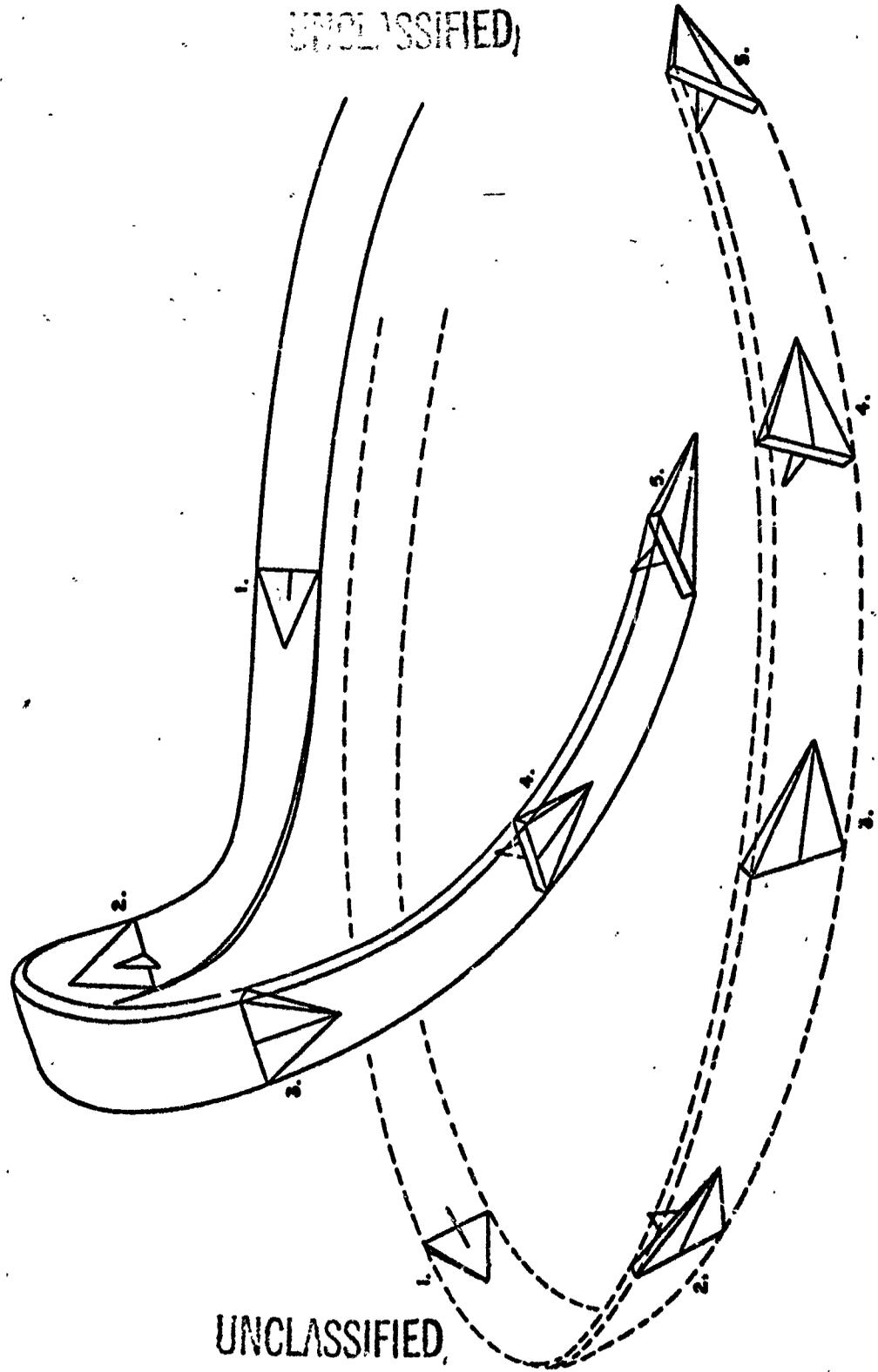
commit themselves to one of the defenders. Once the attacker commitment has been made, the defender under attack maneuvers as required to stay alive, and the free defender effects a "sandwich", with the attacker(s) in the middle. Several options are available depending on the attacker(s) commitment.

9. For full information on Air Combat Tactics Maneuvers, refer to USAF Fighter Weapons School Lesson Plan 50-10-6C "Aerial Attack Study".

F-4

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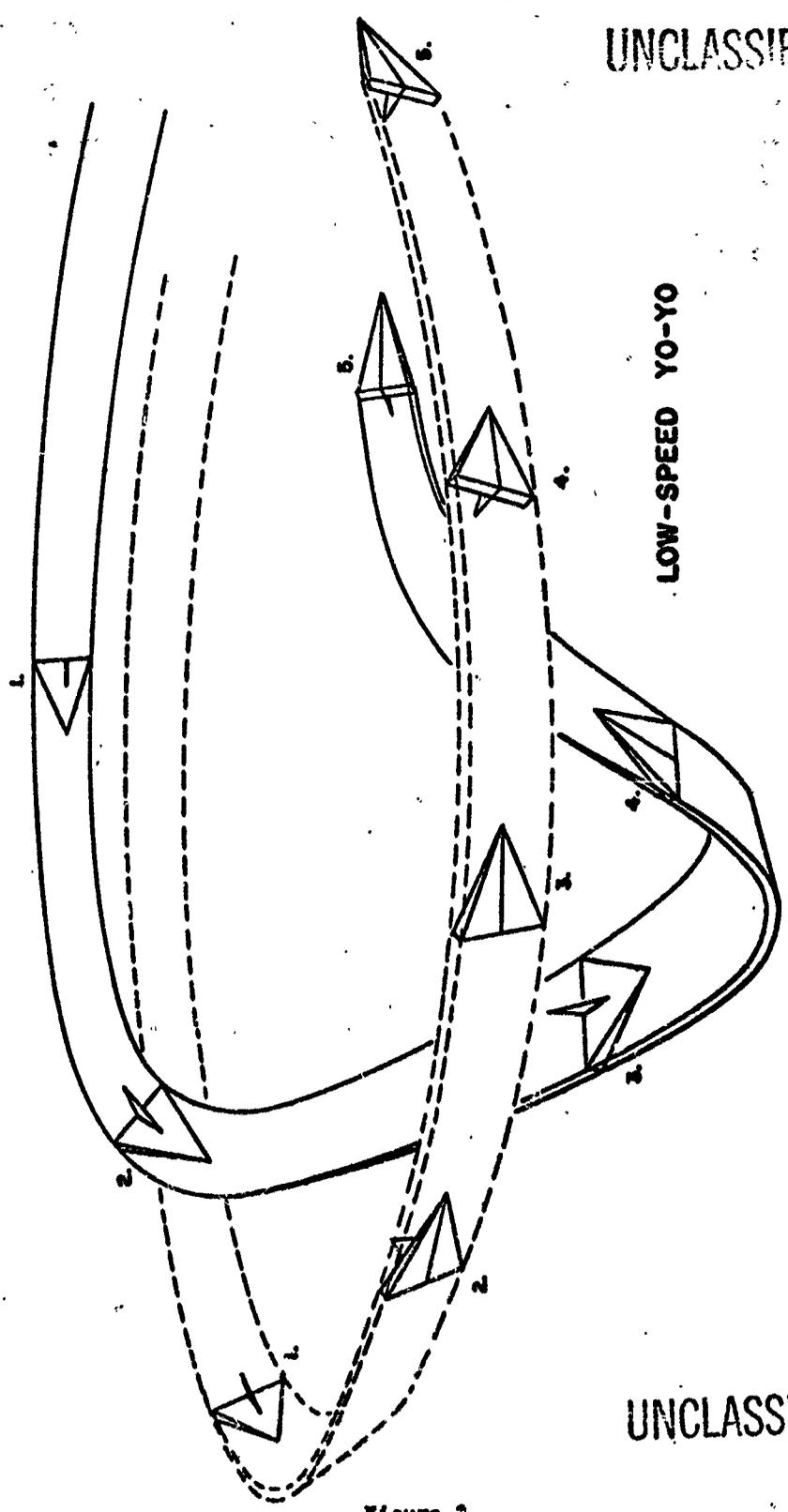


HIGH-SPEED YO-YO

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Figure 1

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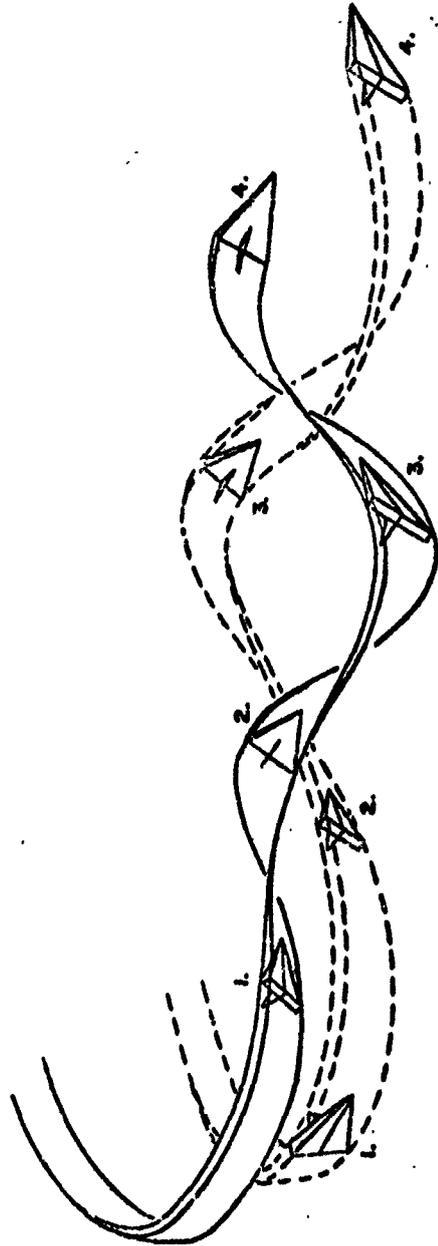


LOW-SPEED YO-YO

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Figure 2

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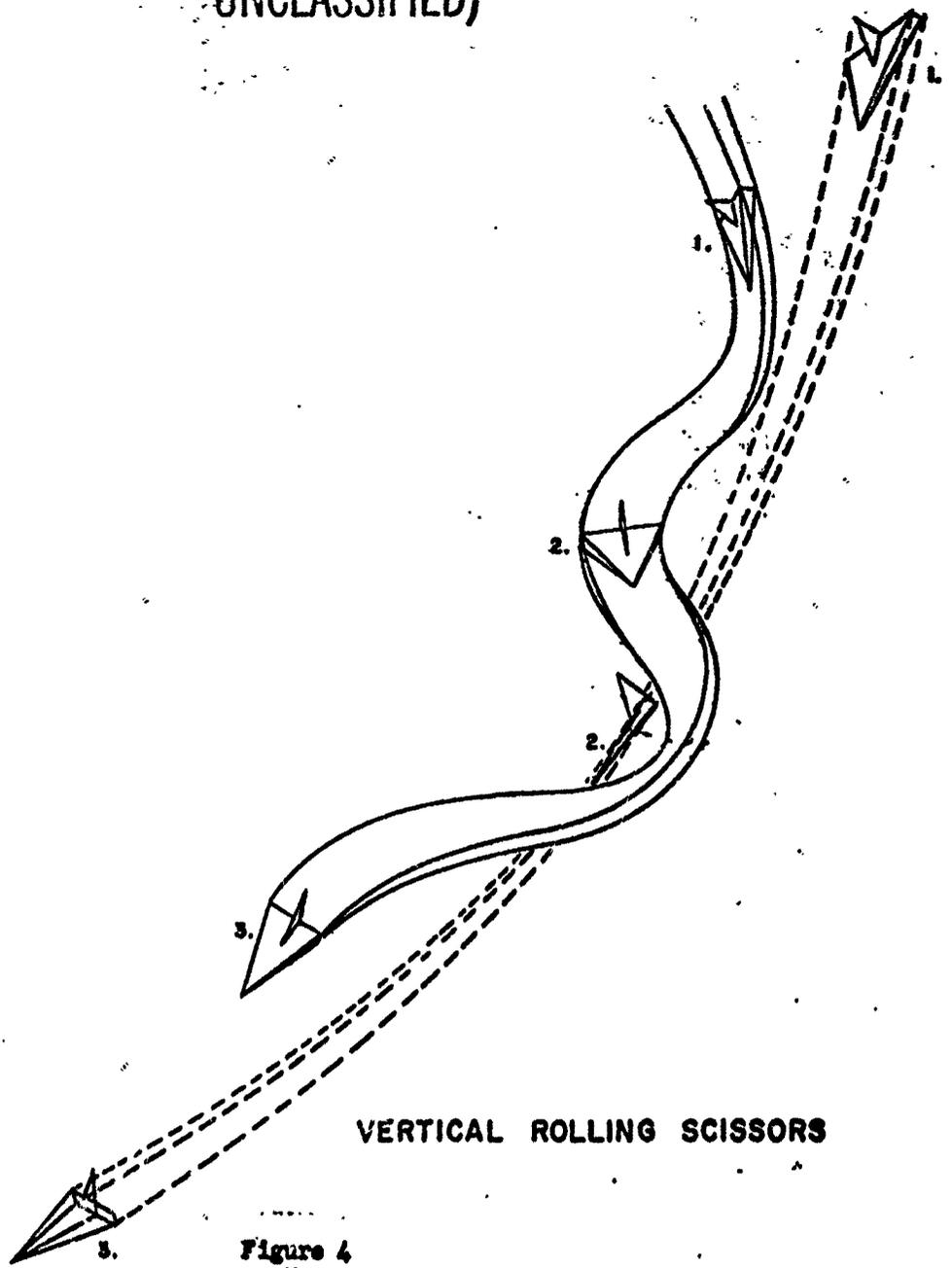


SCISSORS

Figure 3

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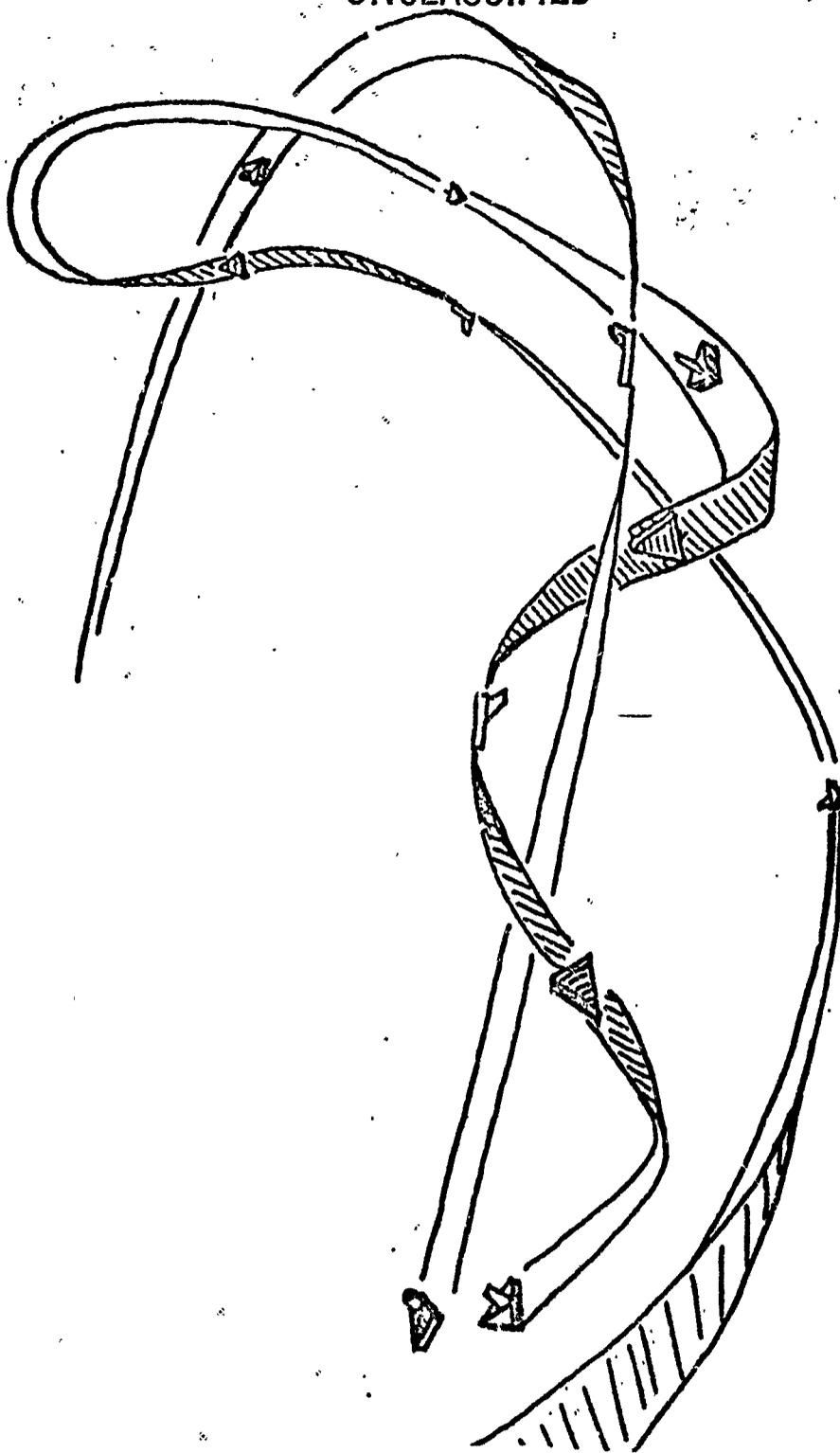
VERTICAL ROLLING SCISSORS

Figure 4

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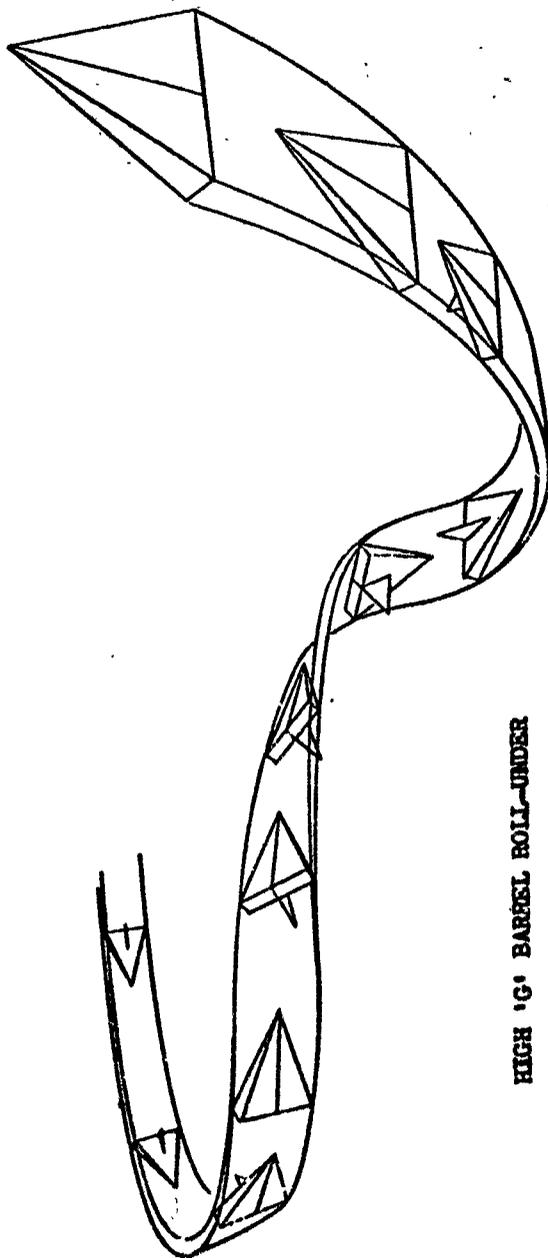


BARREL - ROLL ATTACK

Figure 5

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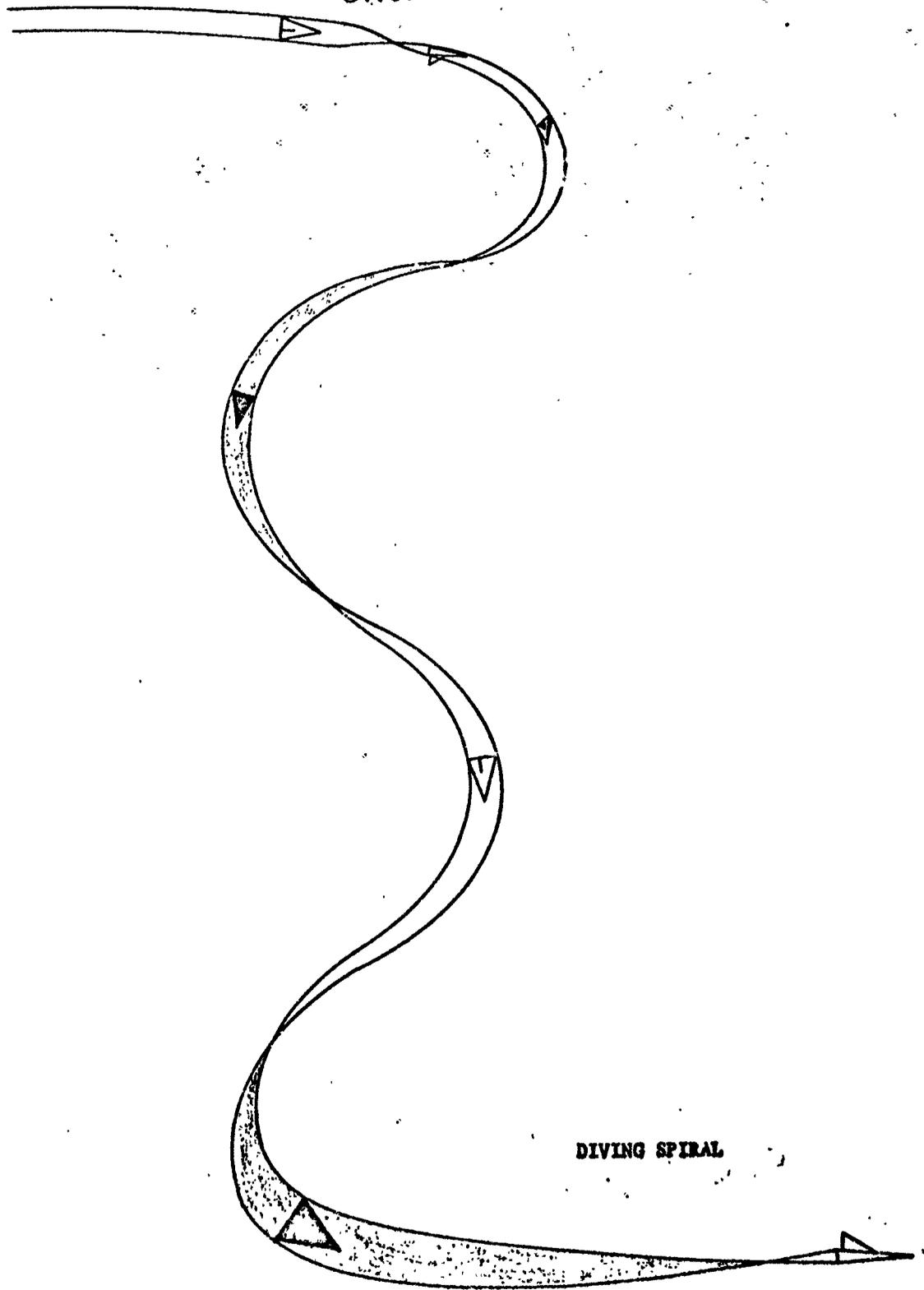
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HIGH 'G' BARREL ROLL-UNDER

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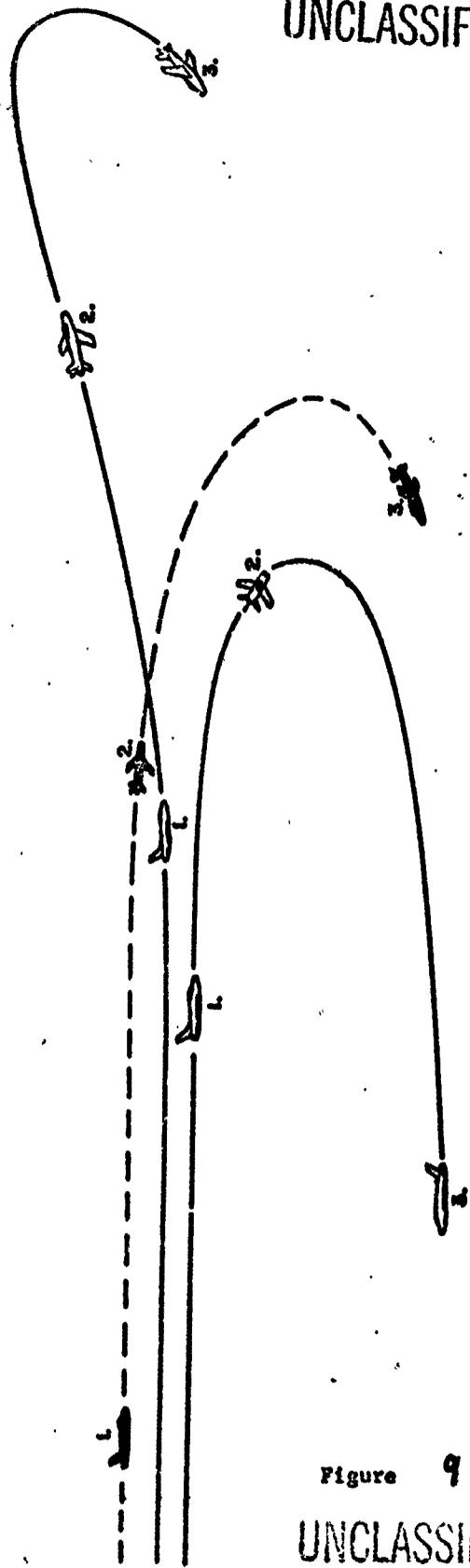


DIVING SPIRAL

Figure 8

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DEFENSIVE SPLIT

Figure 9

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ANNEX G
ENERGY MANEUVERABILITY

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ENERGY MANEUVERABILITY MAXIMUM SUSTAINED G CAPABILITY

1. During the first week of the evaluation, F-86H, F-100D, and F-105D aircraft performed thrust limited level turns to spot check maximum sustained G values at the zero Ps point (level flight) shown on the PsV energy maneuverability charts contained in this annex. These checks were performed at selected indicated machs, and for the F-86H and F-100 .02 mach was added to the recorded speeds to obtain a true mach reading with which to enter the PsV charts. F-105 aircraft cockpit mach indication is in true mach.
2. To gather such data, pilots climbed to either 15,000' or 35,000', as briefed, acquired the specified indicated mach in level flight and then entered a level turn, advancing power to the specified setting as G was increased. The turn was then held as tight as possible without encountering speed or altitude loss, and average cockpit G meter readings were recorded through a stabilized turn of 90° - 180°.
3. This data is presented in Table 1. The values listed under "Predicted Max G" are from the PsV diagrams in this annex for the specified aircraft, true mach, and altitude. For the F-86H, there are presently no PsV charts. For purposes of comparison, corresponding values for the MIG 17 (AB power) are shown in the "Predicted Max G" column for the F-86H entries. The PsV diagrams were computed for 50% of internal fuel remaining. Such amounts of fuel for each type of aircraft are as follows:

F-100 - 3900#
F-105D - 5000#
F-86H - 1800#

The actual fuel remaining at the time the data was recorded is presented, since some degradation or improvement in performance would be reflected

6-1

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with variation in fuel remaining.

4. It must be emphasized that the recorded data is presented only as a guide, in that inaccuracies could be attributed to any or all of the following factors. Data was observed visually by the pilot and recorded on a knee board.

- a. Pilot technique.
- b. Cockpit instrument inaccuracy.
- c. Variations in thrust.
- d. Variation in fuel on board.
- e. Non-standard atmosphere conditions.

5. It should be noted that the values computed for the MIG 17 in AB power exceed in all cases the values recorded for the F-86H.

6. At the present time a full test on verification of EM data is being conducted at Eglin AFB, utilizing instrumented aircraft and more exact testing techniques.

G-2

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TABLE 1

<u>Type Aircraft</u>	<u>Altitude</u>	<u>True Mach</u>	<u>Power Setting</u>	<u>Recorded Max G</u>	<u>Predicted Max G</u>	<u>Fuel Remaining/#</u>
F-100D	35,000'	.92	MIL	1.2		5200
F-100D	35,000'	.92	MIL	1.2	2.0	5200
F-100D	35,000'	.82	MIL	1.5		5100
F-100D	35,000'	.82	MIL	1.5	1.9	4800
F-100D	35,000'	.92	MAX	2.3		5000
F-100D	35,000'	.92	MAX	3.0	2.6	4800
F-100D	35,000'	1.12	MAX	2.0		3800
F-100D	35,000'	1.12	MAX	2.5	1.3	4900
F-100D	15,000'	.82	MIL	3.0	3.5	3000
F-100D	15,000'	.92	MIL	1.0		4500
F-100D	15,000'	.92	MIL	1.0	2.2	4500
F-100D	15,000'	.82	MAX	4.5	5.0+	2800
F-100D	15,000'	.92	MAX	3.5		3300
F-100D	15,000'	.92	MAX	3.5	5.0+	4400
F-105D	35,000'	.8	MIL	1.3	1.2	2300
F-105D	35,000'	.9	MIL	1.4	1.3	7100
F-105D	35,000'	.8	MAX	1.75	1.5	7200
F-105D	35,000'	.9	MAX	2.0	1.9	7000
F-105D	35,000'	1.1	MAX	2.0	2.0	6900
F-105D	35,000'	1.3	MAX	2.1	2.0	5500
F-105D	15,000'	.7	MIL	2.5	2.3	3500

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<u>Type Aircraft</u>	<u>Altitude</u>	<u>True Mach</u>	<u>Power Setting</u>	<u>Recorded Max G</u>	<u>Predicted Max G</u>	<u>Fuel Remaining/#</u>
F-105D	15,000'	.8	MIL	2.7	2.6	3300
F-105D	15,000'	.9	MIL	3.2	3.0	3200
F-86H*	35,000'	.72	MIL	2.0		2200
F-86H	35,000'	.72	MIL	2.5		2600
F-86H	35,000'	.72	MIL	2.2	(2.8)	2000
F-86H	35,000'	.82	MIL	2.2		2100
F-86H	35,000'	.82	MIL	2.6		2600
F-86H	35,000'	.82	MIL	2.0		1800
F-86H	35,000'	.82	MIL	1.9	(3.0)	3200
F-86H	35,000'	.92	MIL	1.6		2200
F-86H	35,000'	.92	MIL	1.1		1600
F-86H	35,000'	.92	MIL	1.6		3300
F-86H	35,000'	.92	MIL	1.75	(2.8)	2200
F-86H	15,000'	.72	MIL	5.0 +		1500
F-86H	15,000'	.72	MIL	4.5 - 5.0		1600
F-86H	15,000'	.72	MIL	5.5		2400
F-86H	15,000'	.72	MIL	5.0	(5.0+)	-
F-86H	15,000'	.82	MIL	4.5		1700
F-86H	15,000'	.82	MIL	4.5		2300
F-86H	15,000'	.82	MIL	4.7		1700
F-86H	15,000'	.82	MIL	4.0	(5.0+)	-
F-86H	15,000'	.92	MIL	2.5		1700

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<u>Type Aircraft</u>	<u>Altitude</u>	<u>True Mach</u>	<u>Power Setting</u>	<u>Recorded Max G</u>	<u>Predicted Max G</u>	<u>Fuel Remaining/#</u>
F-86H	15,000'	.92	MIL	1.3		1500
F-86H	15,000'	.92	MIL	1.8		-
F-86H	15,000'	.92	MIL	2.75		2200
F-86H	15,000'	.92	MIL	3.0	(4.3)	1600

*Note variation between individual F-86H readings, particularly at .92 mach and 15,000'.

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ENERGY MANEUVERABILITY THEORY

1. DEFINITION OF TERMS: Energy Maneuverability Theory is a system of quantitatively relating the performance of different aircraft at any airspeed or altitude. For use of this theory in tactics evaluation and performance comparison, two basic concepts are involved.

a. Specific Energy Level: This is a measure of the energy possessed by a fighter as a result of its position at a particular speed and altitude. A fighter with a high Specific Energy Level has an advantage in speed and/or altitude over one with low Specific Energy Level. Hard maneuvering especially at high altitudes, normally causes a Specific Energy Loss, hence it is to the advantage of an attacking aircraft to initiate the attack with a higher energy level than its opponent. The attacker can afford then to trade this energy while maneuvering for position.

b. Specific Excess Power or Energy Rate: Energy rate is a measure of the time rate at which a fighter gains or loses energy and is equivalent to the specific excess power of that fighter. Specific excess power is that amount of extra power possessed by the fighter after the normal power required merely to "stay in the air" has been subtracted. In other words, it is a measure of the extra power available to climb, accelerate, or turn tighter as required by the maneuvering situation. A positive energy rate, thus indicates capability for gain of speed, altitude, or G, while a negative rate indicates that the fighter must lose speed and/or altitude or it must relax the G load.

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$$E_s = \text{Specific Energy} = h + \frac{v^2}{64.4}$$

E_s Units in feet.

h = height in feet

V = velocity in feet per second (true airspeed)

P_s = Specific excess power = energy rate

P_s Units in feet/sec.

2. PsV DIAGRAM: Refer to figure 10 and note the following.

a. At .8M, pulling 5 Gs, the F-104 and MIG 21 are an even match.

Both have a positive P_s of approximately 325 ft/sec. The specific excess power (energy rate) can be used to increase altitude, airspeed, or turn (G).

b. At 1.1M, pulling 5 Gs, the F-104 has a negative P_s of 220 and the MIG 21 has a negative P_s of 150. Both aircraft are losing energy, but the F-104 is losing it faster.

c. The F-104 has an advantage (sea level) from .7 or .8M to slightly over mach one.

3. HV (Energy Rate) DIAGRAM: Refer to figure 11 and note:

a. At 45M, 1.35M, the F-104 and MIG 21 are an even match. Both aircraft have a positive P_s of 100 ft/sec. This P_s can be used to increase altitude, airspeed, or turn (G).

b. At 48M, the max steady state mach number for the F-104 is 2.0. At the same altitude the MIG 21s max velocity is 2.2M.

c. At 1.3 or 1.4 to mach 2.0 the F-104 enjoys an advantage at all altitudes, since the solid (F-104) lines fall above the dotted (MIG 21) lines.

G-7
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For more detailed information on Energy Maneuverability Theory,
refer to:

APGD-TDR-64-35 & 38, May 64.

Fighter Weapons School Lesson Plan - "Energy Maneuverability"
50-10-6e.

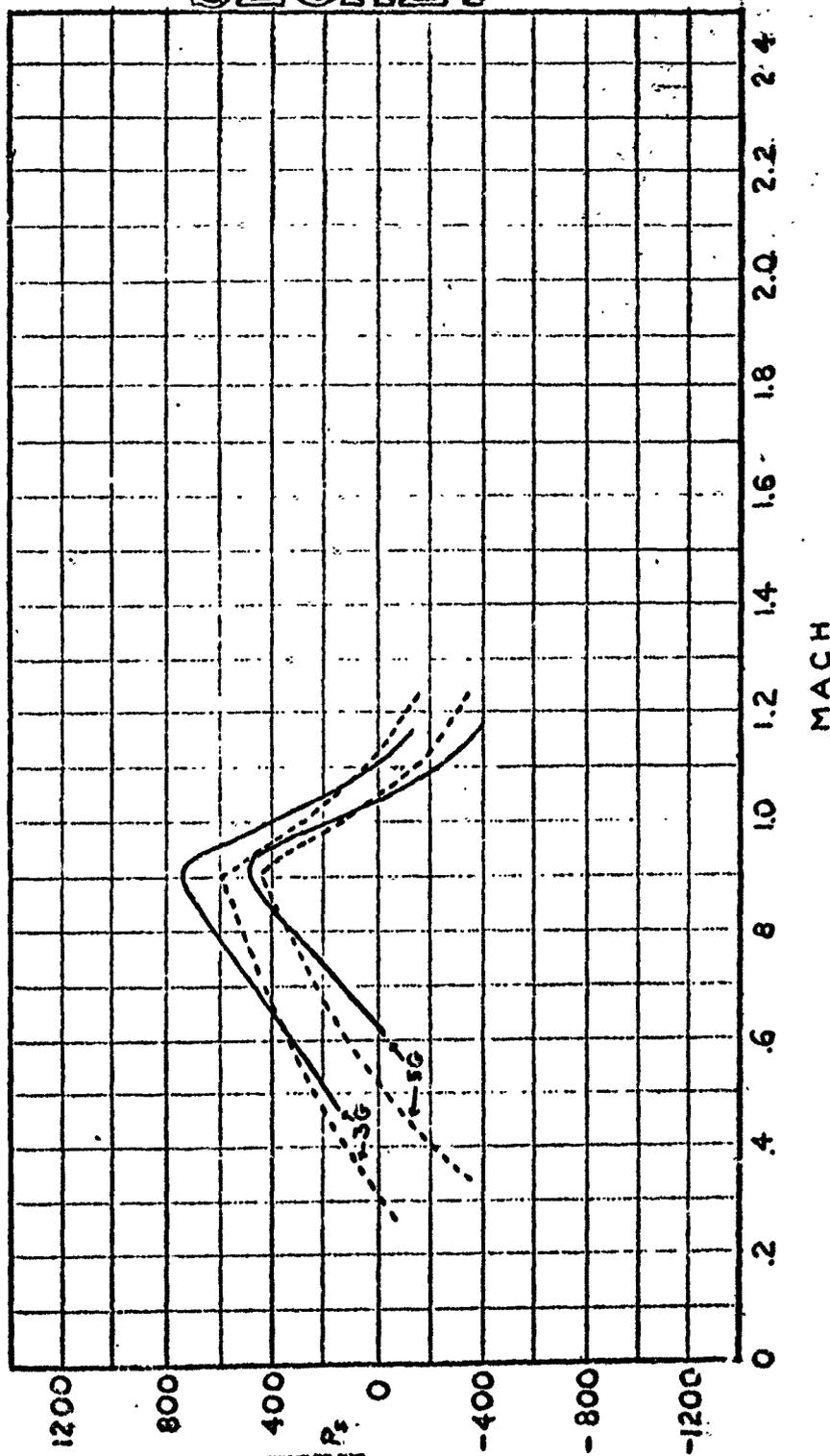
4. Energy Maneuverability diagrams are included in this annex to allow
comparison of energy rate capabilities of the participating TAC Fighters
and the MIG 15 & 17.

G-8
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F-104C ———
MIG-21C - - - - -

MAXIMUM POWER SEA LEVEL



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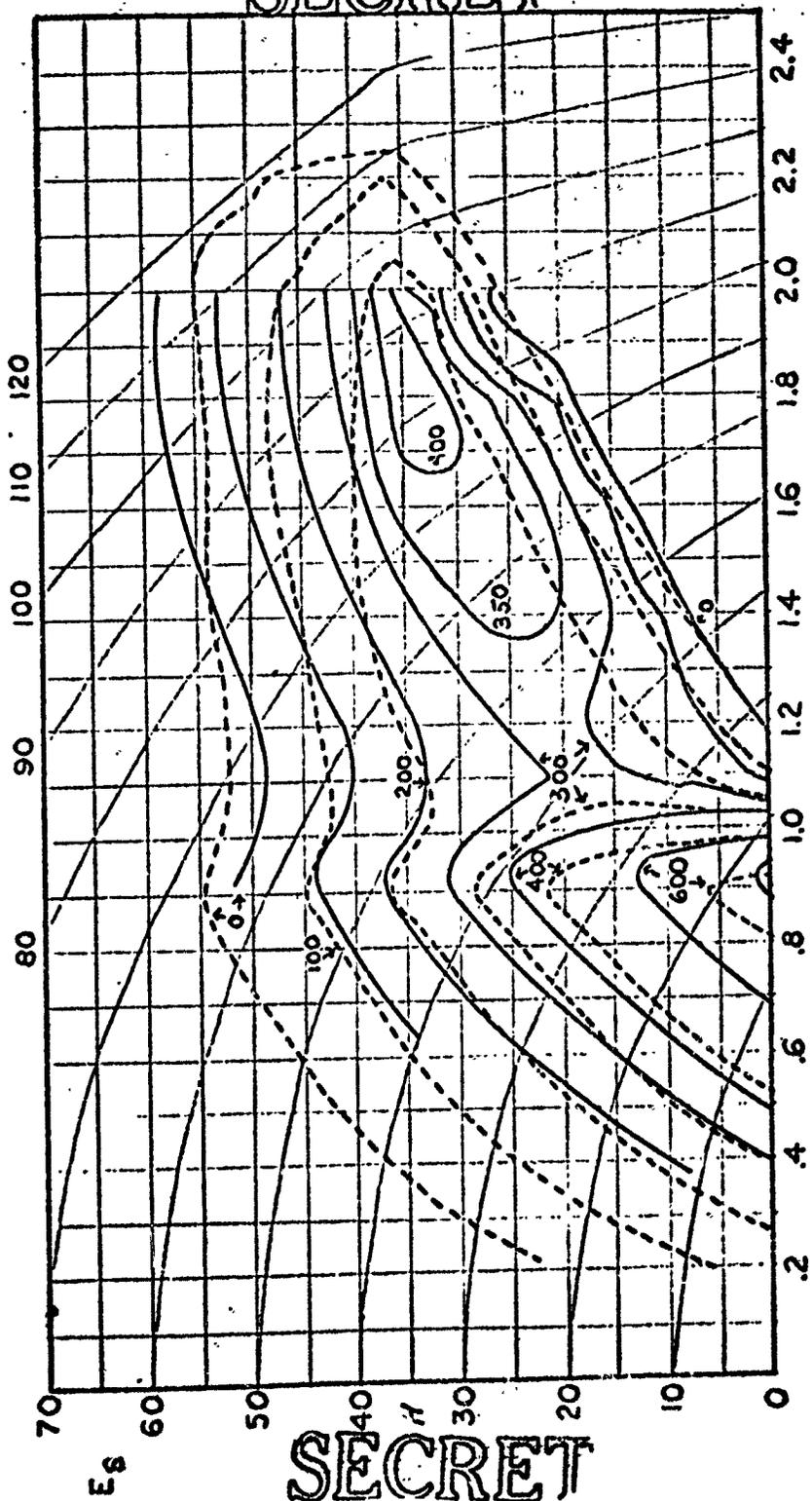
Figure 10

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F-104-C ———
MIG-21C - - - -

H-V DIAGRAM MAXIMUM POWER IG

H-V DIAGRAM



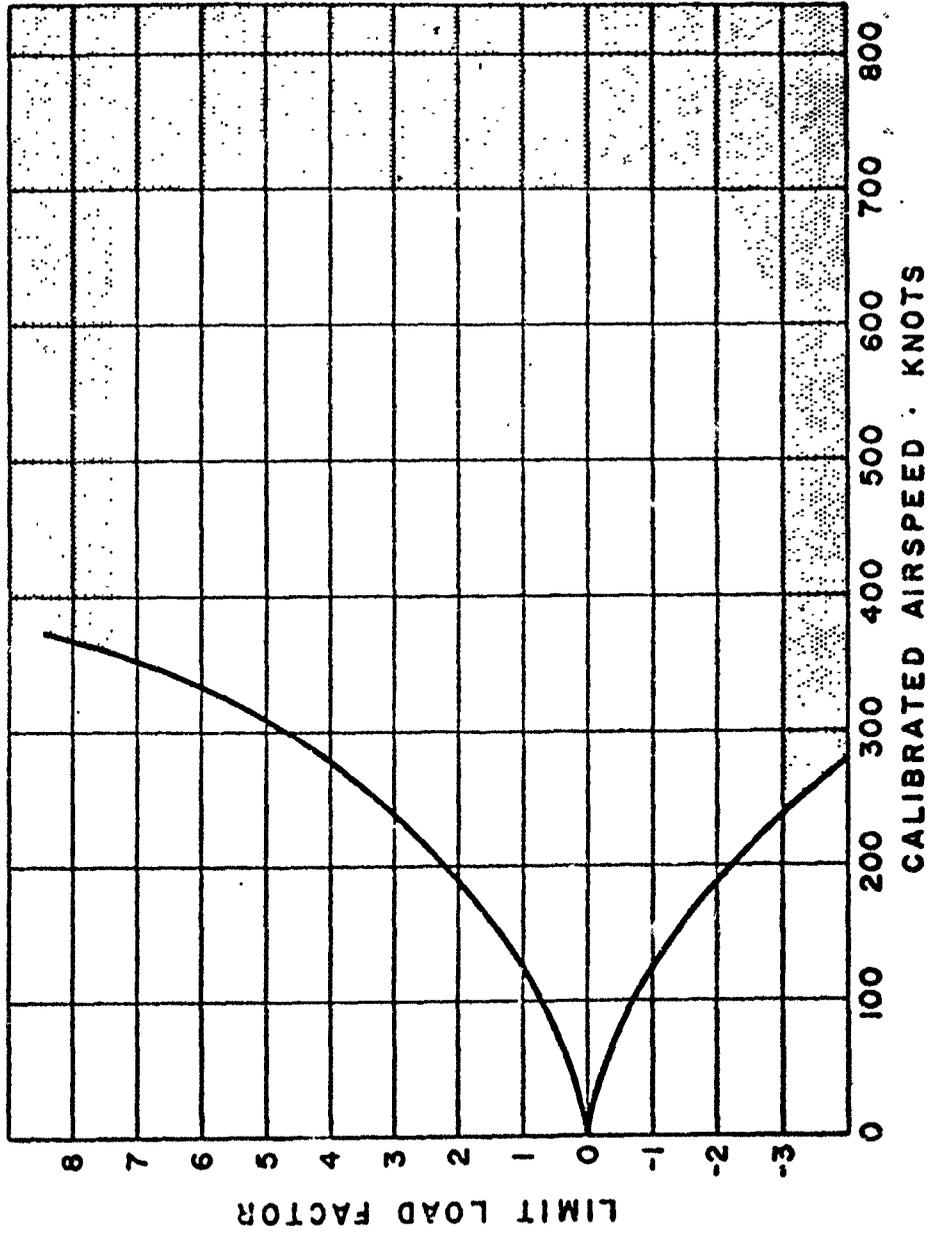
MACH

Figure 11

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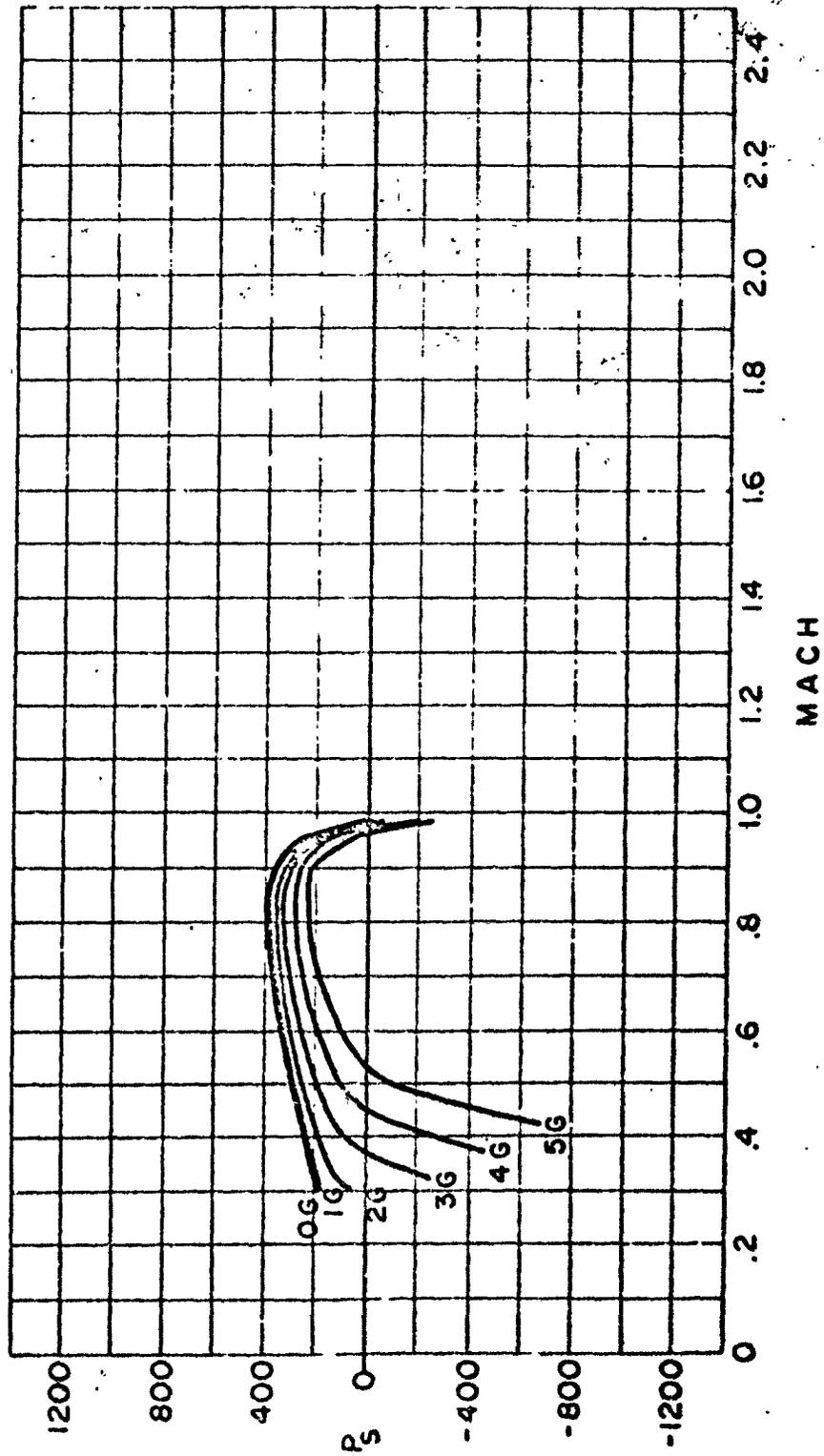
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FLIGHT OPERATING LIMITS · F-100D · 30,000'



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58 **MAXIMUM POWER · SEA LEVEL** **F-100D**

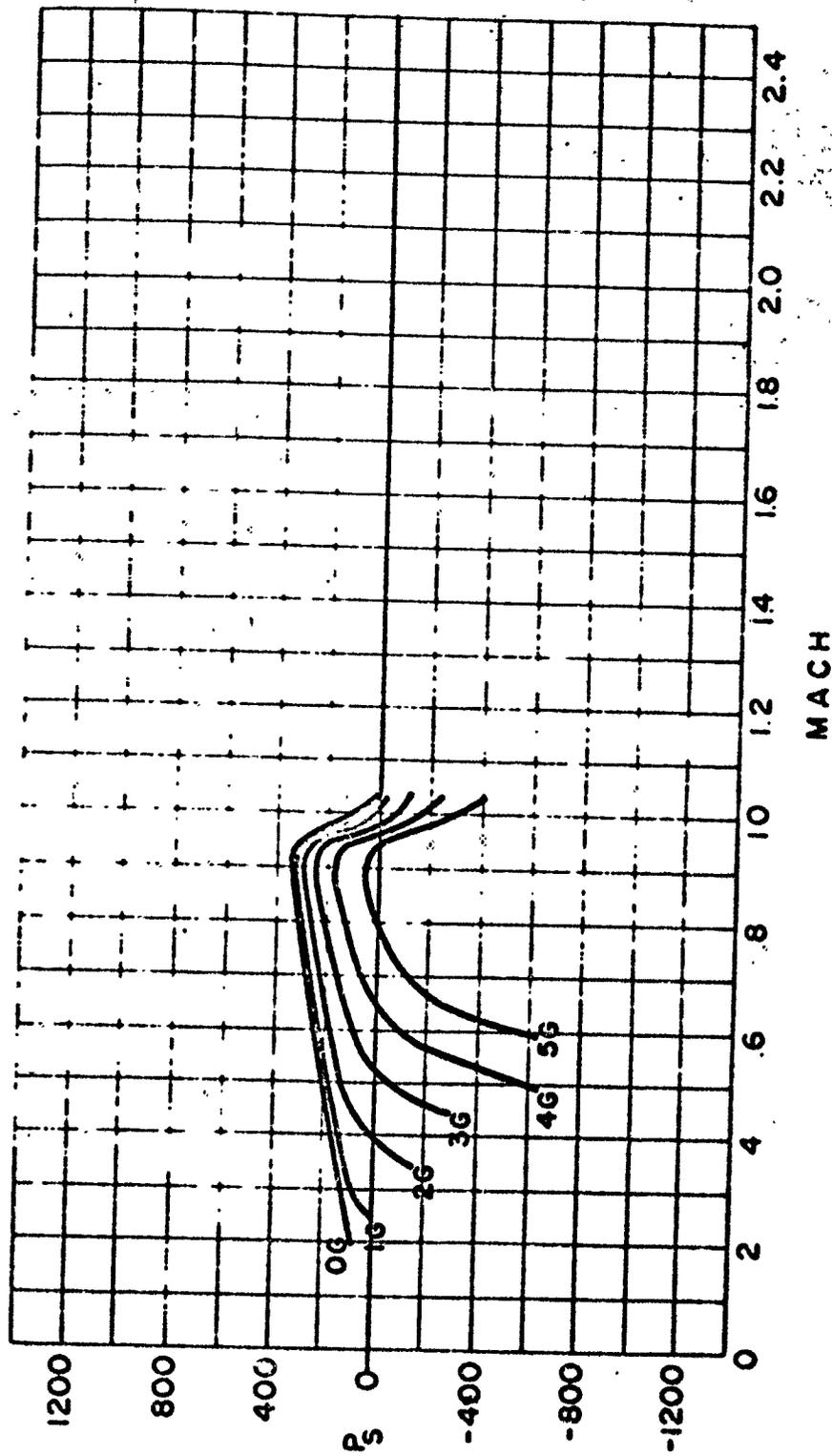


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MAXIMUM POWER · 15,000'

-- F-100D

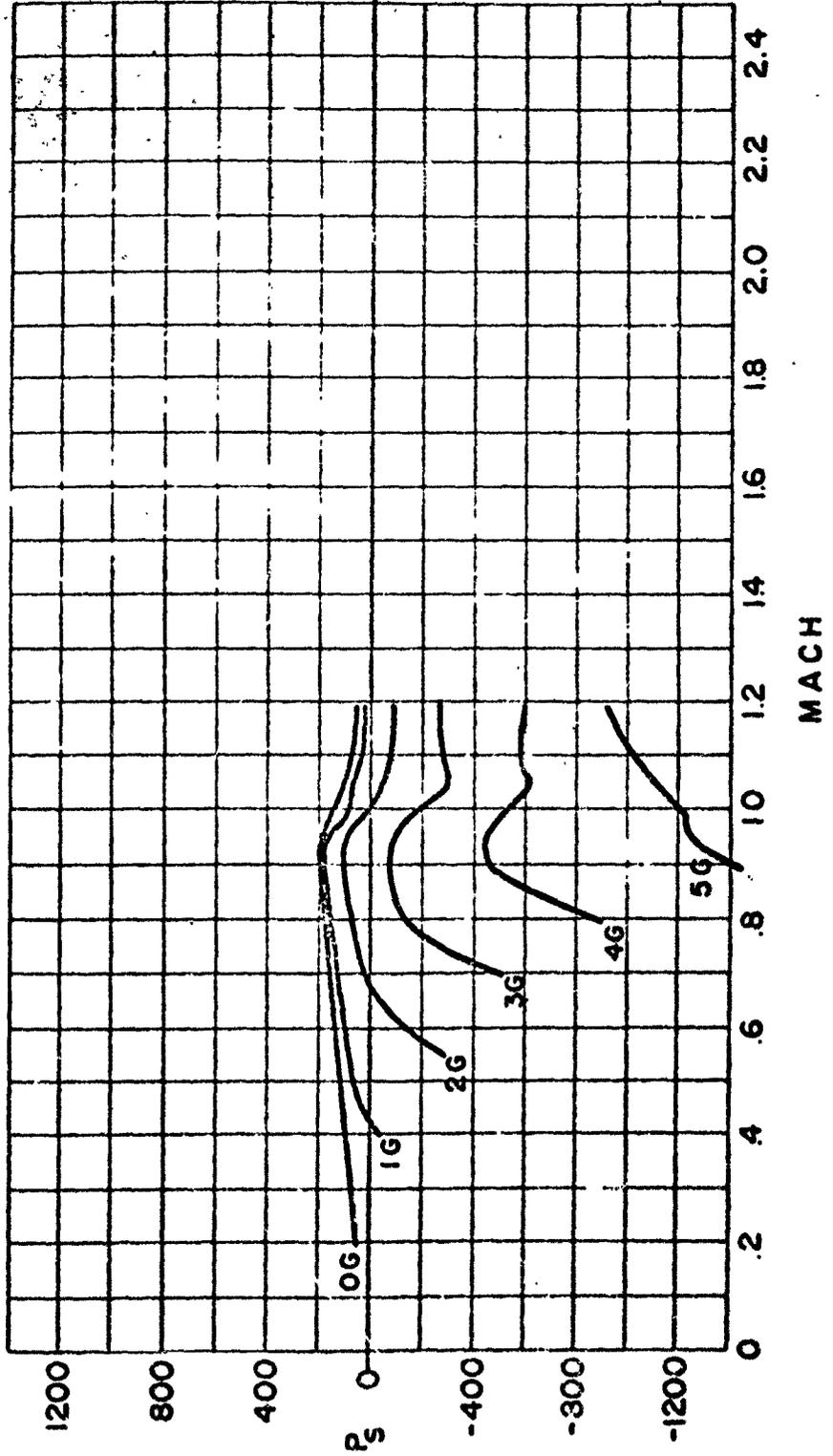


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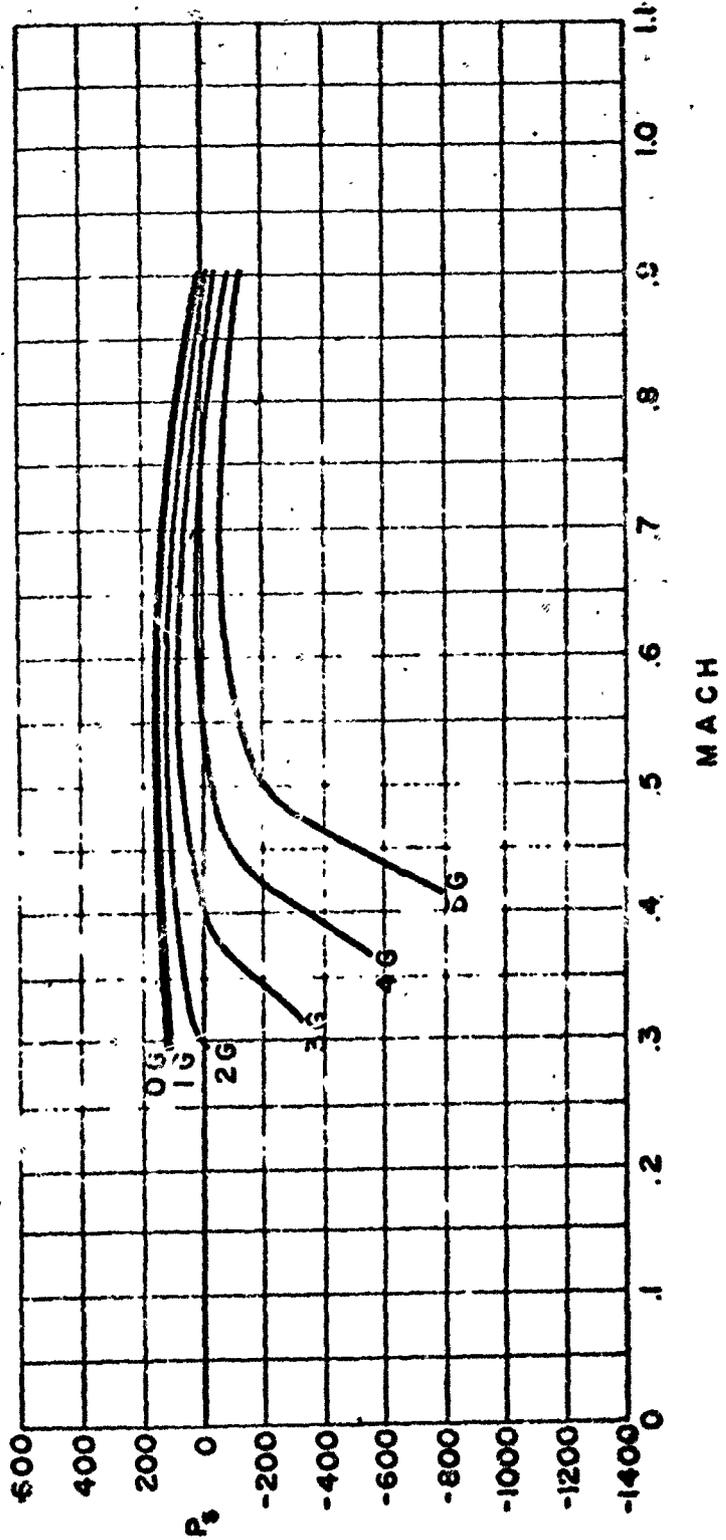
6 MAXIMUM POWER · 35,000' — F-100D



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MILITARY POWER · SEA LEVEL

F-100D

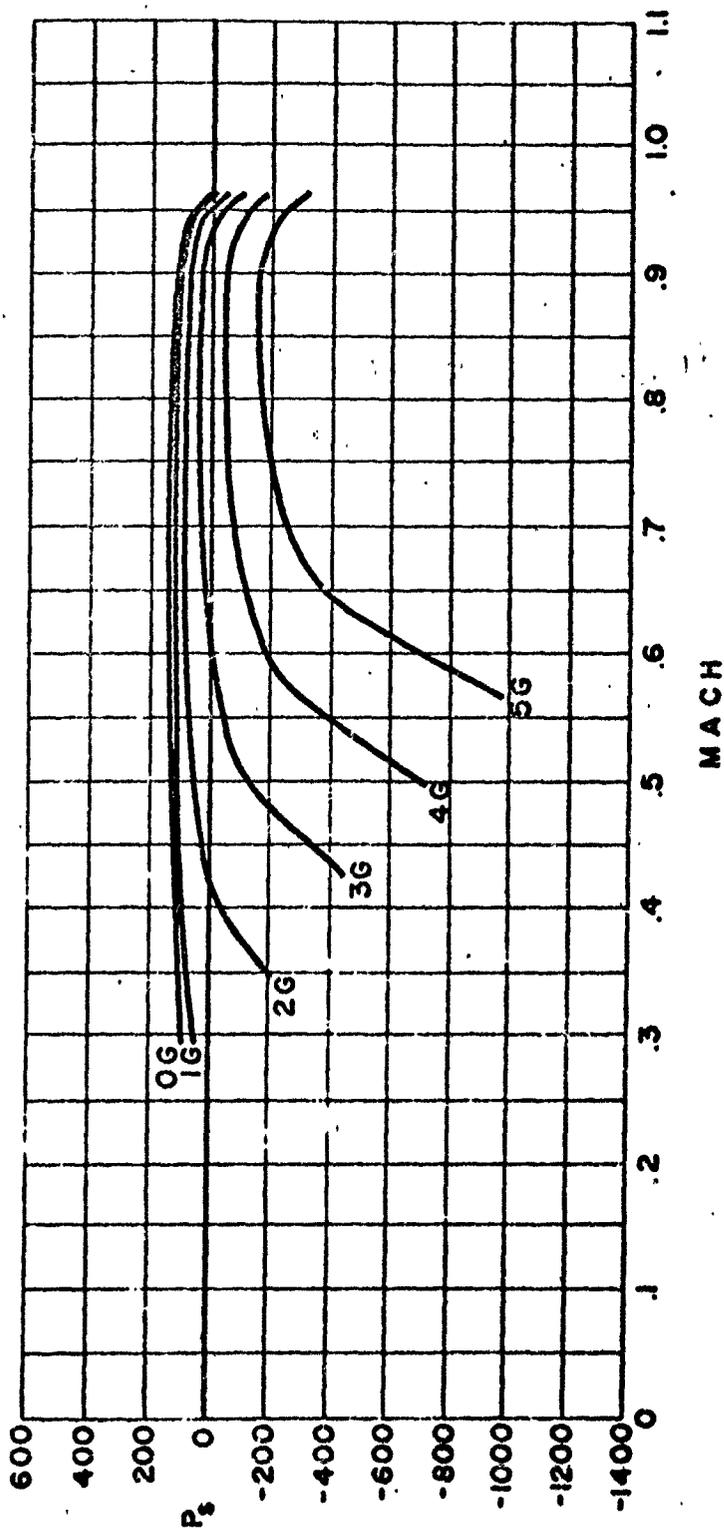


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MILITARY POWER · 15,000'

F-100D

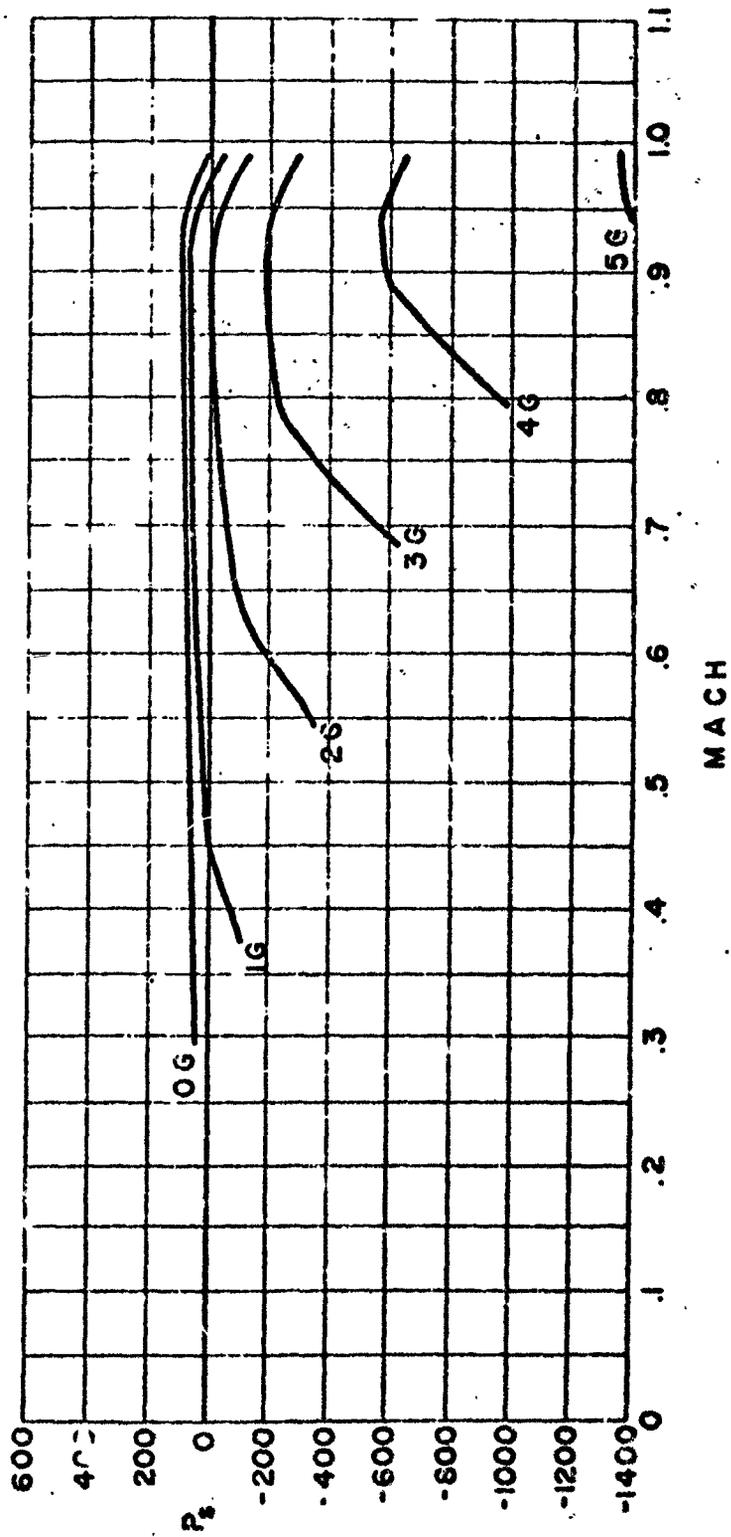


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MILITARY POWER · 35,000'

F-100D



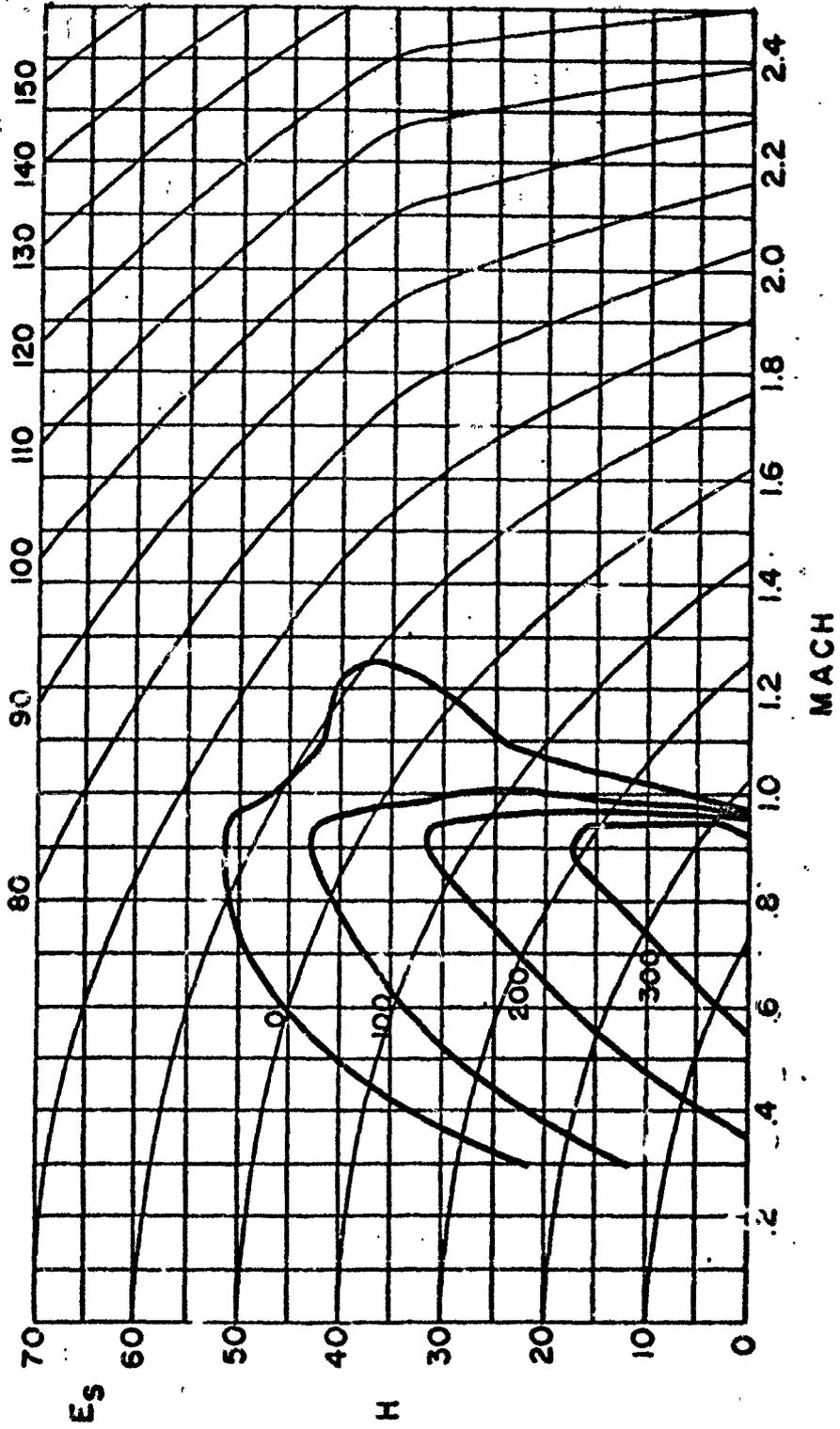
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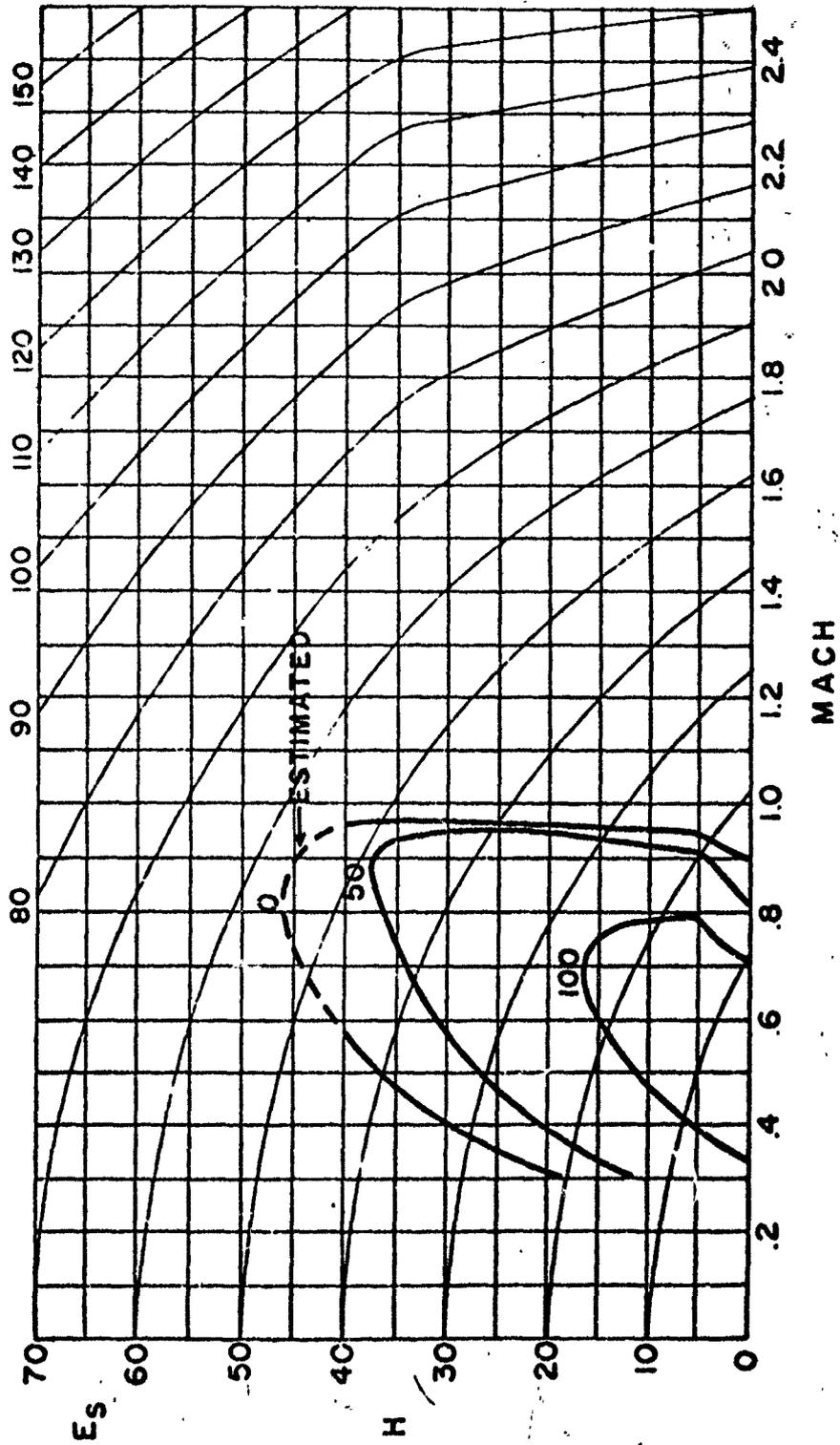
MAXIMUM POWER · IG



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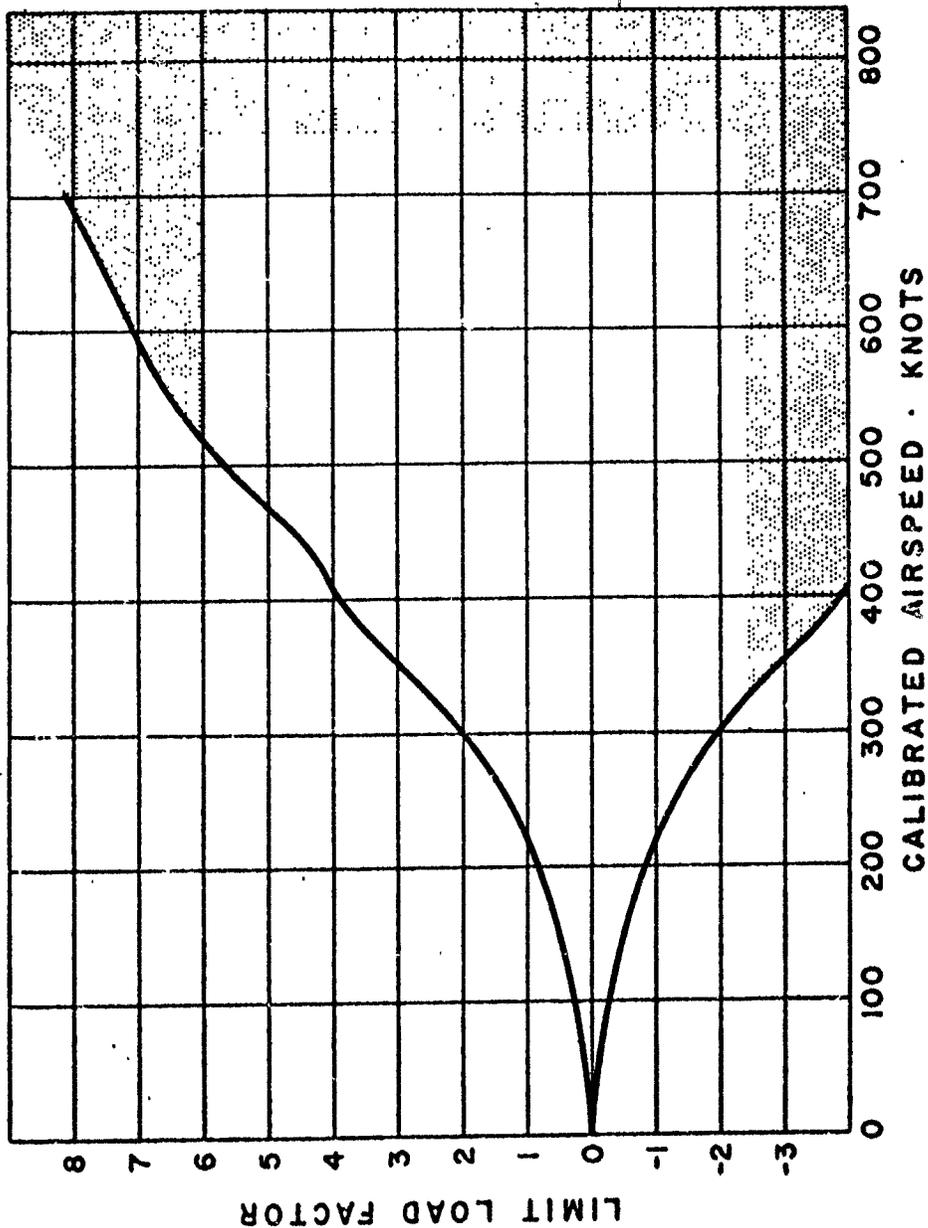
MILITARY POWER · IG F-100D



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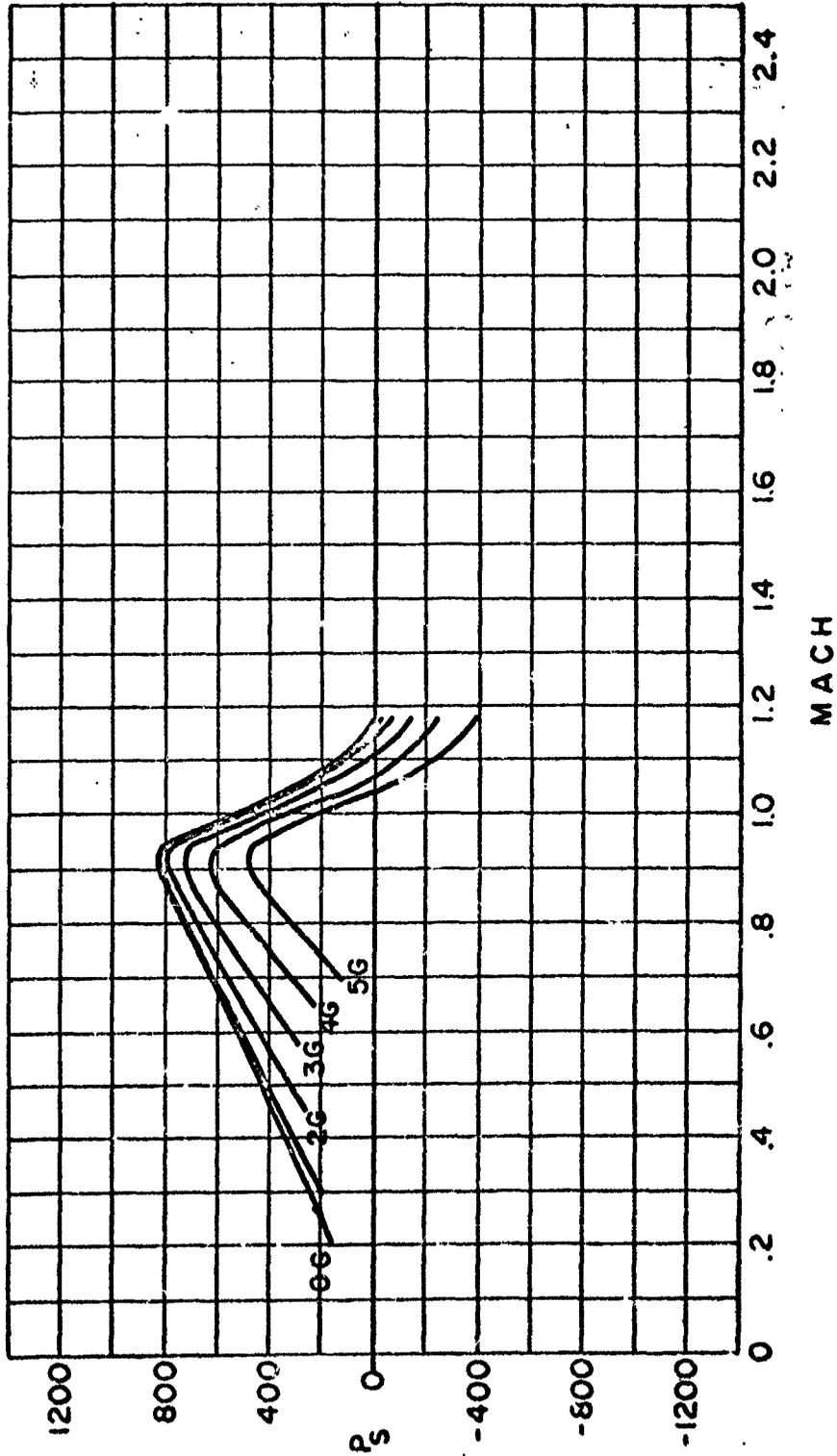
FLIGHT OPERATING LIMITS • F-104C • 30,000'



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MAXIMUM POWER · SEA LEVEL

F-104C

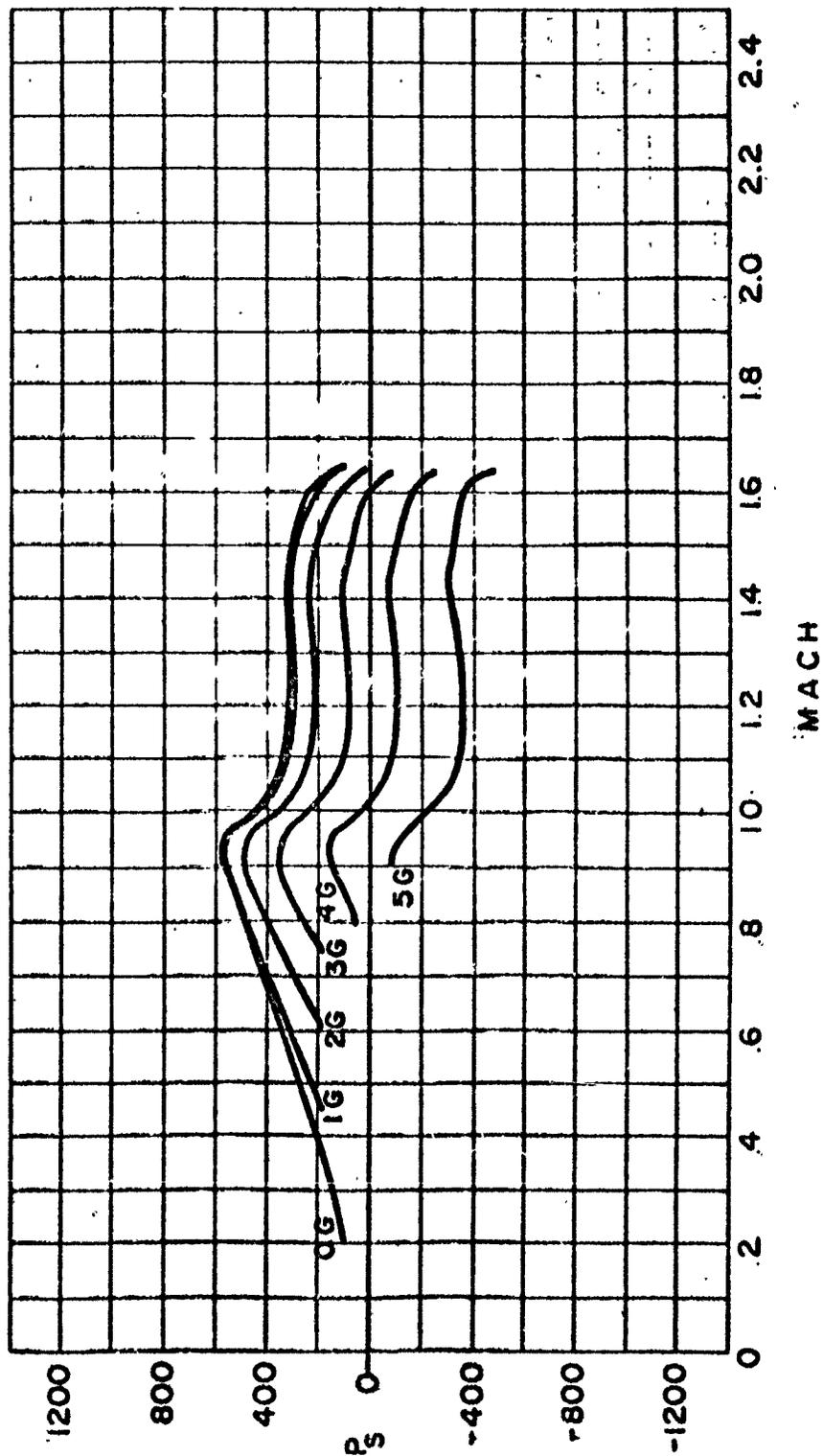


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MAXIMUM POWER · 15,000'

F-104C

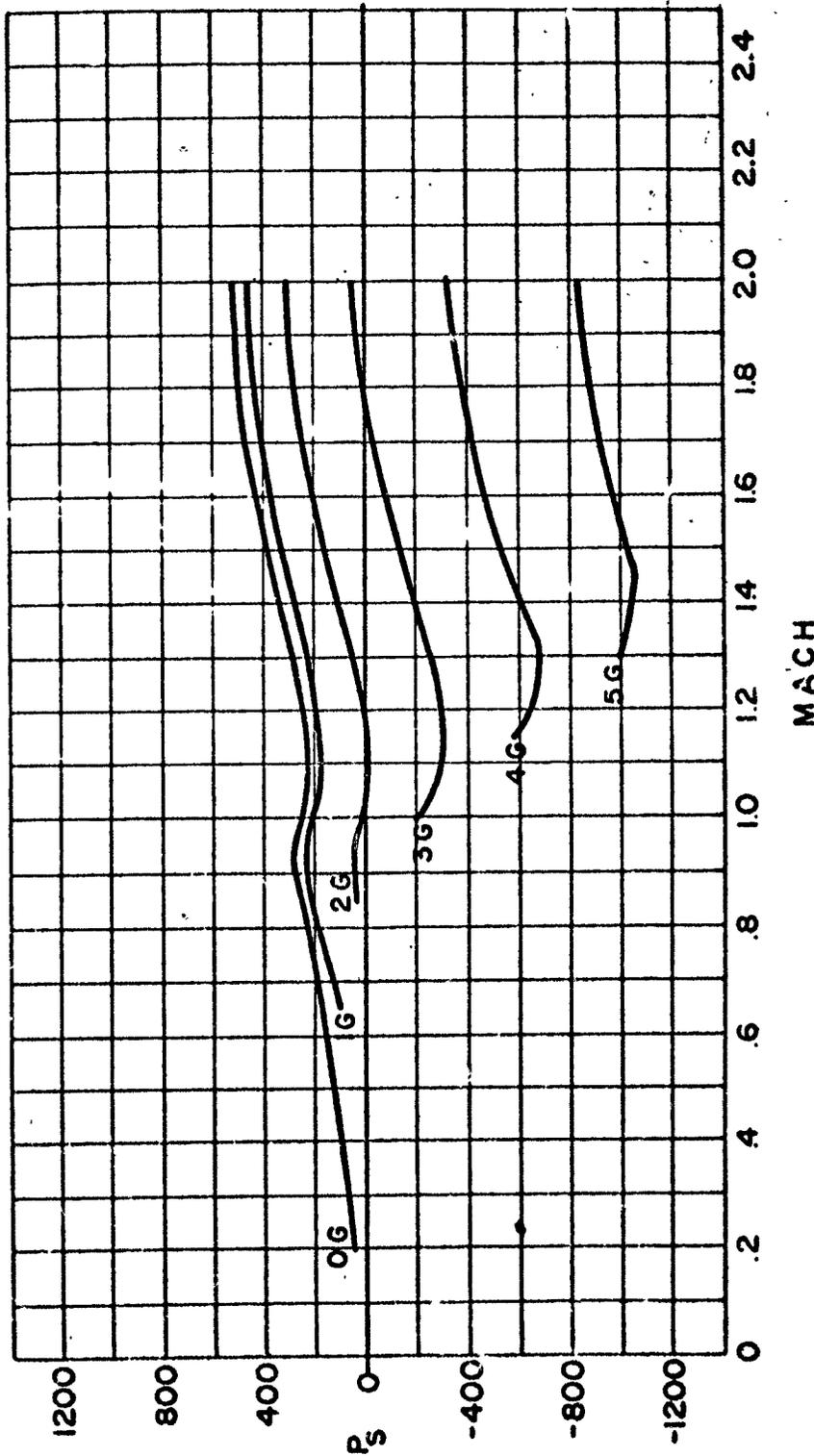


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MAXIMUM POWER · 35,000'

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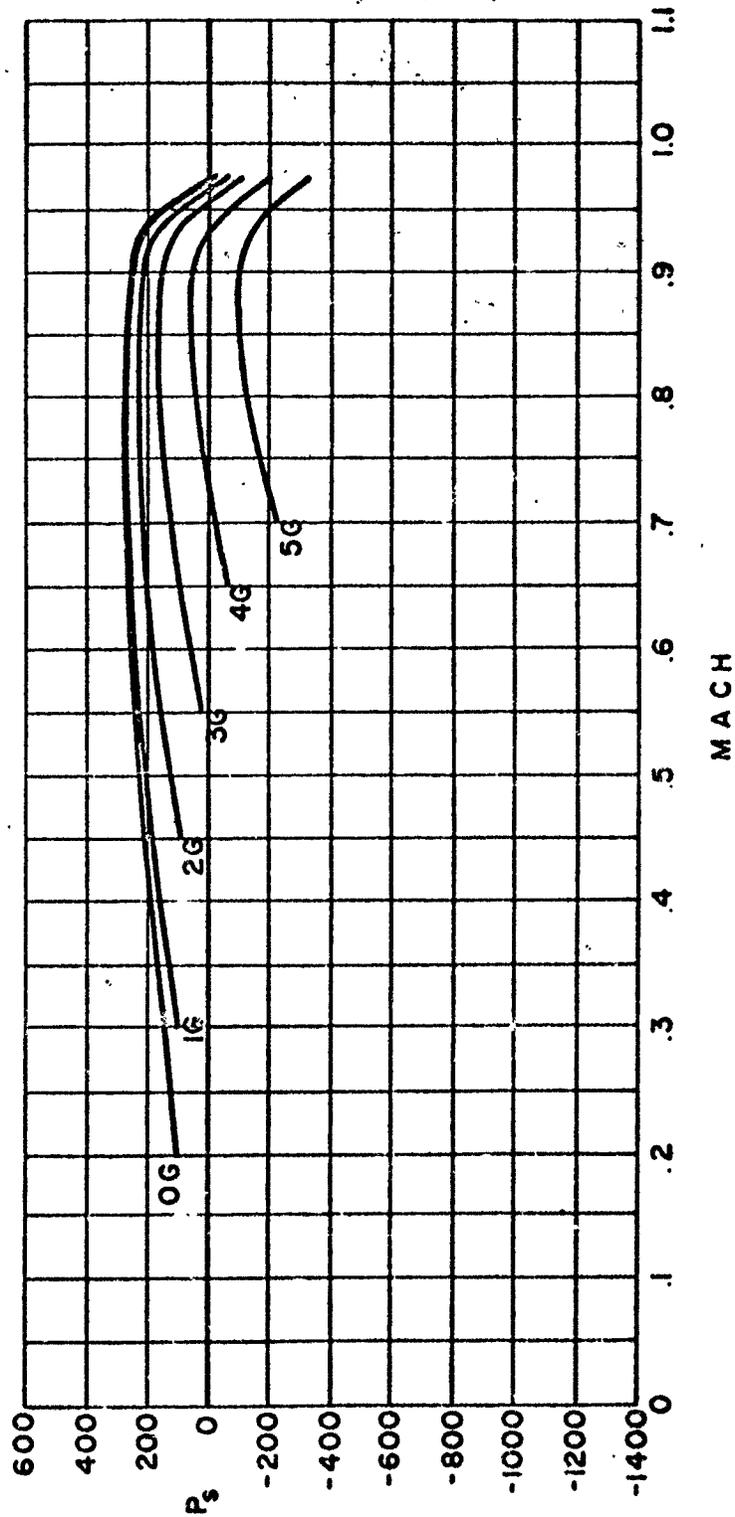


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MILITARY POWER · SEA LEVEL

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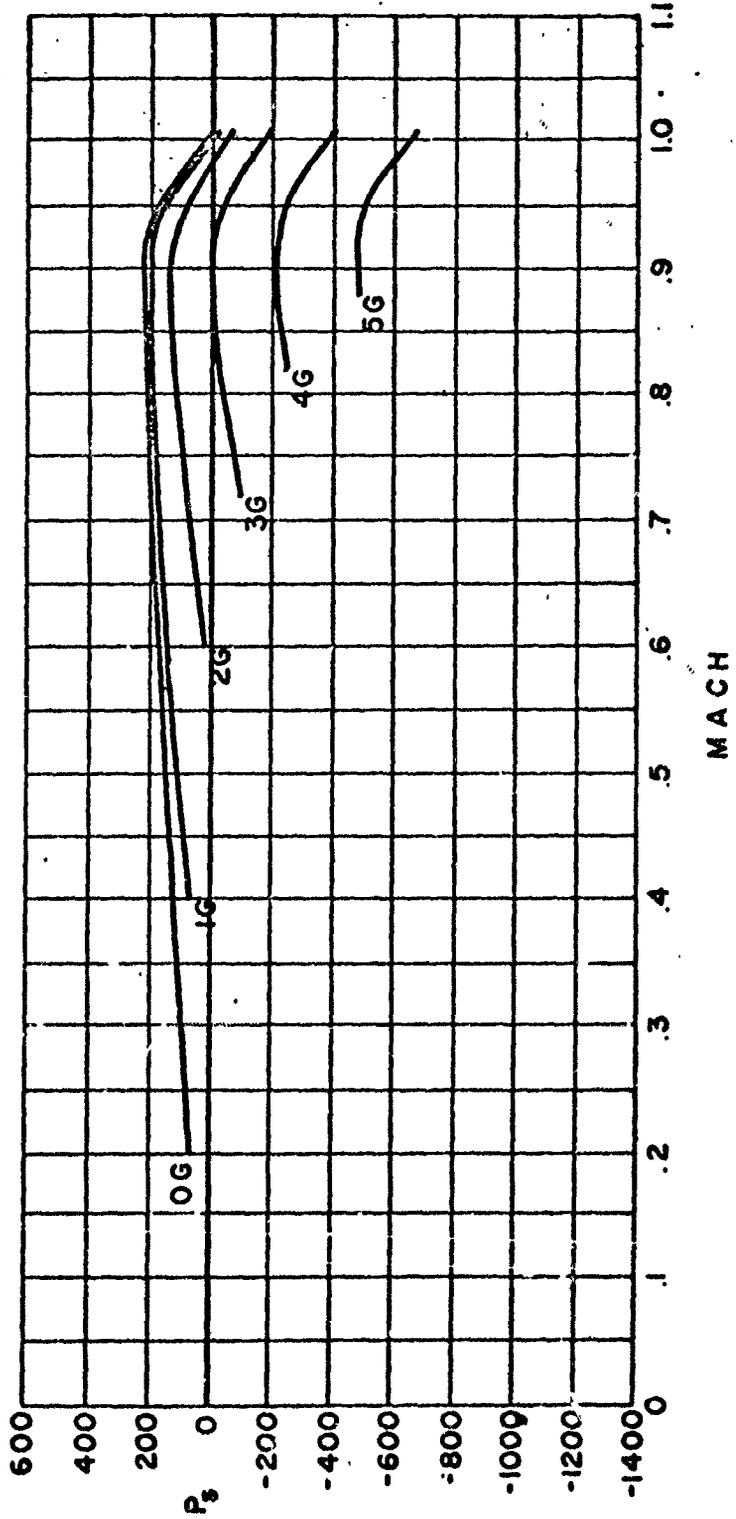


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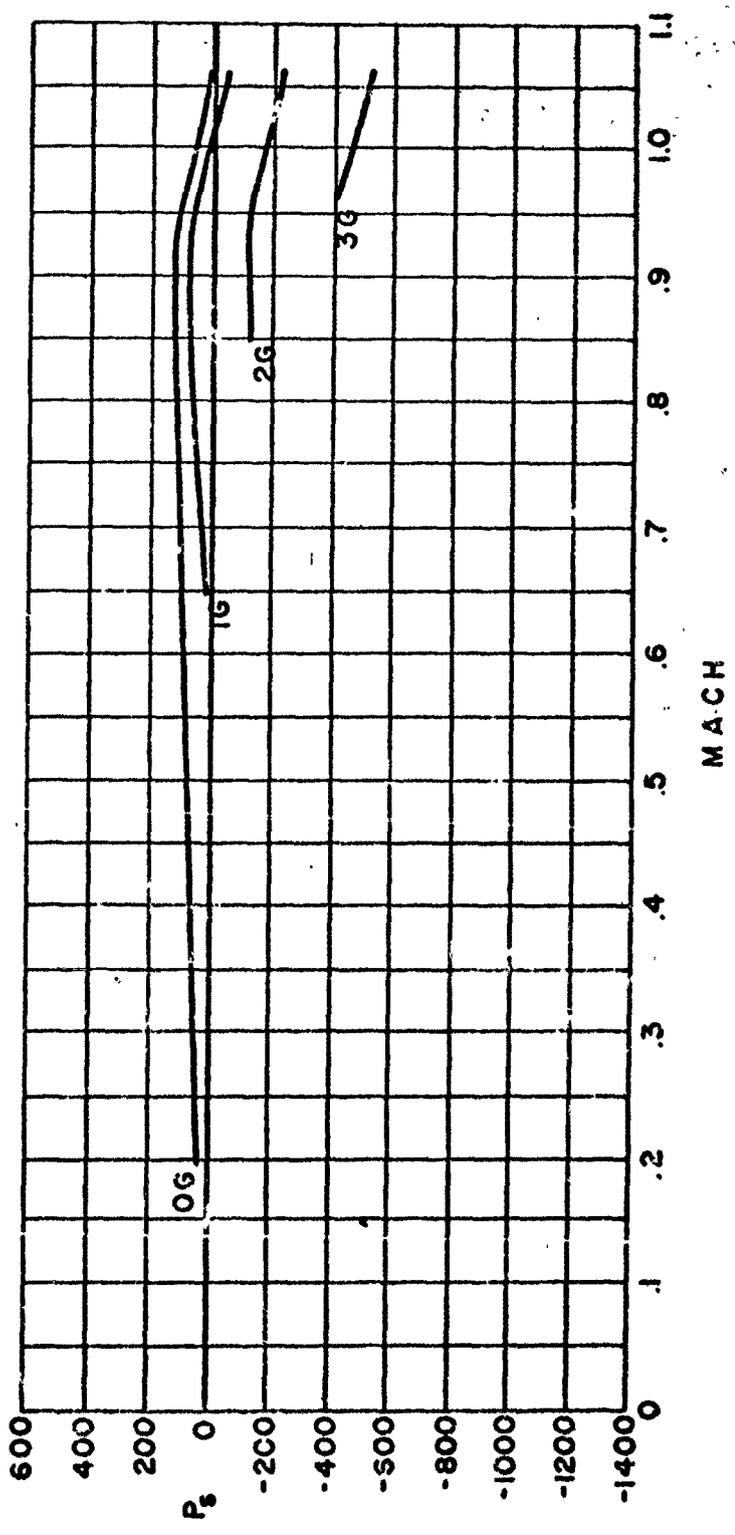
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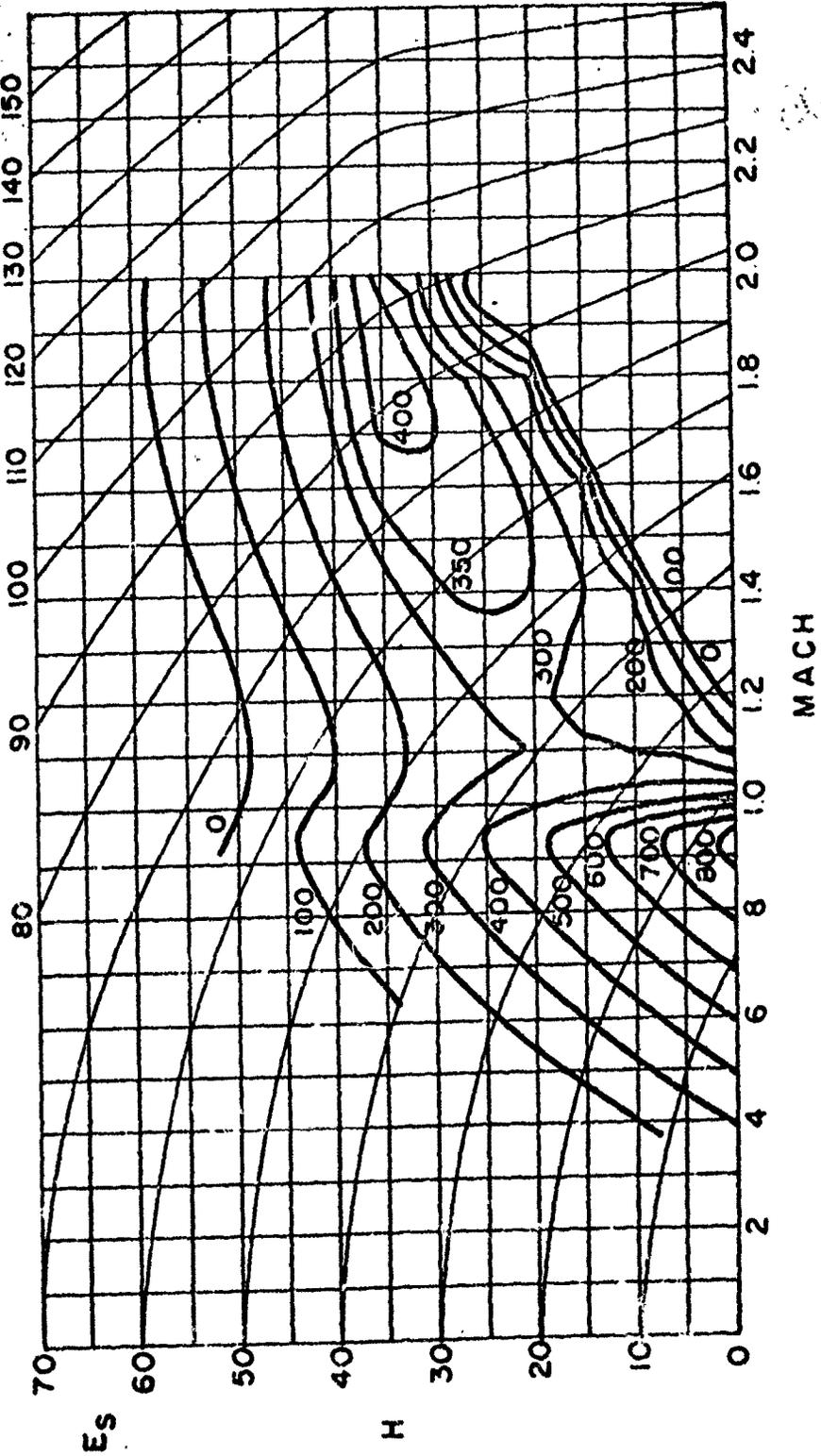


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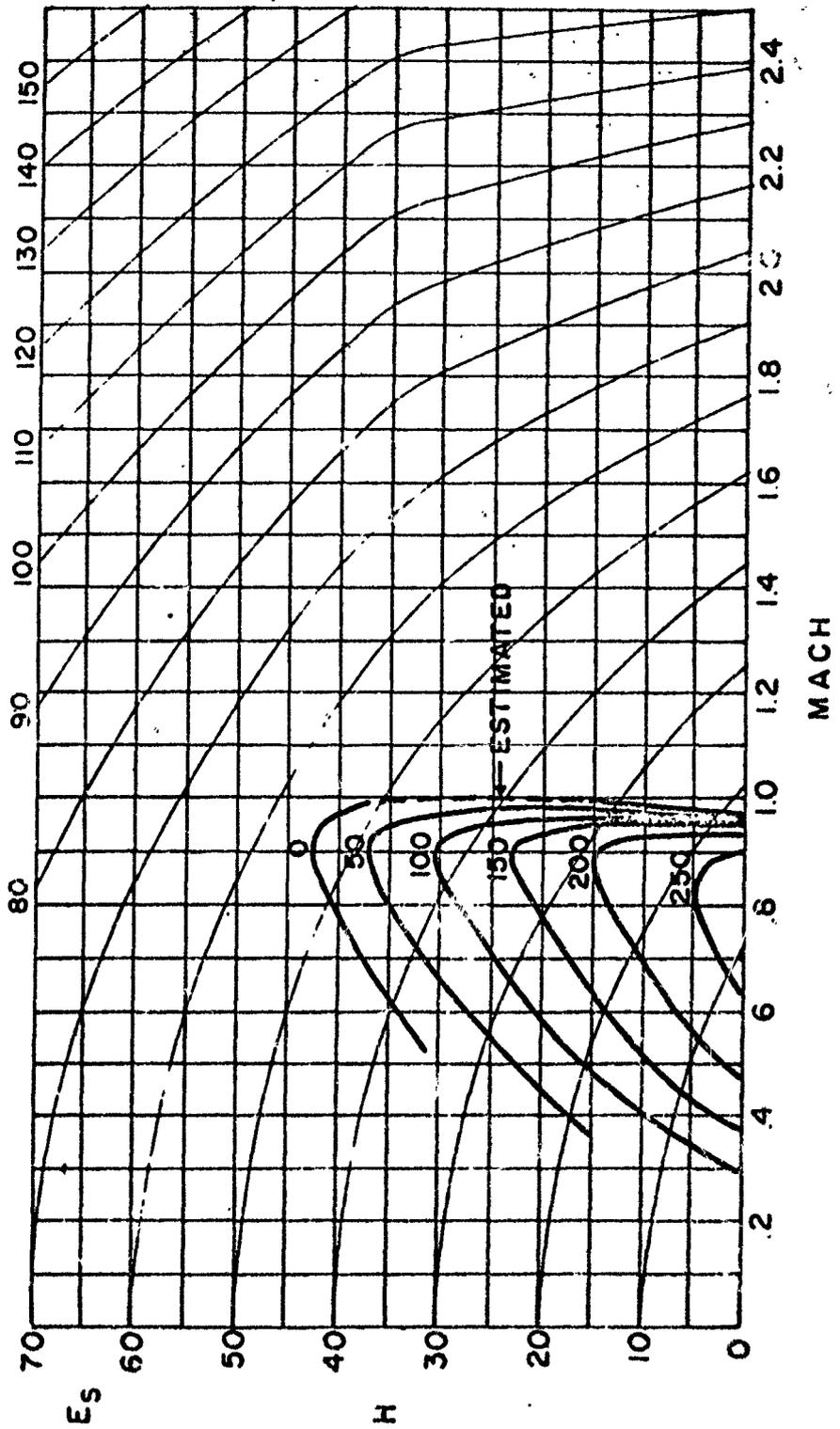
MAXIMUM POWER · 1G



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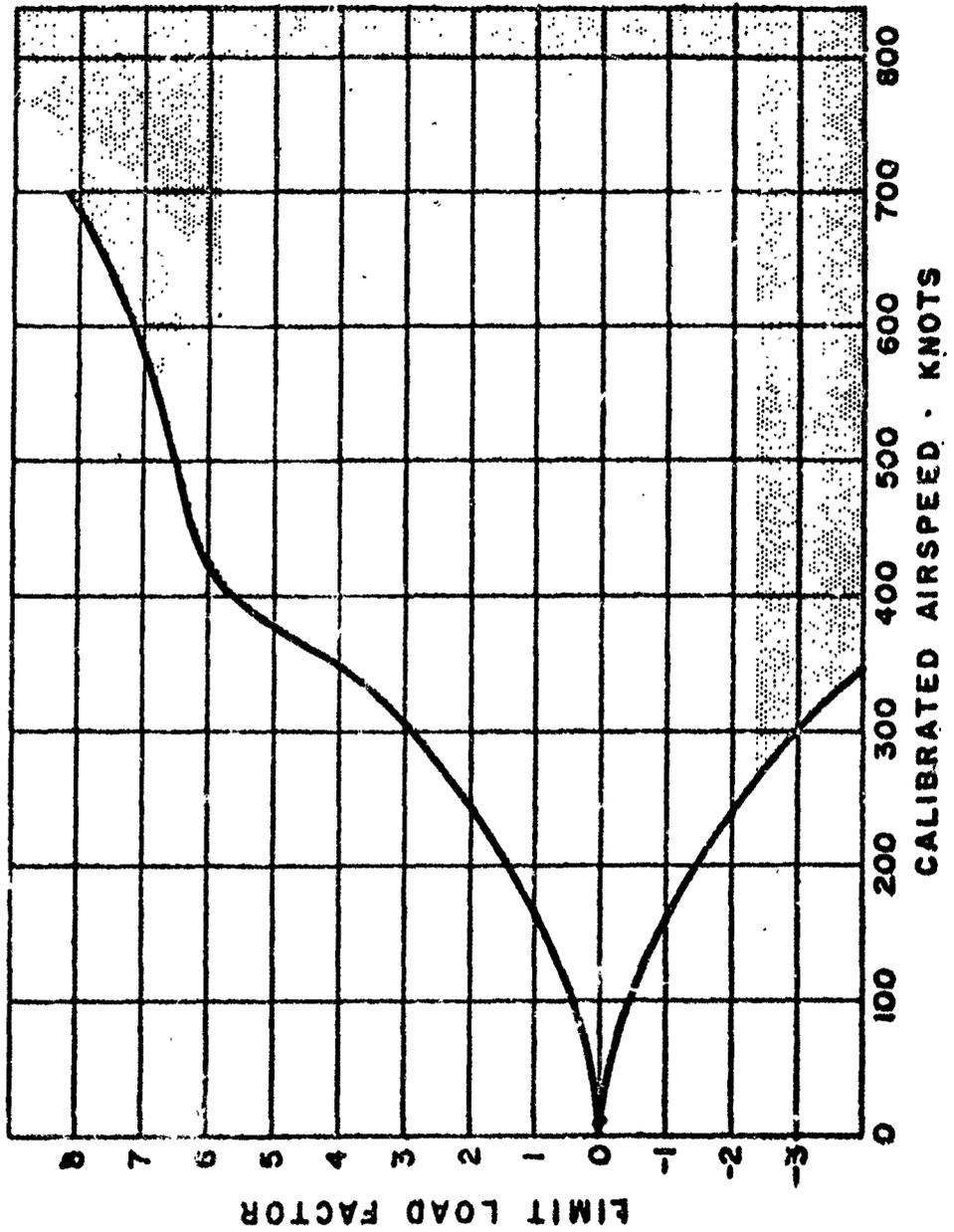
% MILITARY POWER · IG **F-104C**



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FLIGHT OPERATING LIMITS • F-105D • 30,000'

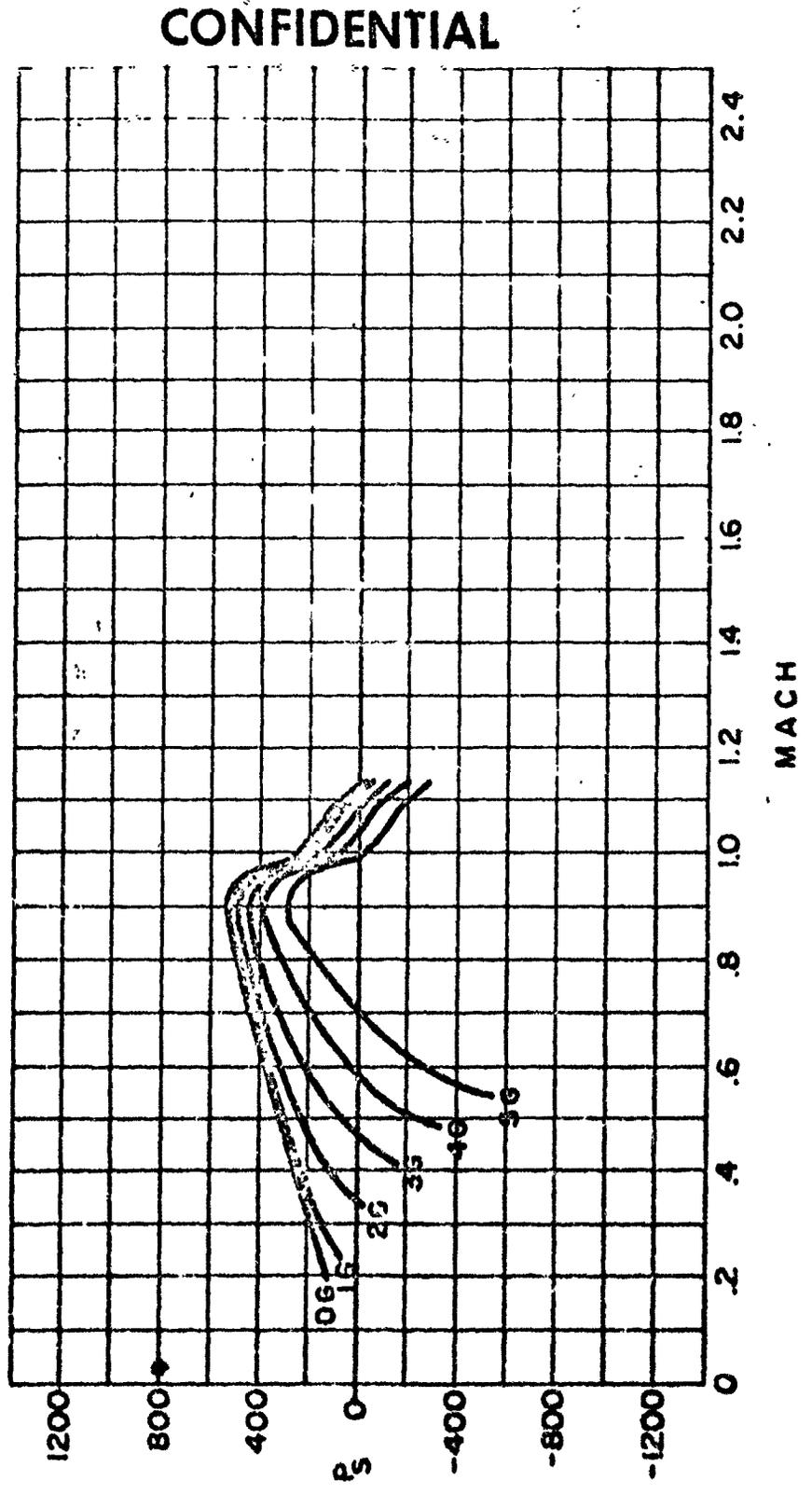


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MAXIMUM POWER · SEA LEVEL F-105D

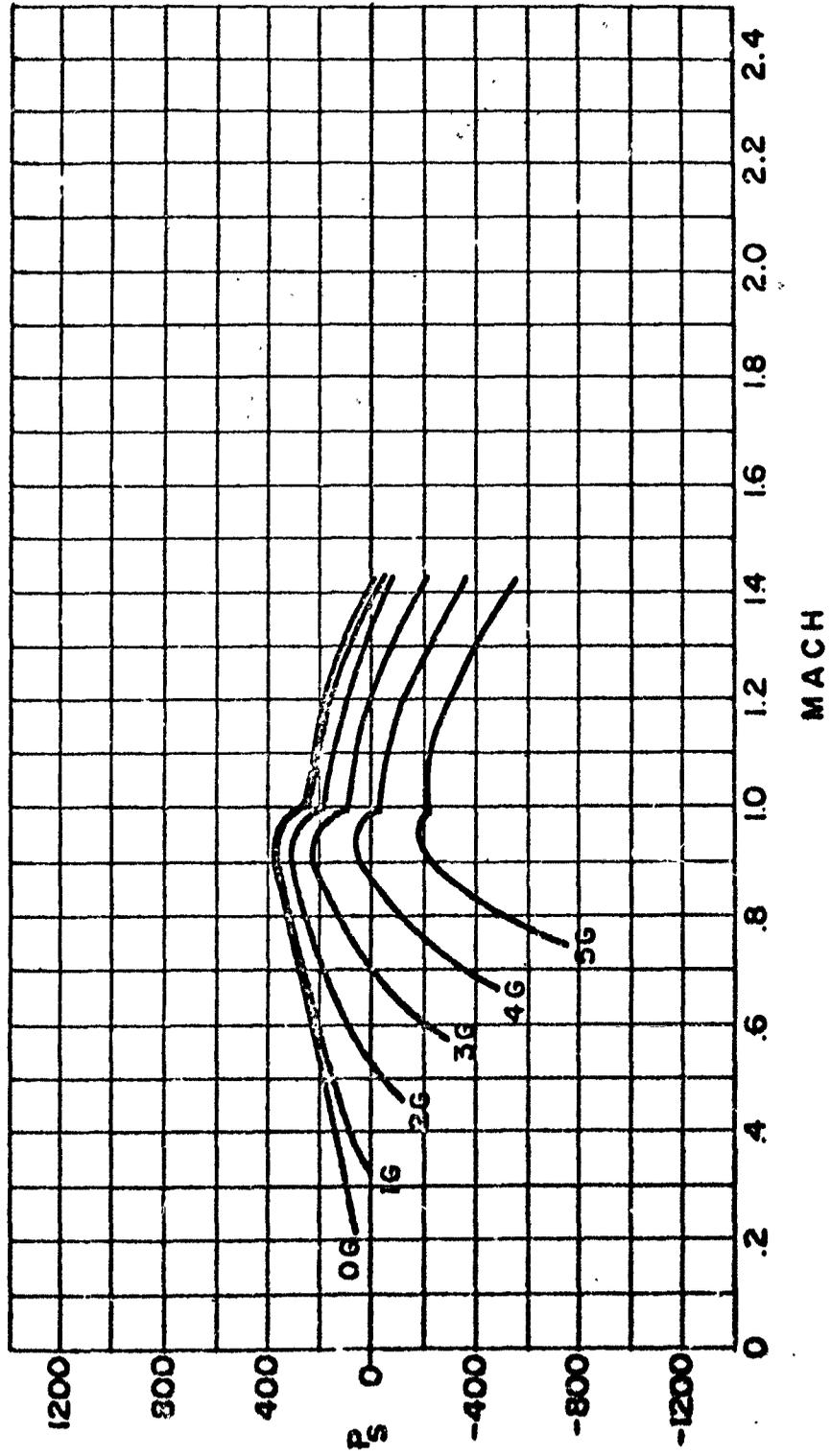
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MAXIMUM POWER · 15,000'

F-105D



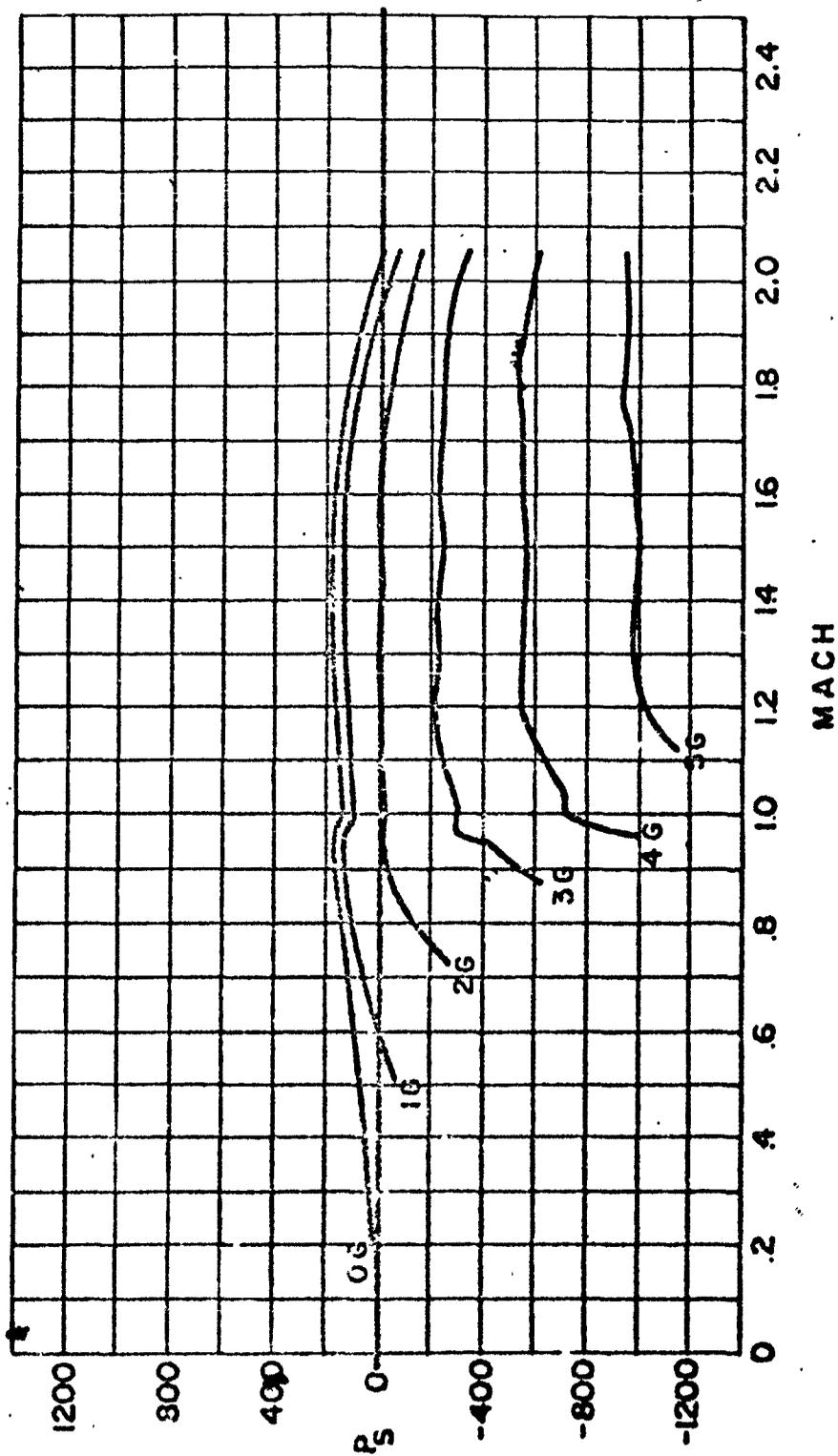
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MAXIMUM POWER · 35,000'

F-105D

102

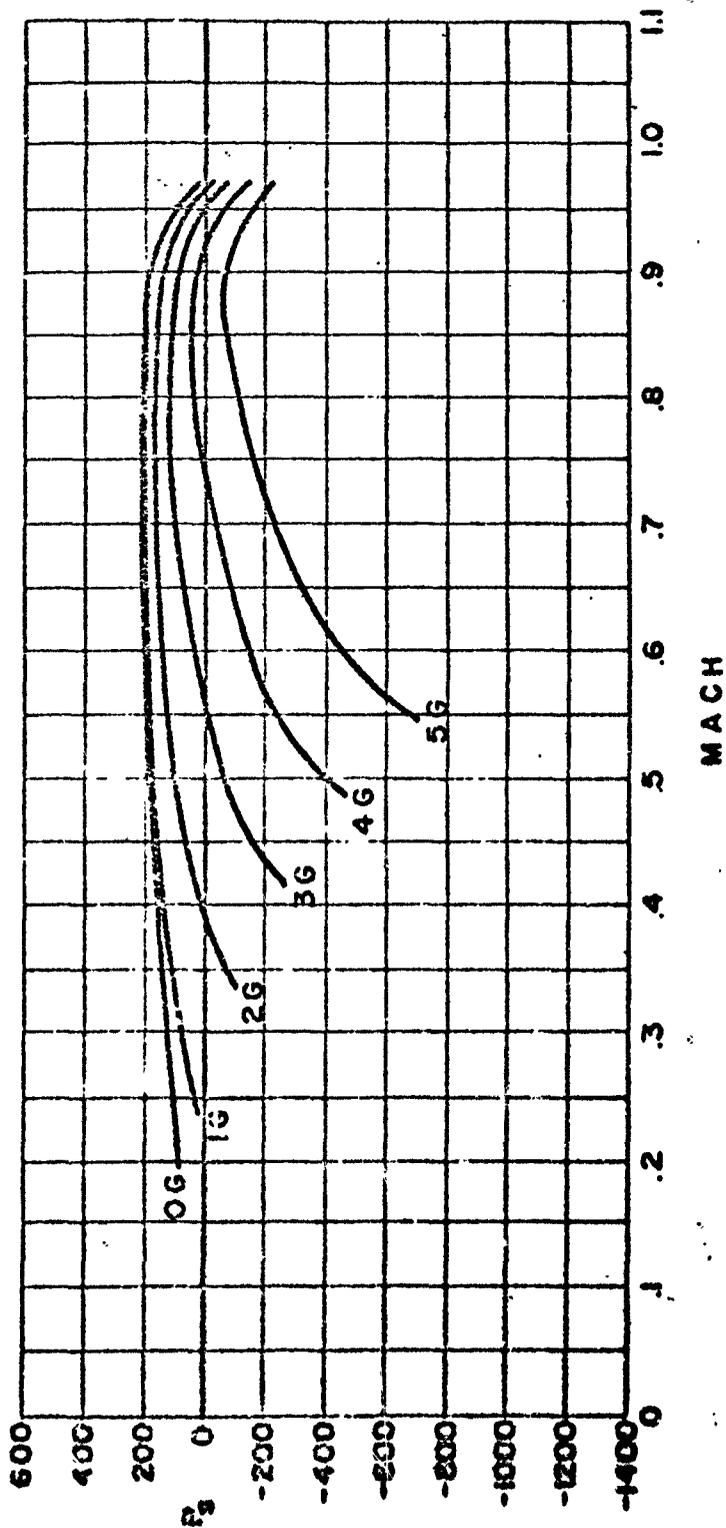


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MILITARY POWER · SEA LEVEL

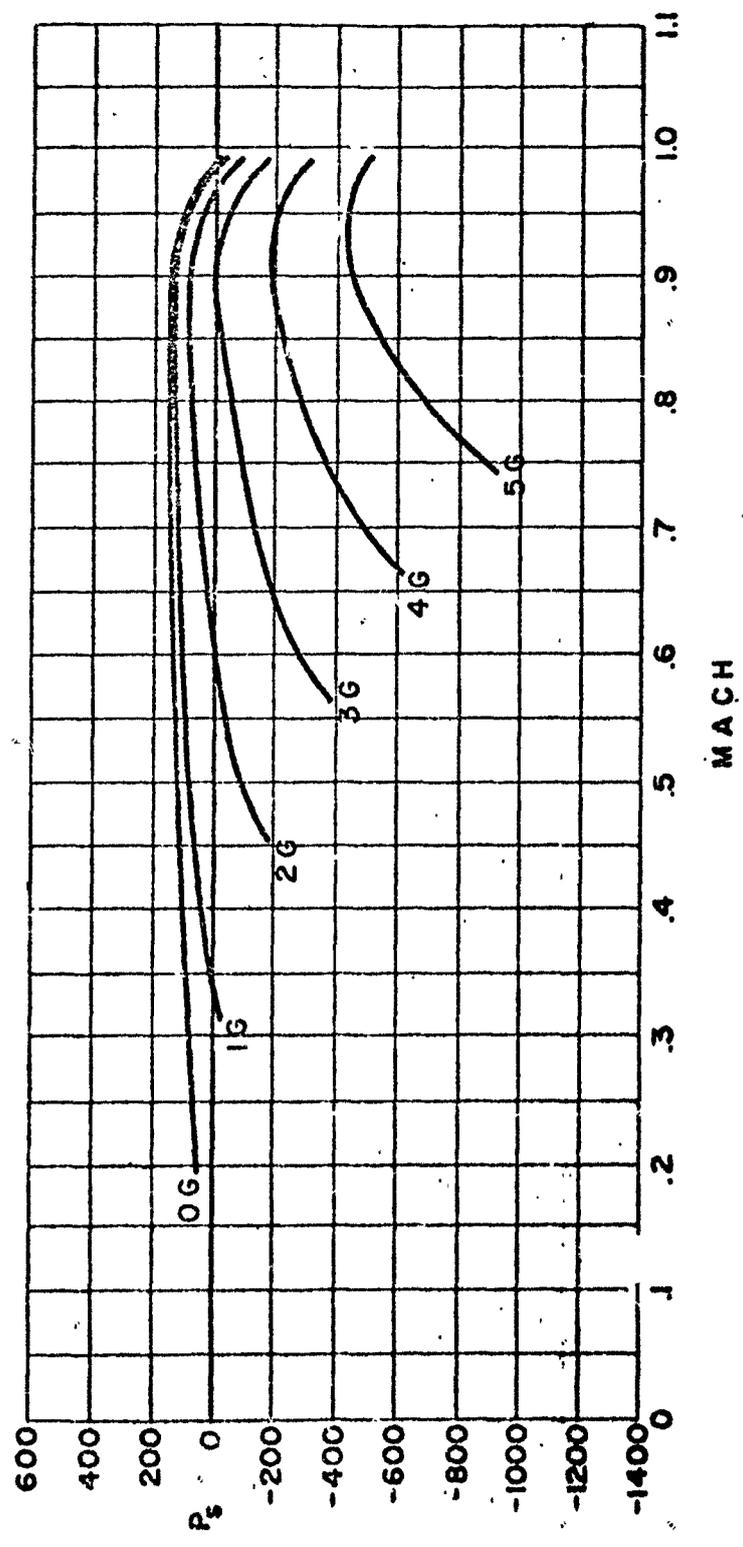
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MILITARY POWER · 15,000'

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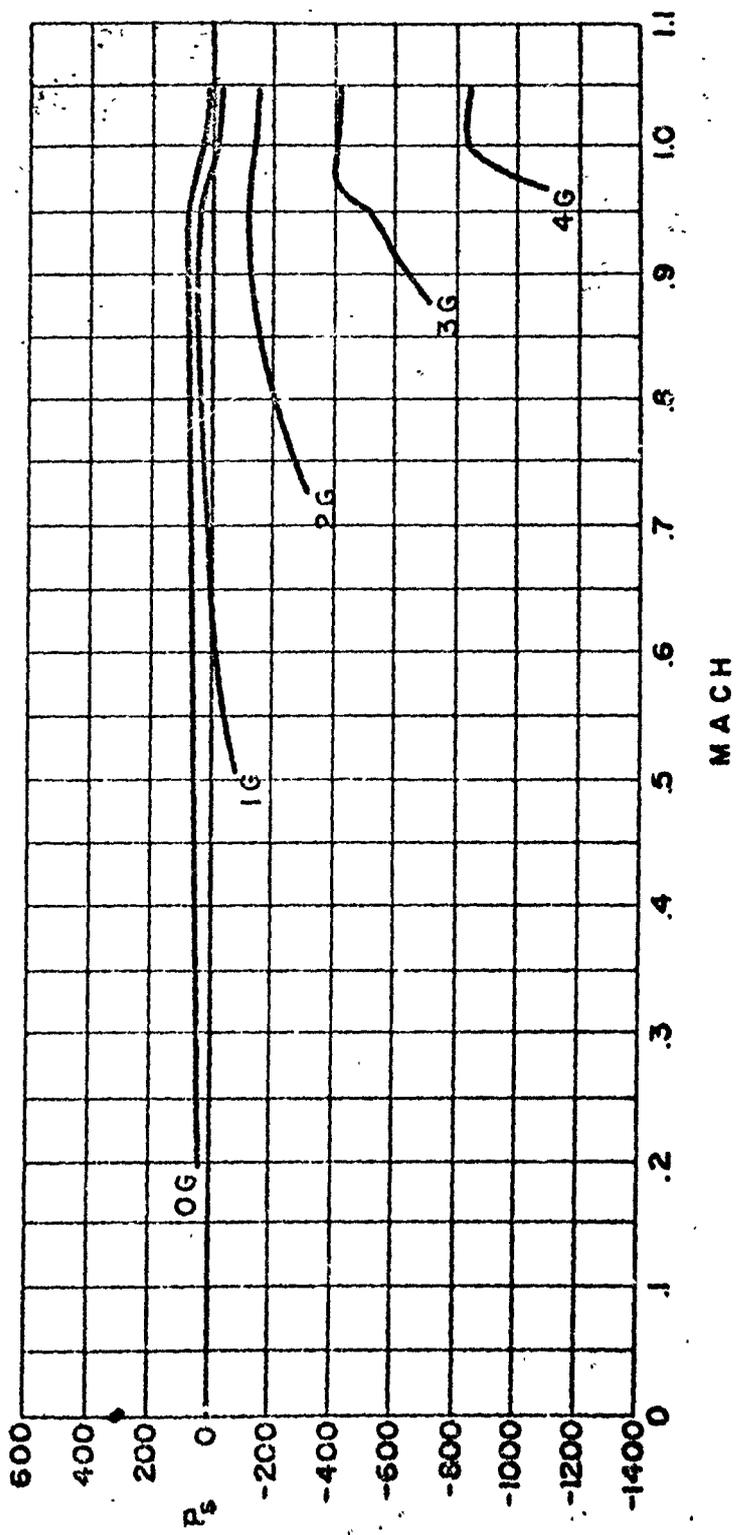


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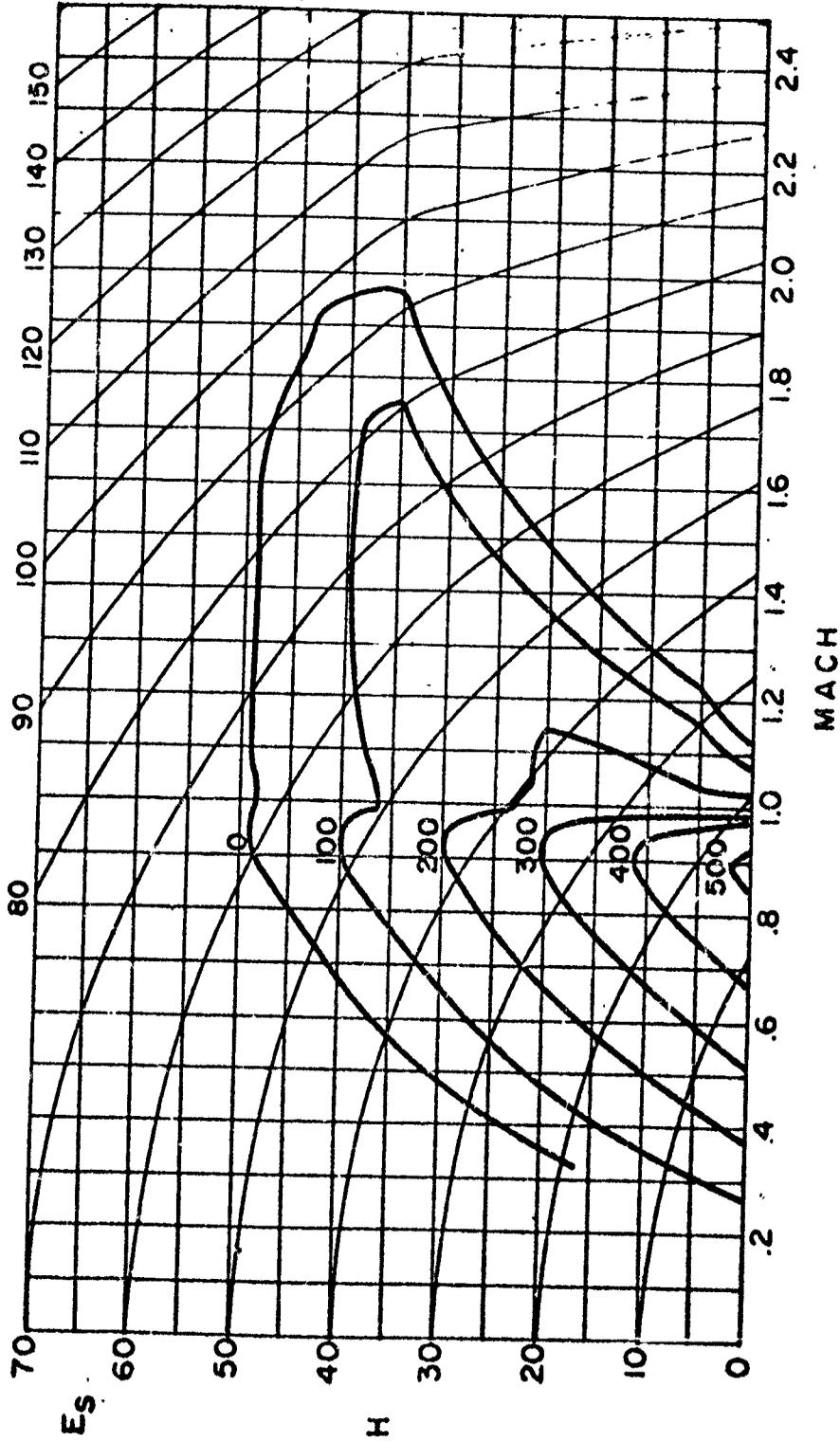
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106 **MAXIMUM POWER · IG** **F-105D**

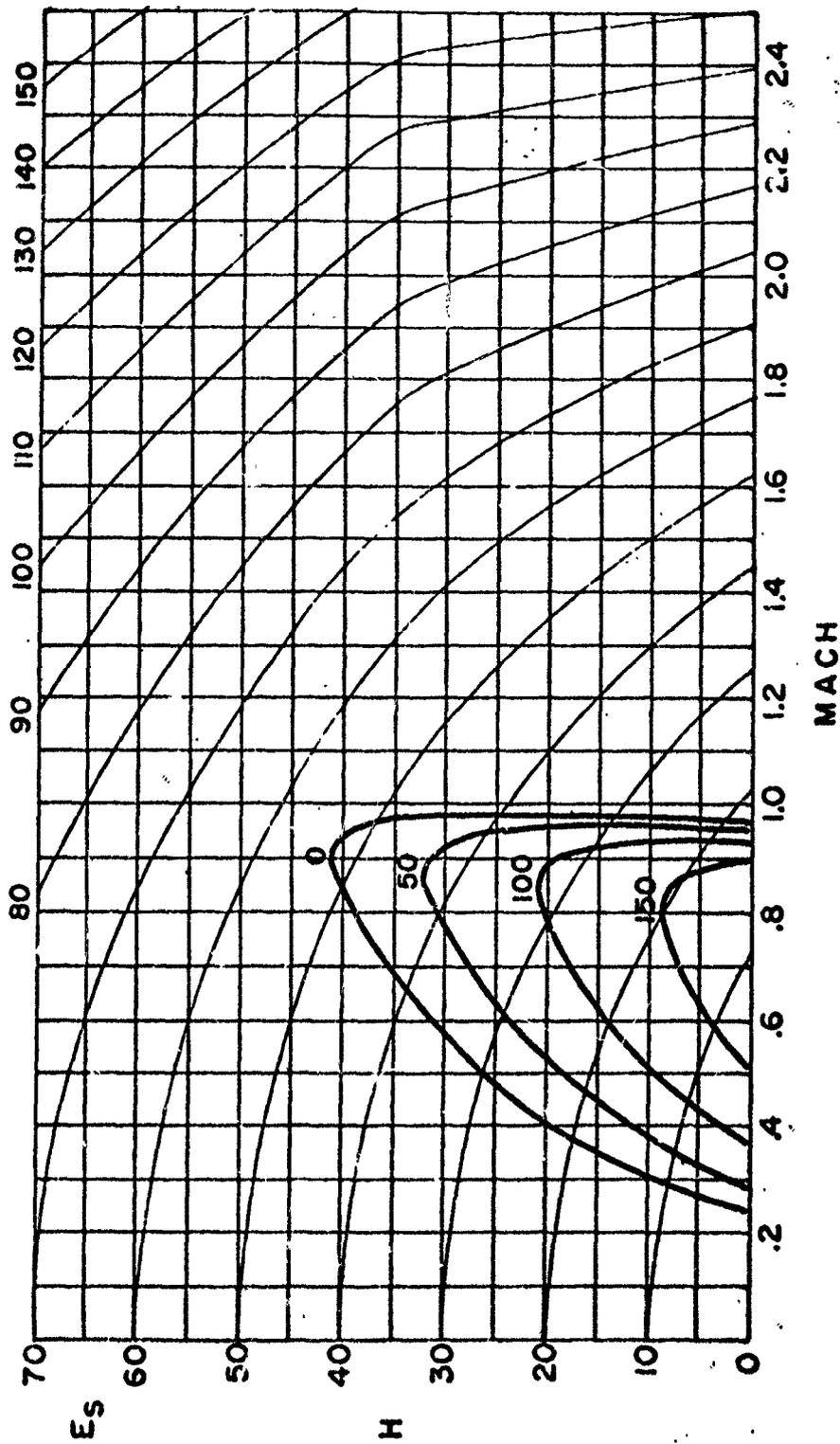


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188 **MILITARY POWER · IG** **F-105D**

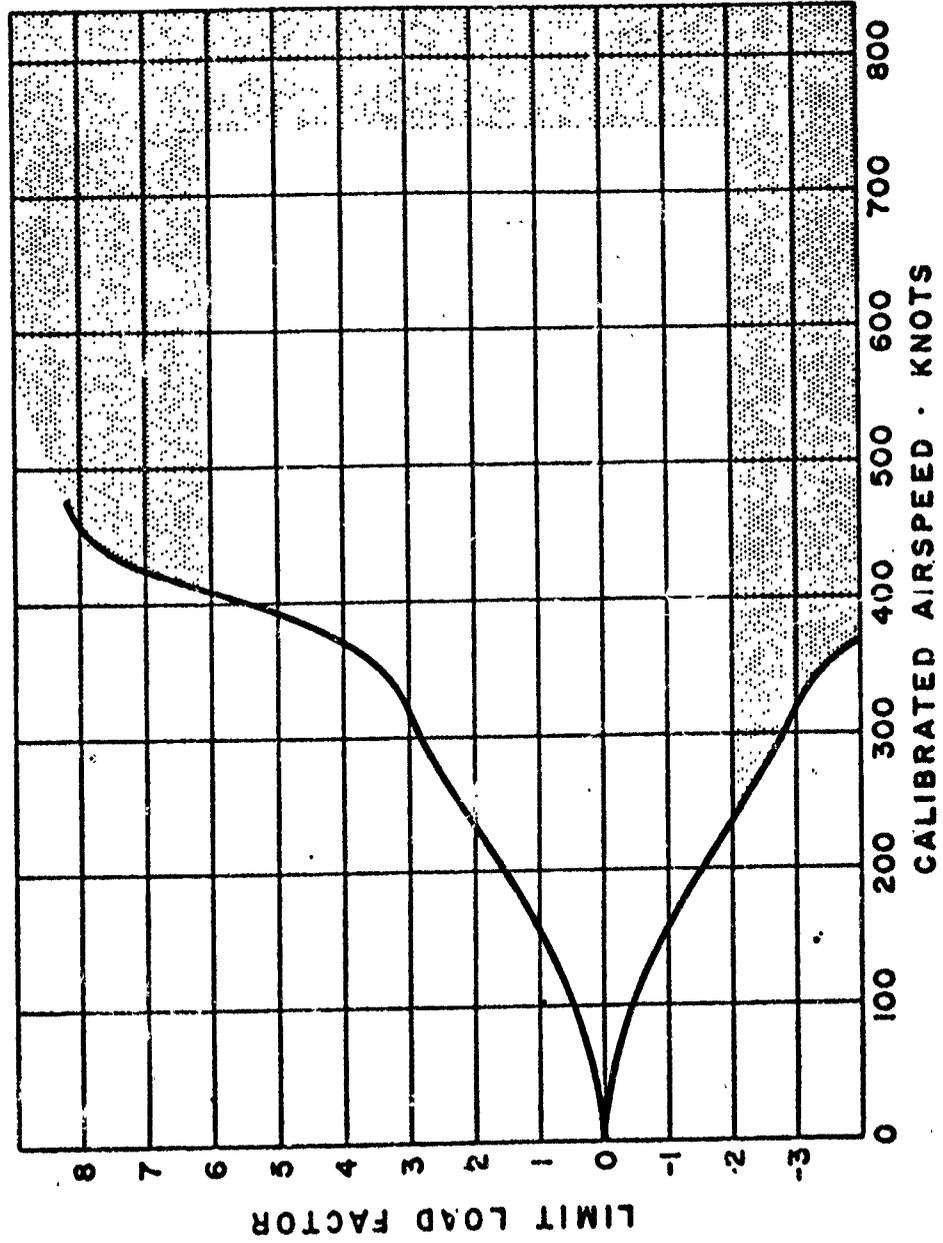
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FLIGHT OPERATING LIMITS · F-4C · 30,000'



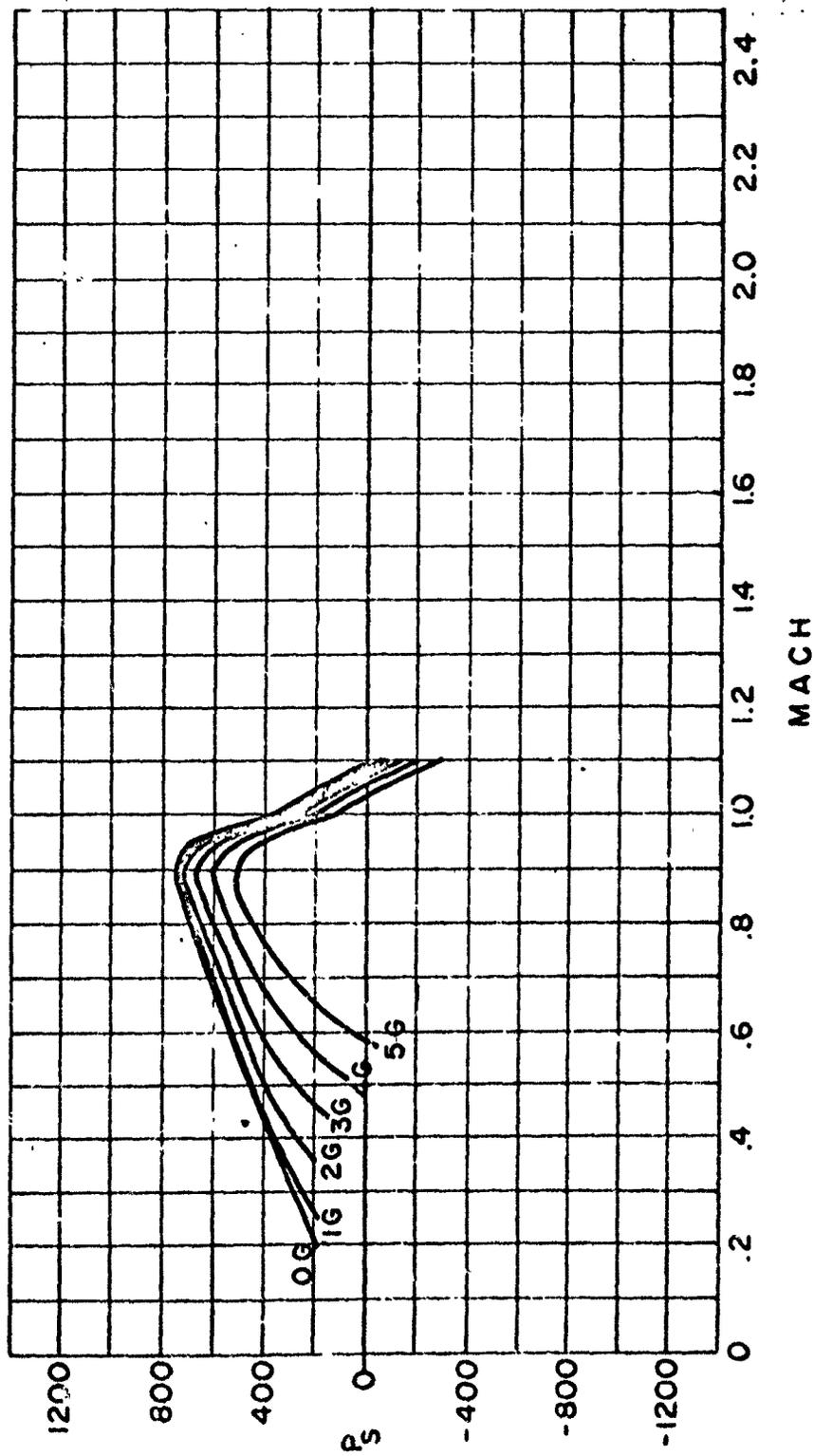
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MAXIMUM POWER · SEA LEVEL F-4C

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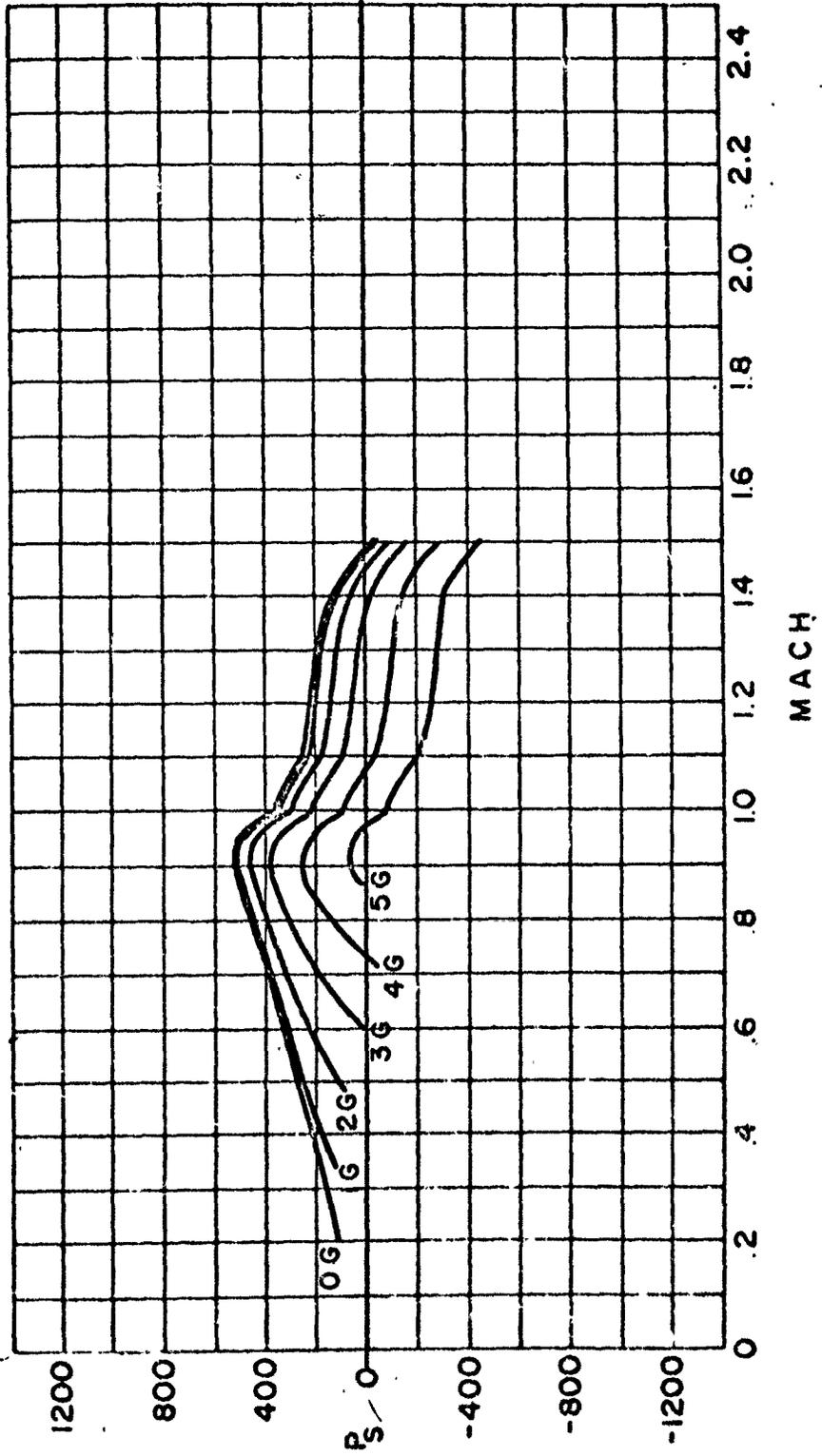


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MAXIMUM POWER · 15,000' F-4C

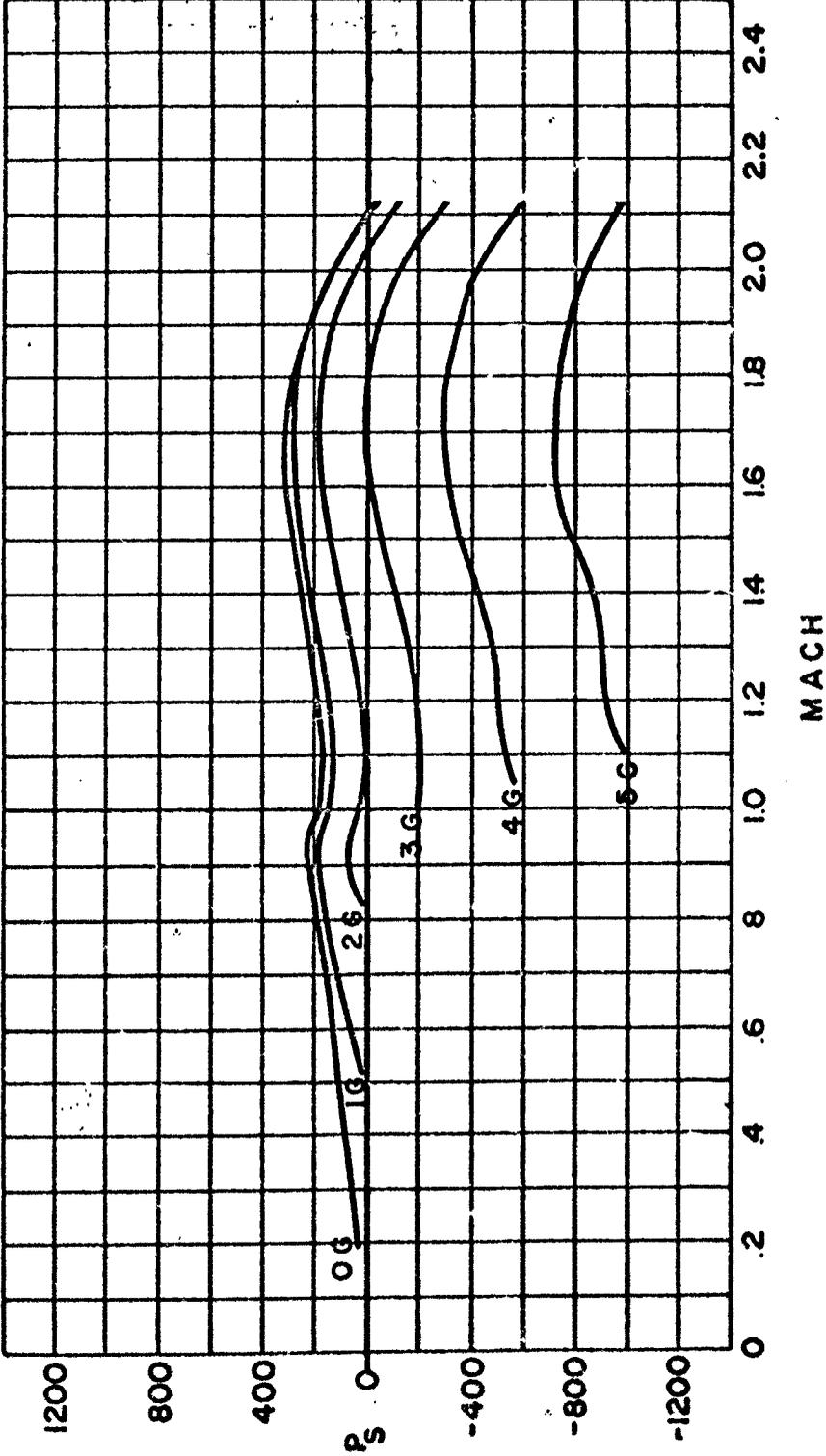


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MAXIMUM POWER · 35,000'

F-4C

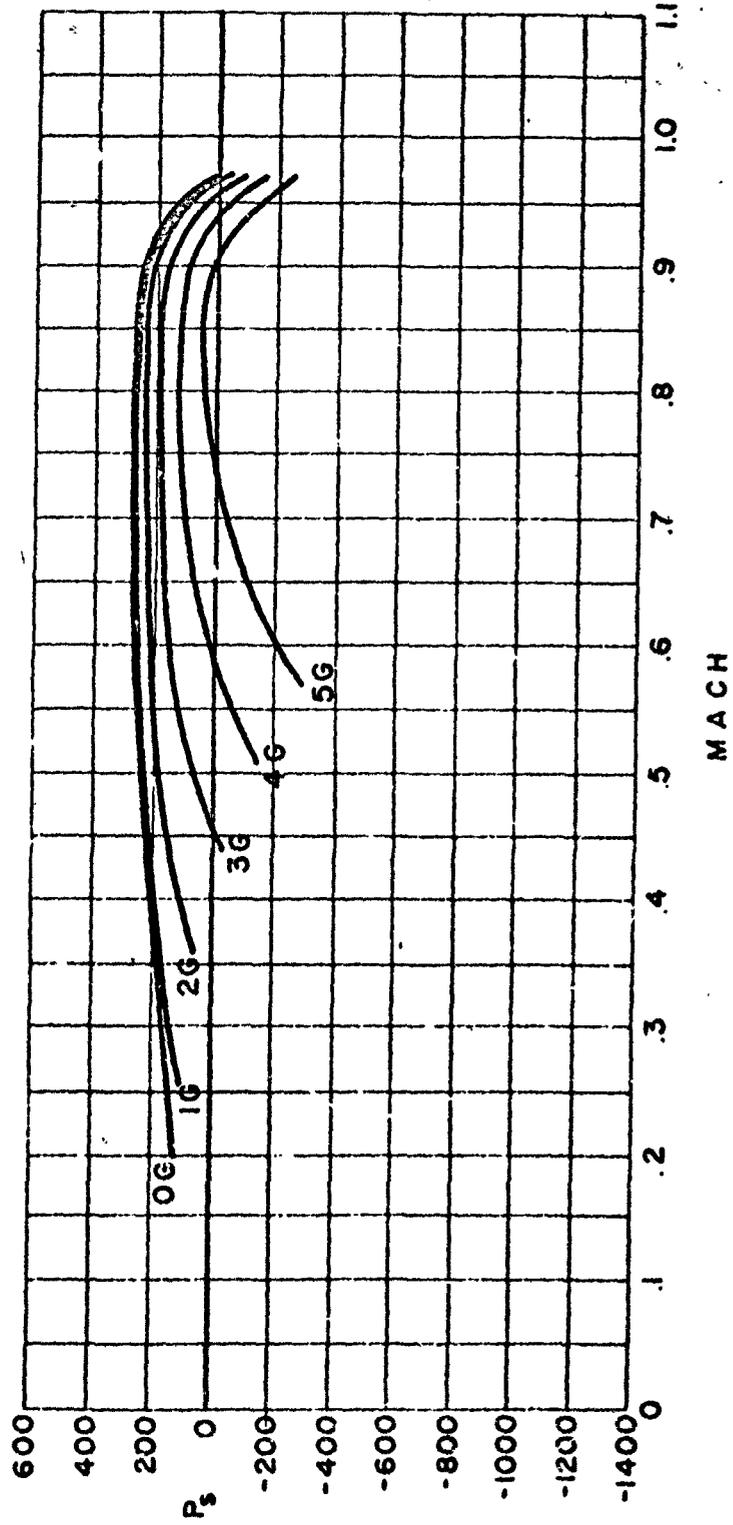
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MILITARY POWER · SEA LEVEL

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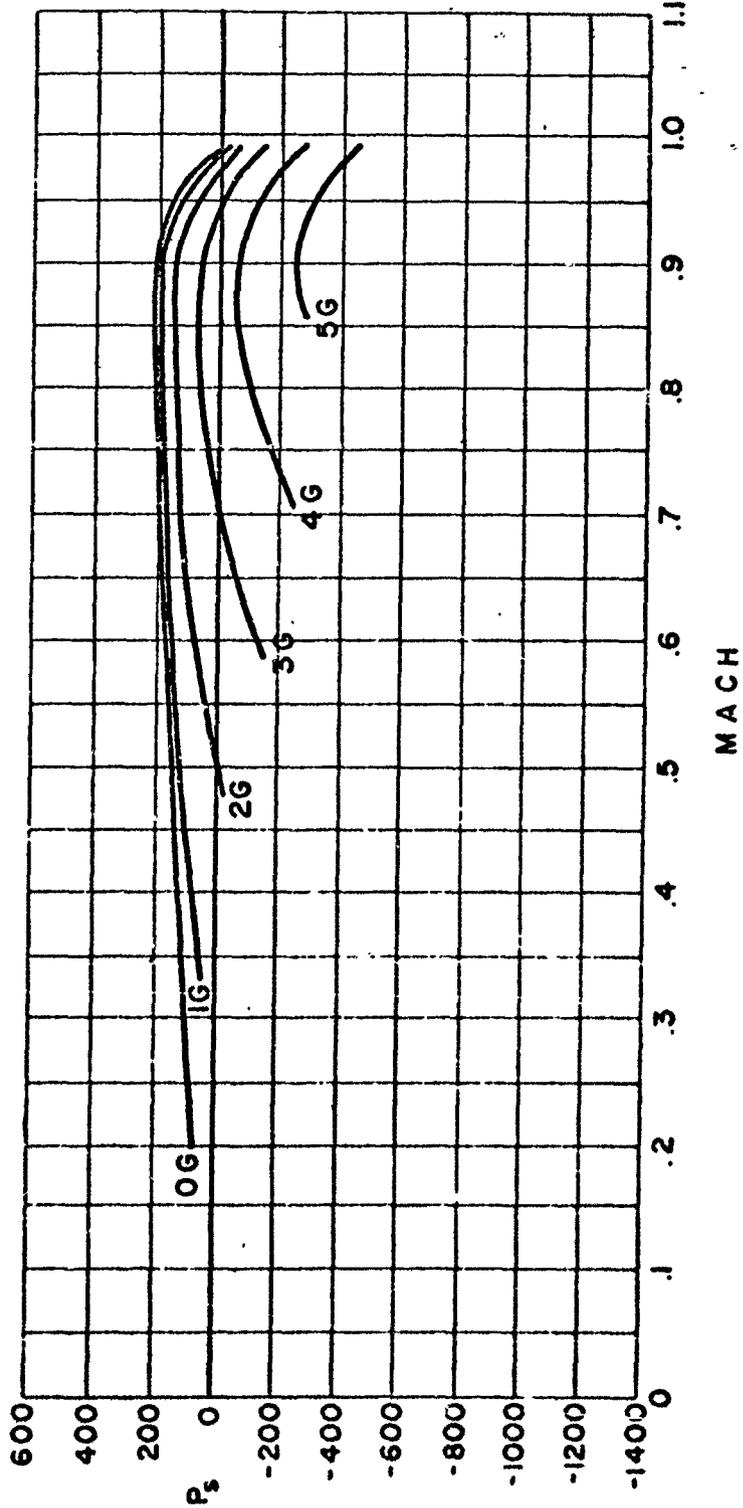


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MILITARY POWER · 15,000'

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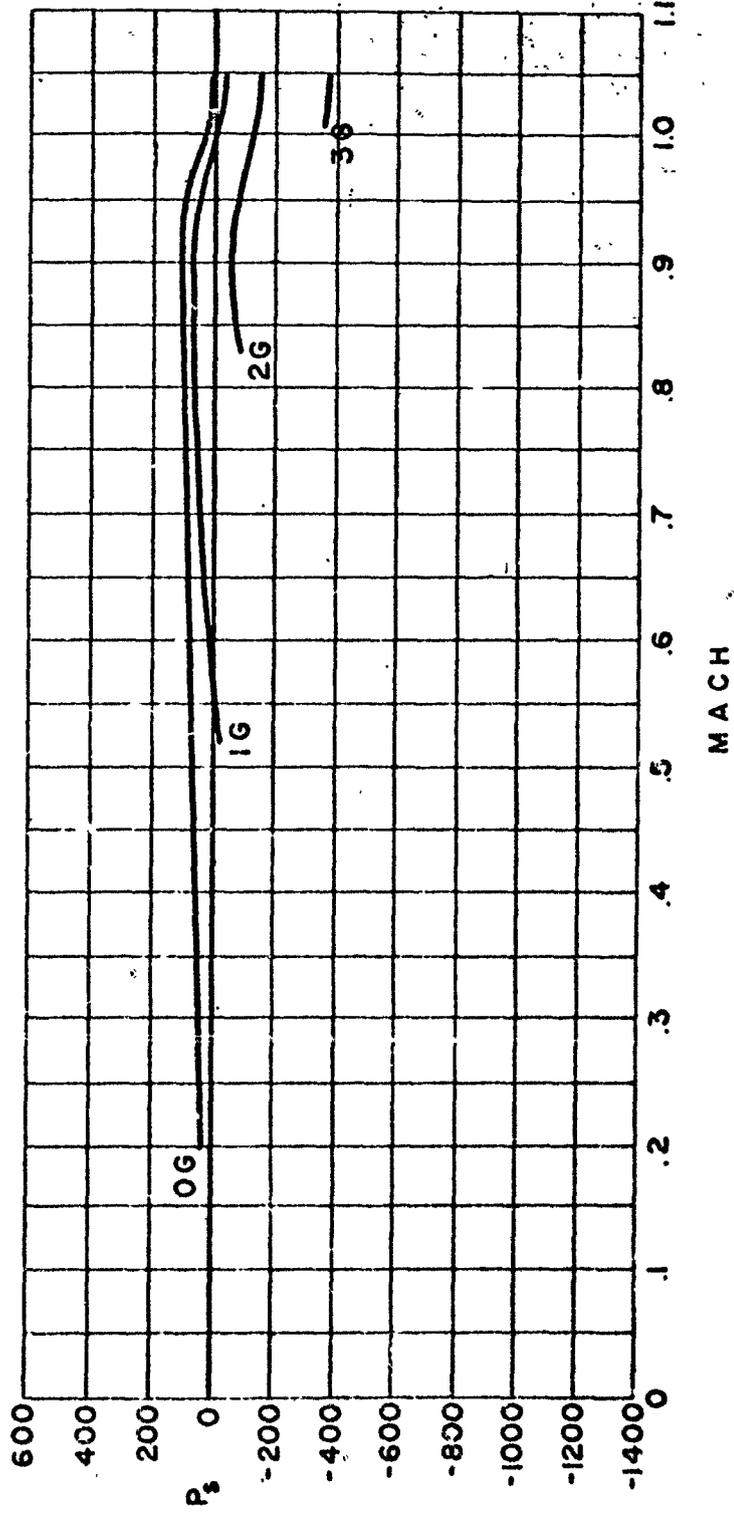


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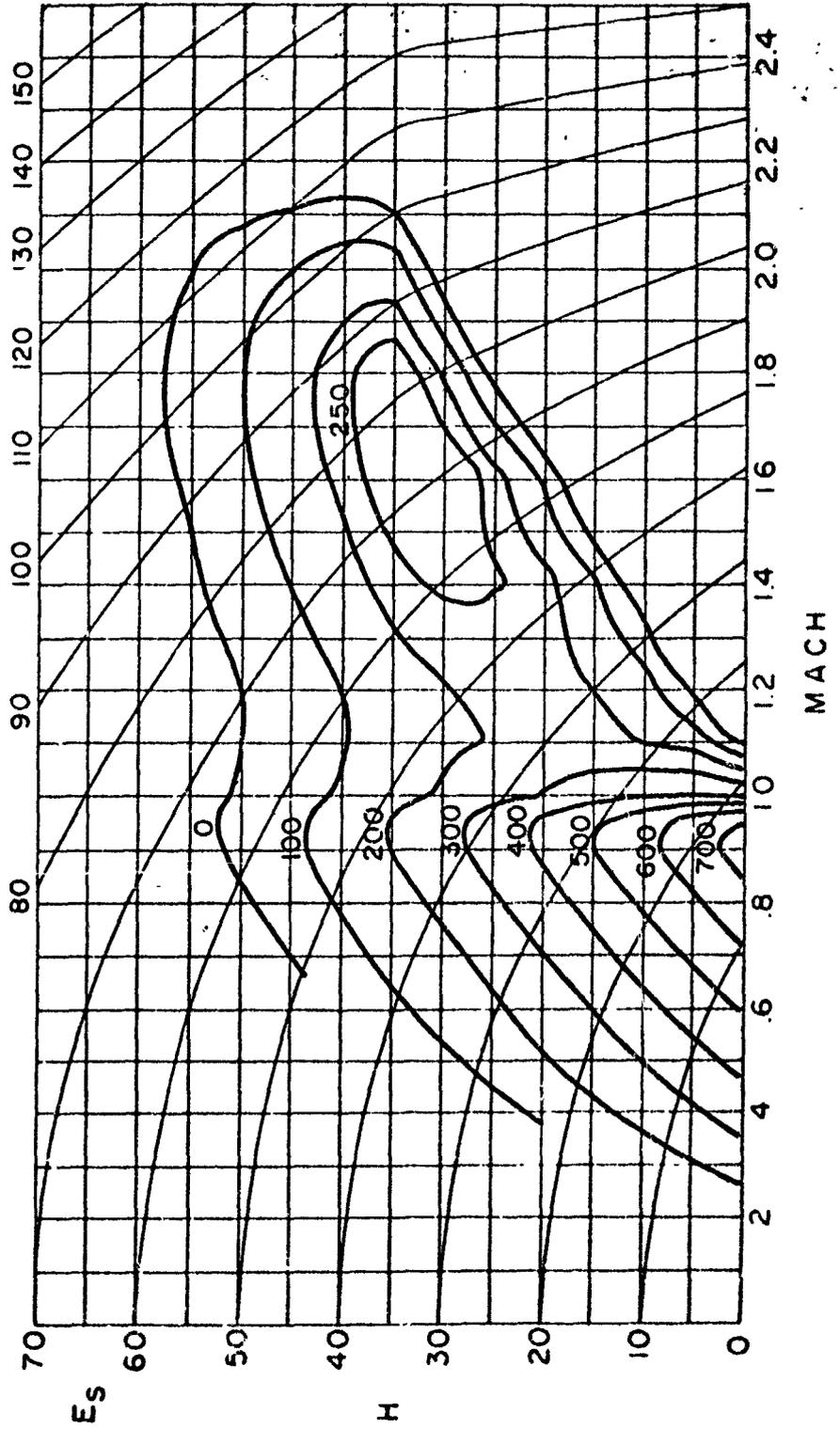


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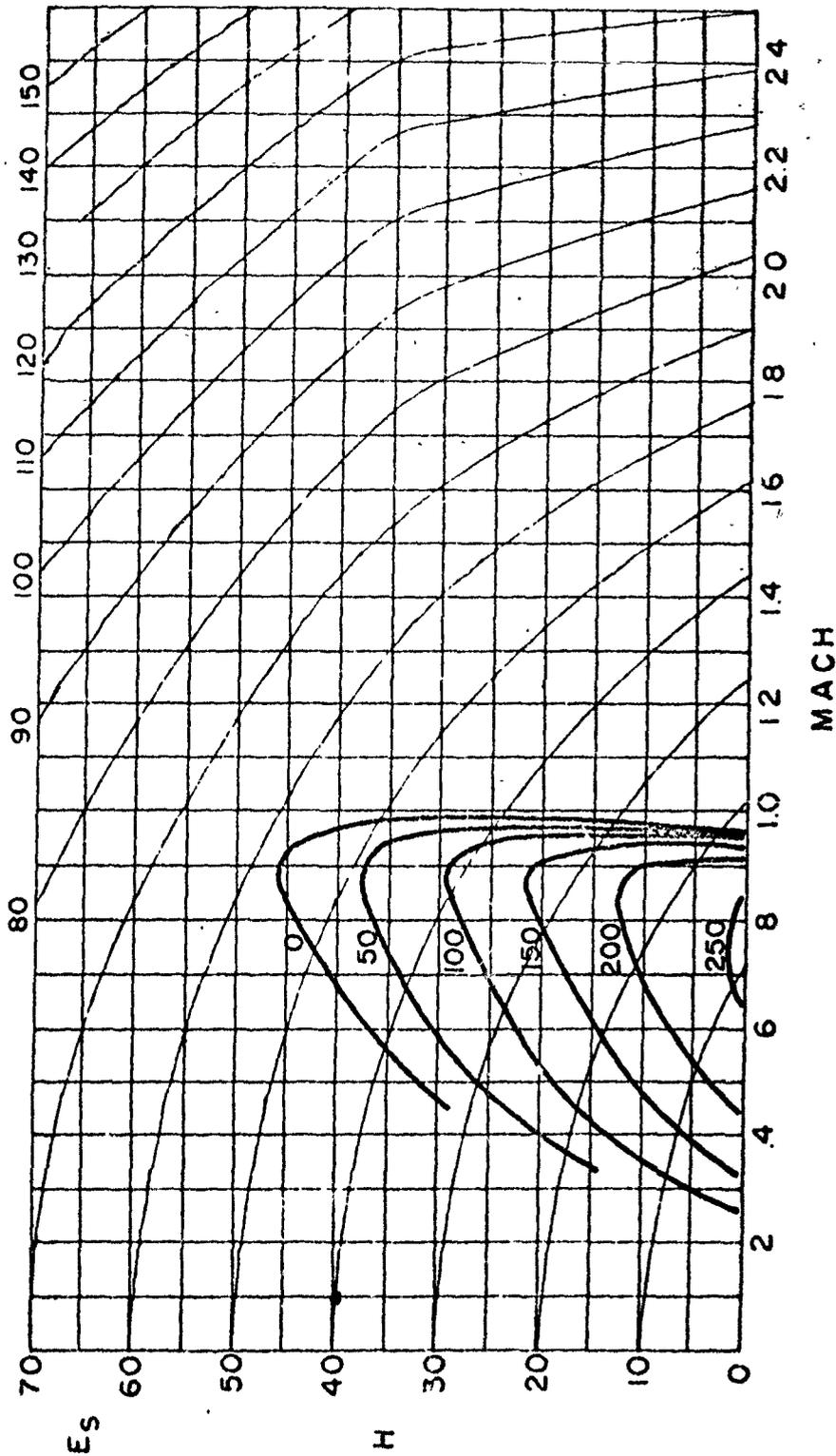


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MILITARY POWER · IG

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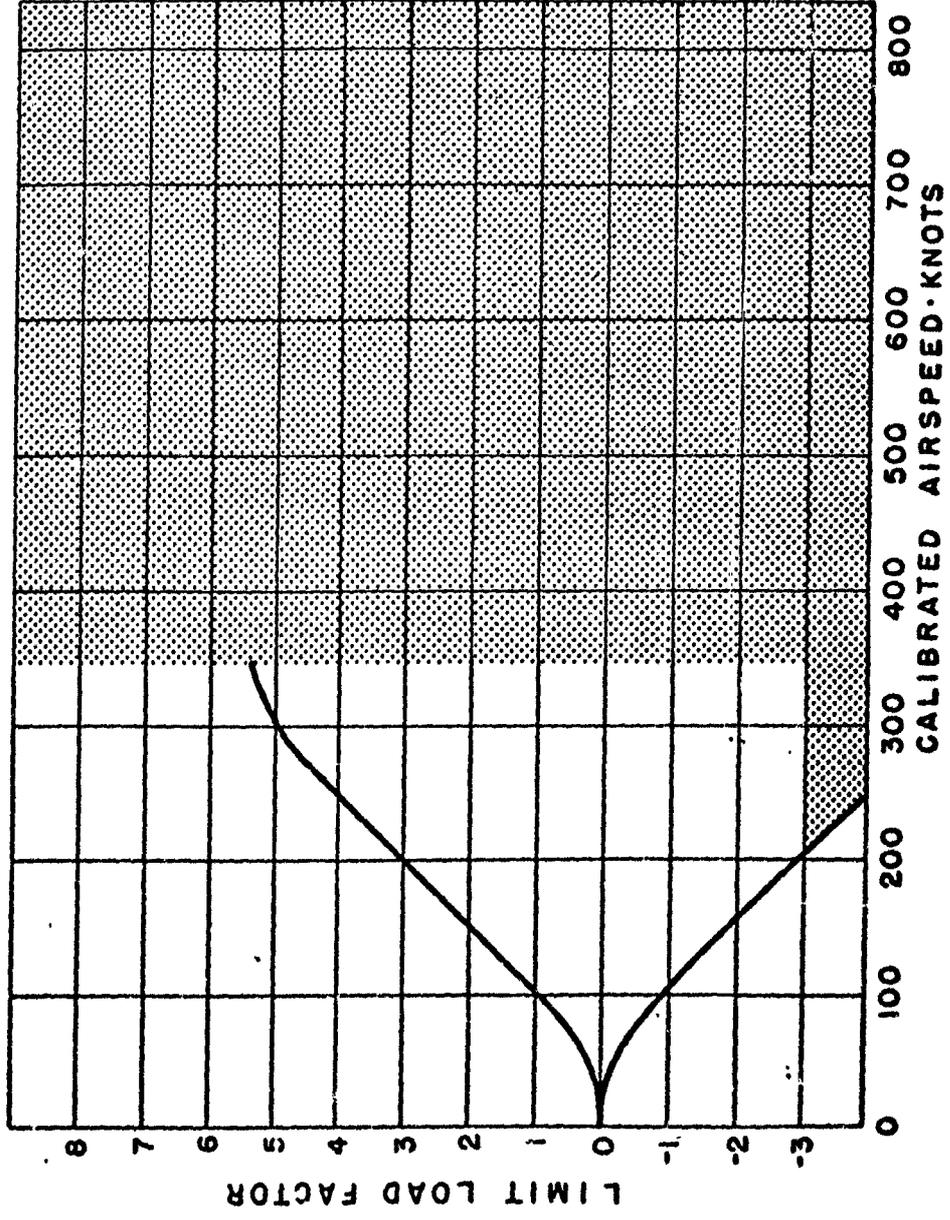


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FLIGHT OPERATING LIMITS 30,000'

MIG-15

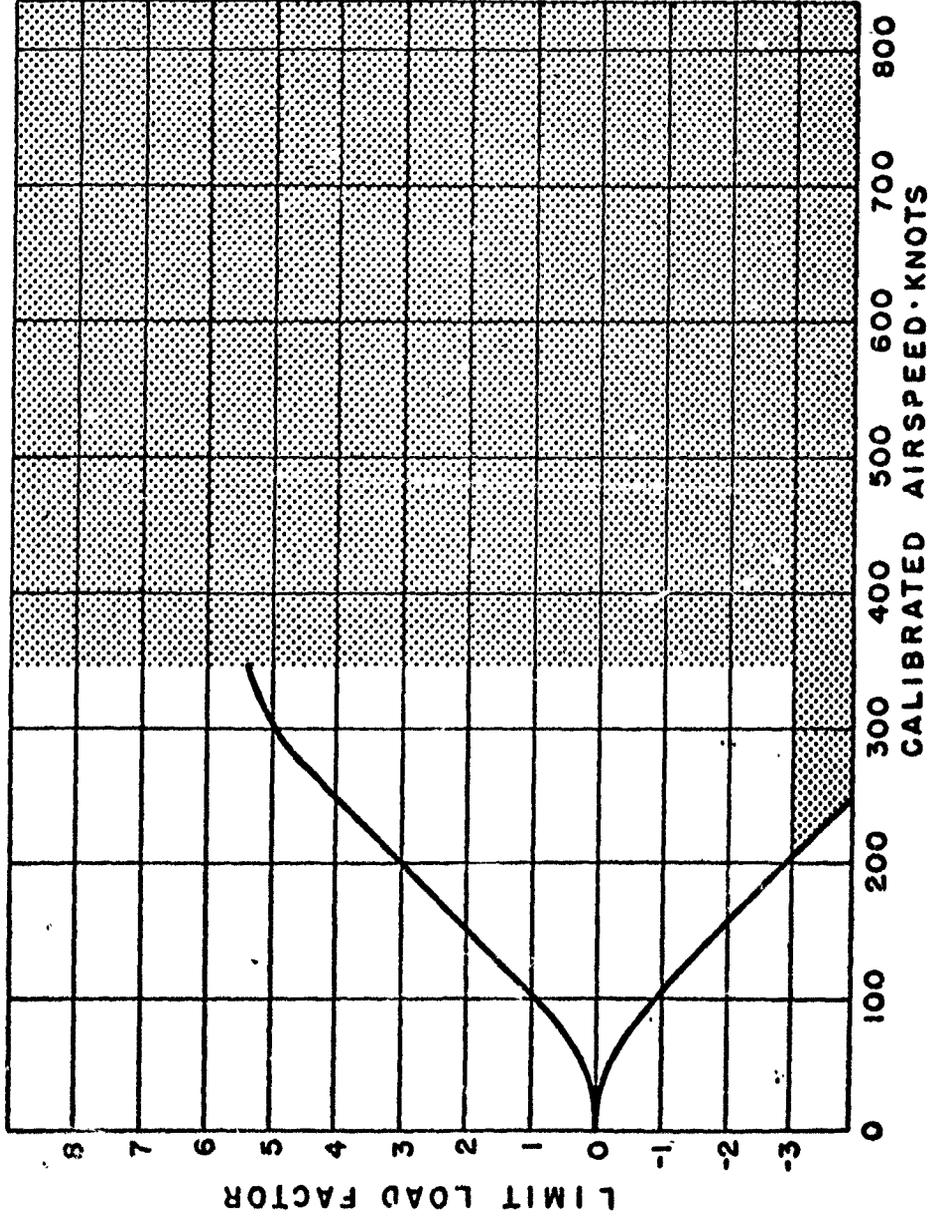


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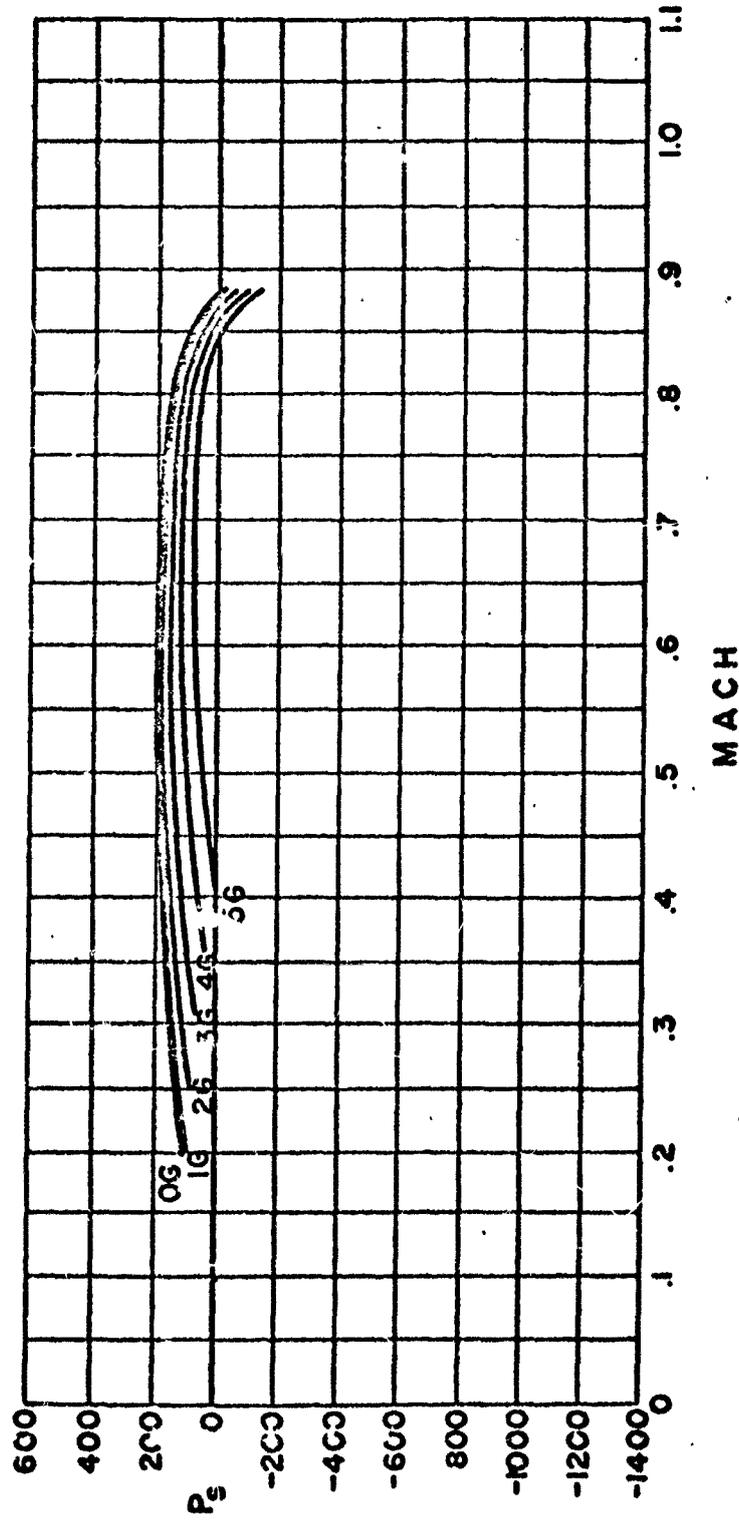


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MILITARY POWER · SEA LEVEL

MIG-15

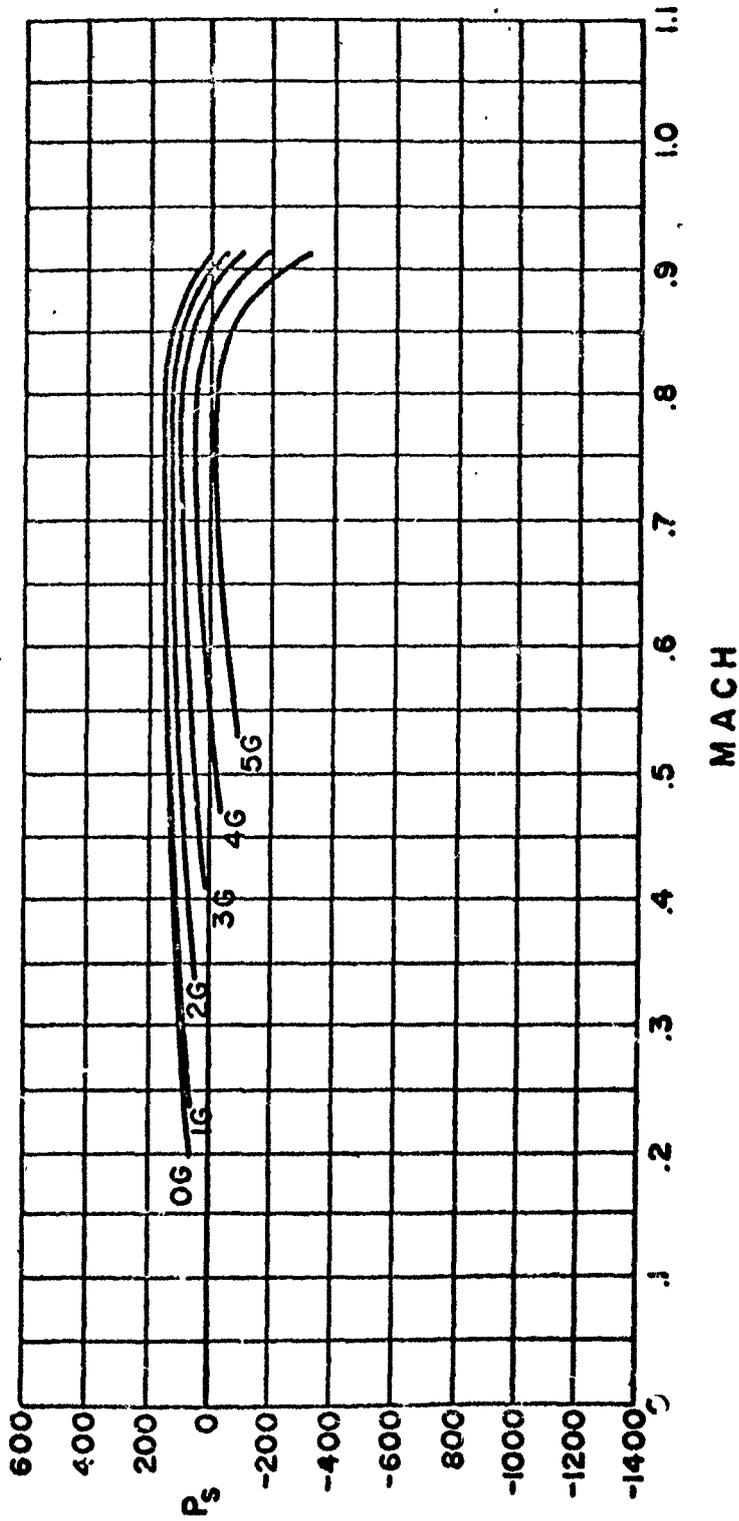


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MILITARY POWER · 15,000'

MIG-15

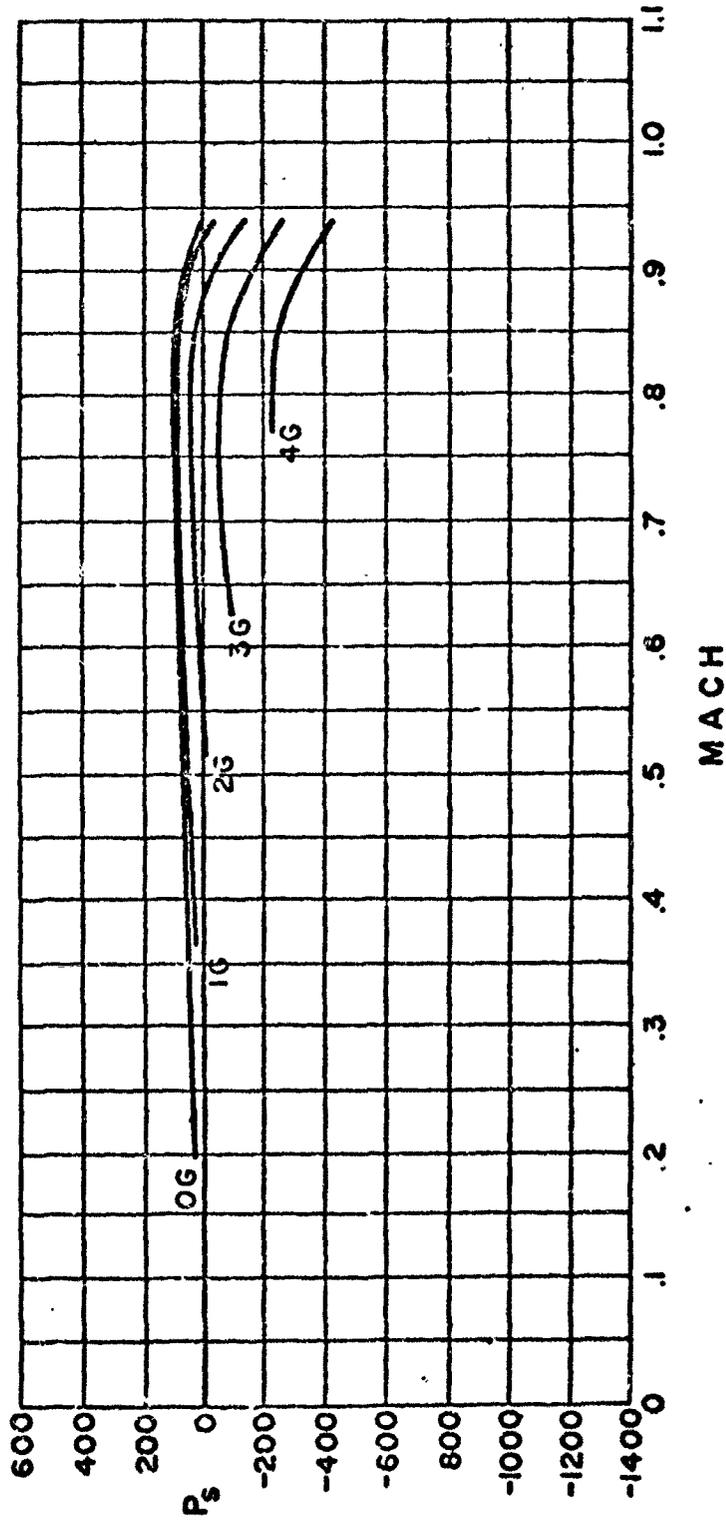


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MILITARY POWER - 35,000'

MIG-15

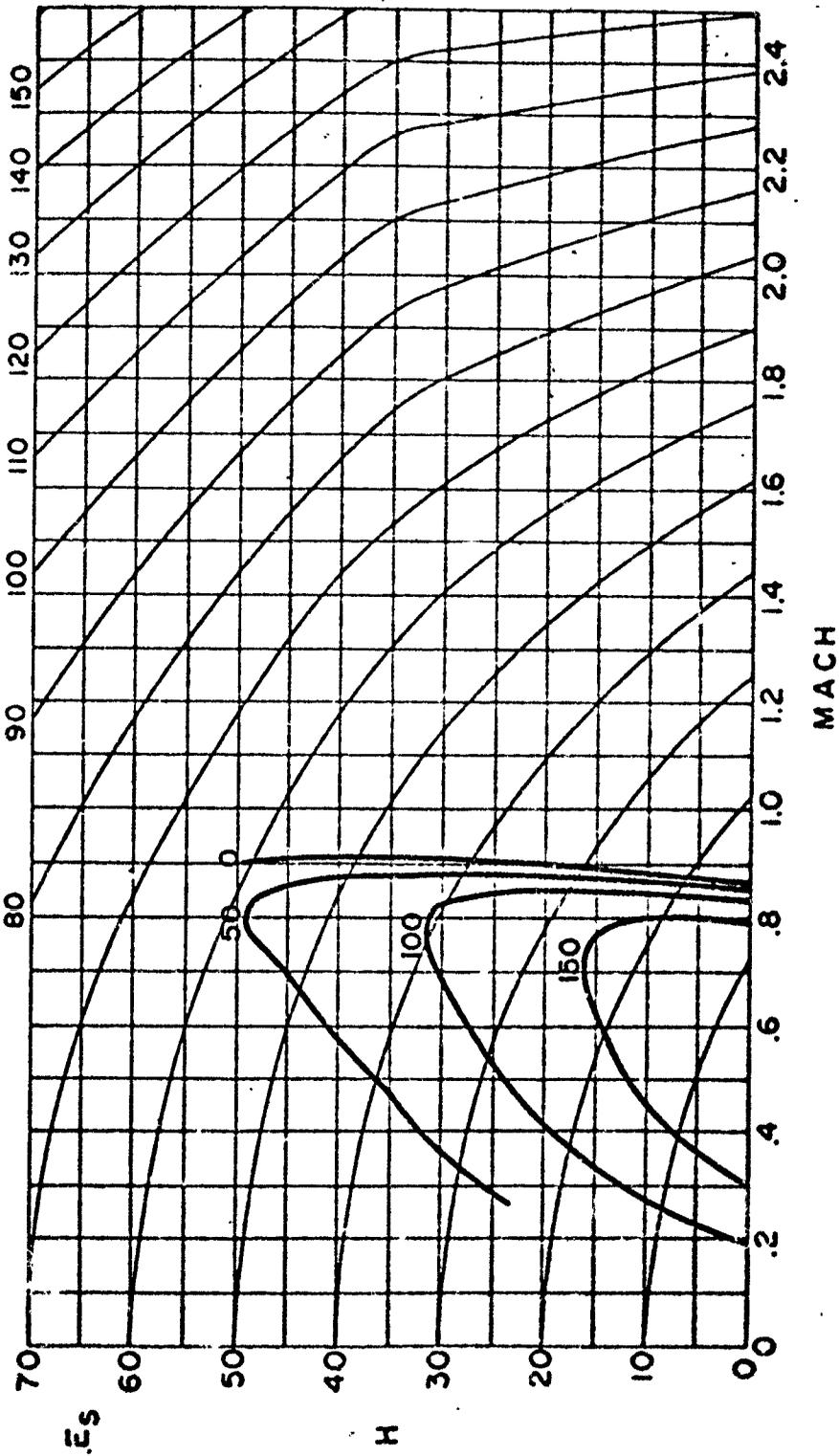


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ENERGY RATE MILITARY POWER · IG

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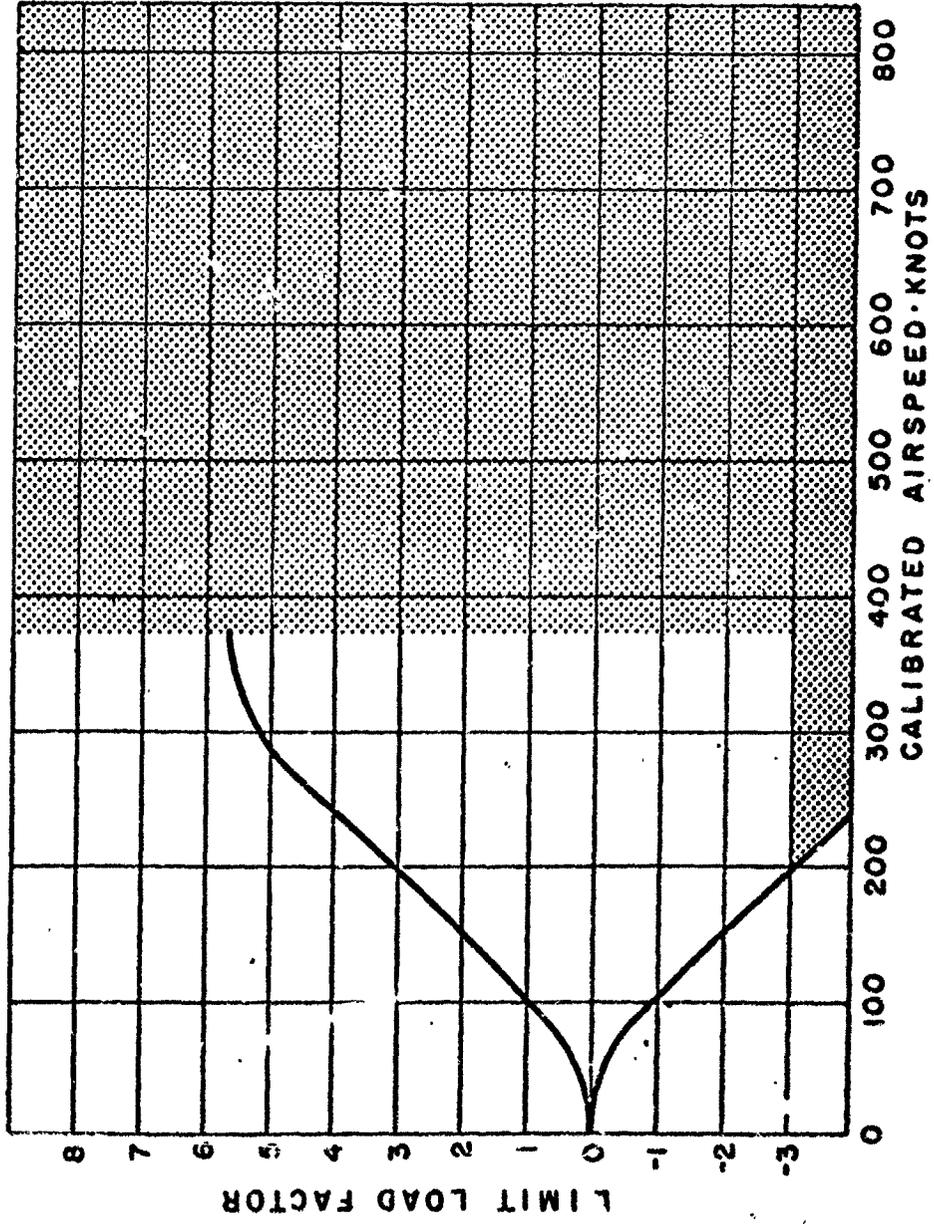


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FLIGHT OPERATING LIMITS 30,000'

MIG-17

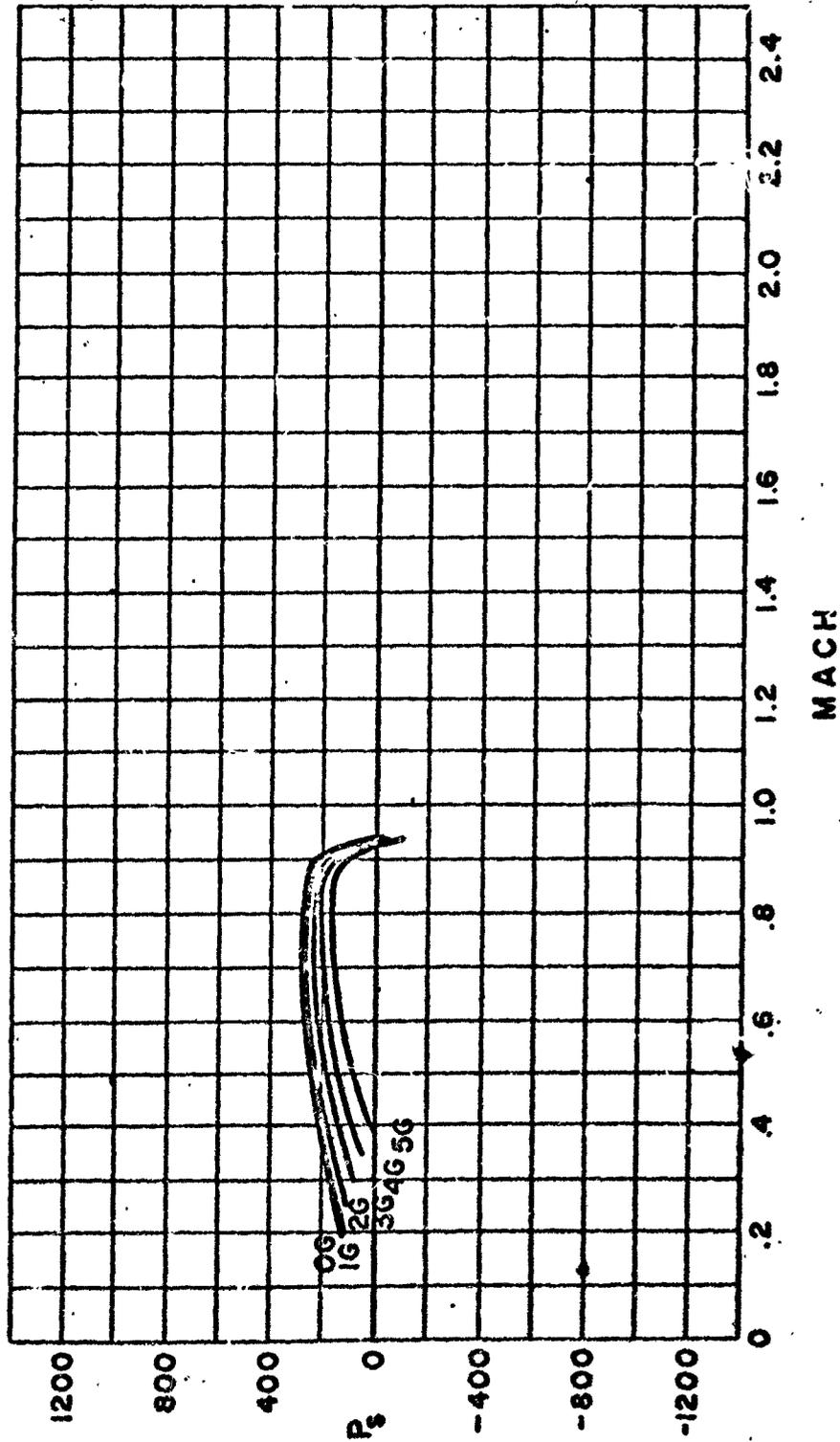


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MAXIMUM POWER · SEA LEVEL

MIG-17

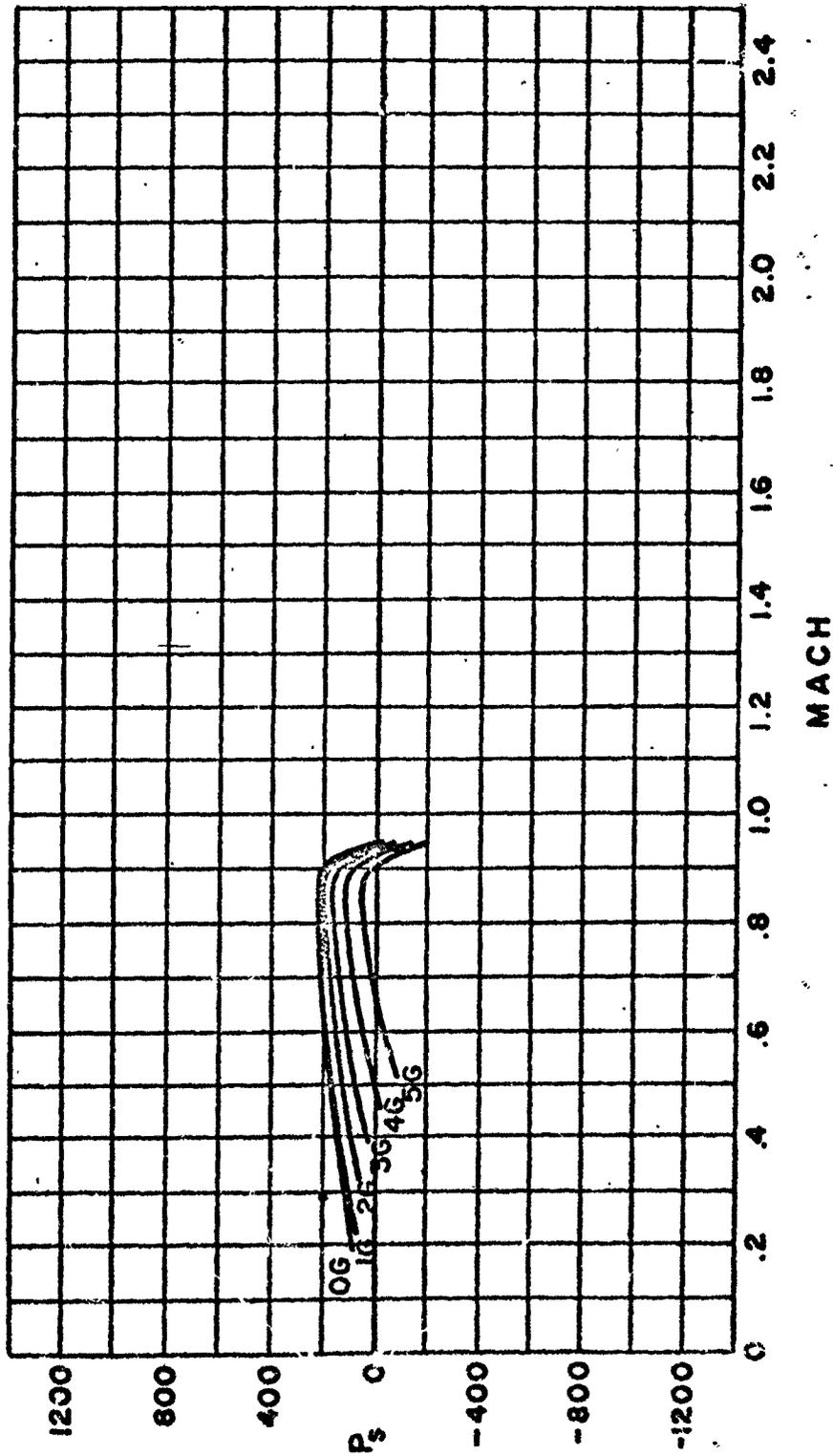


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MAXIMUM POWER · 15,000'

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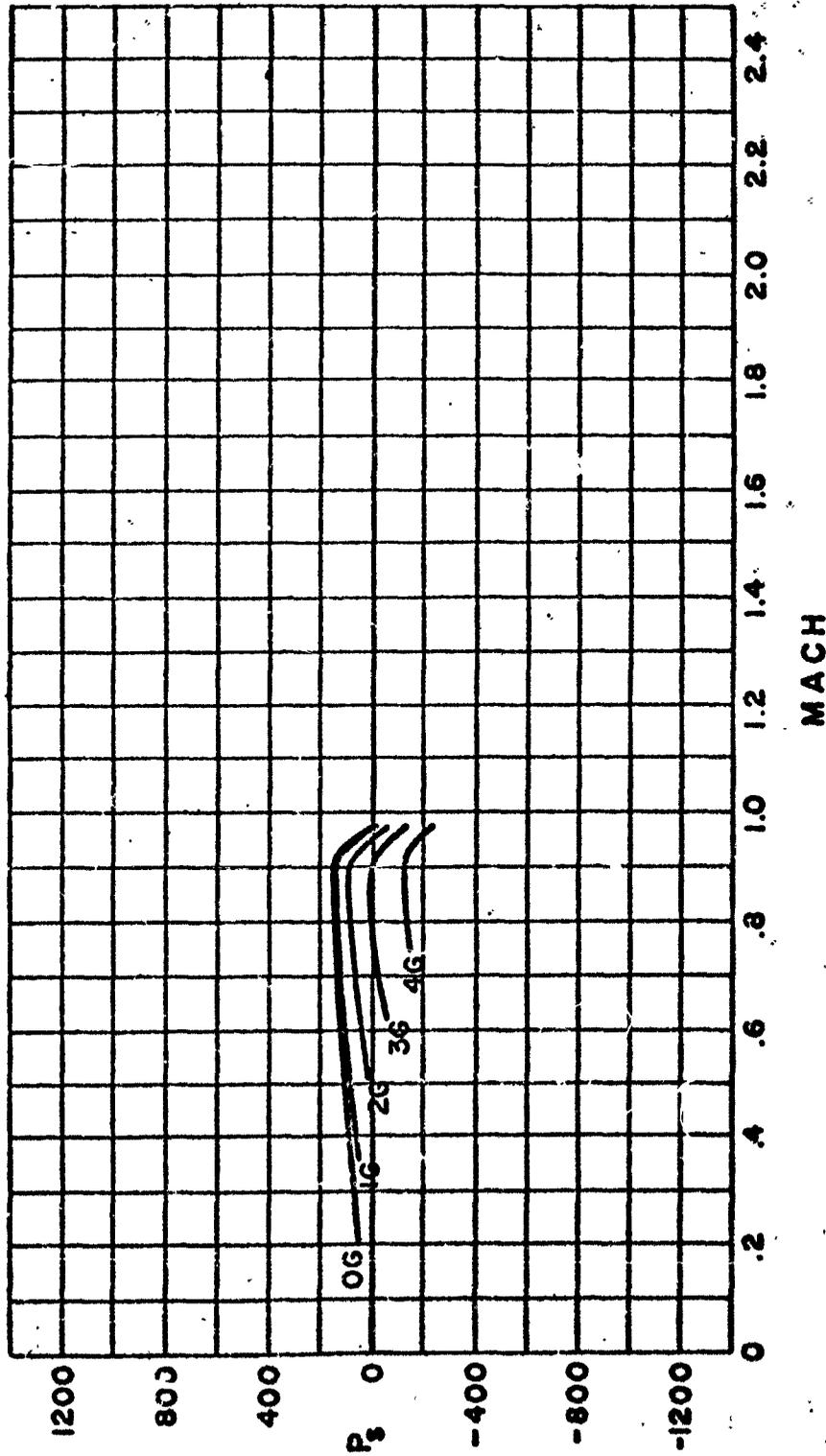


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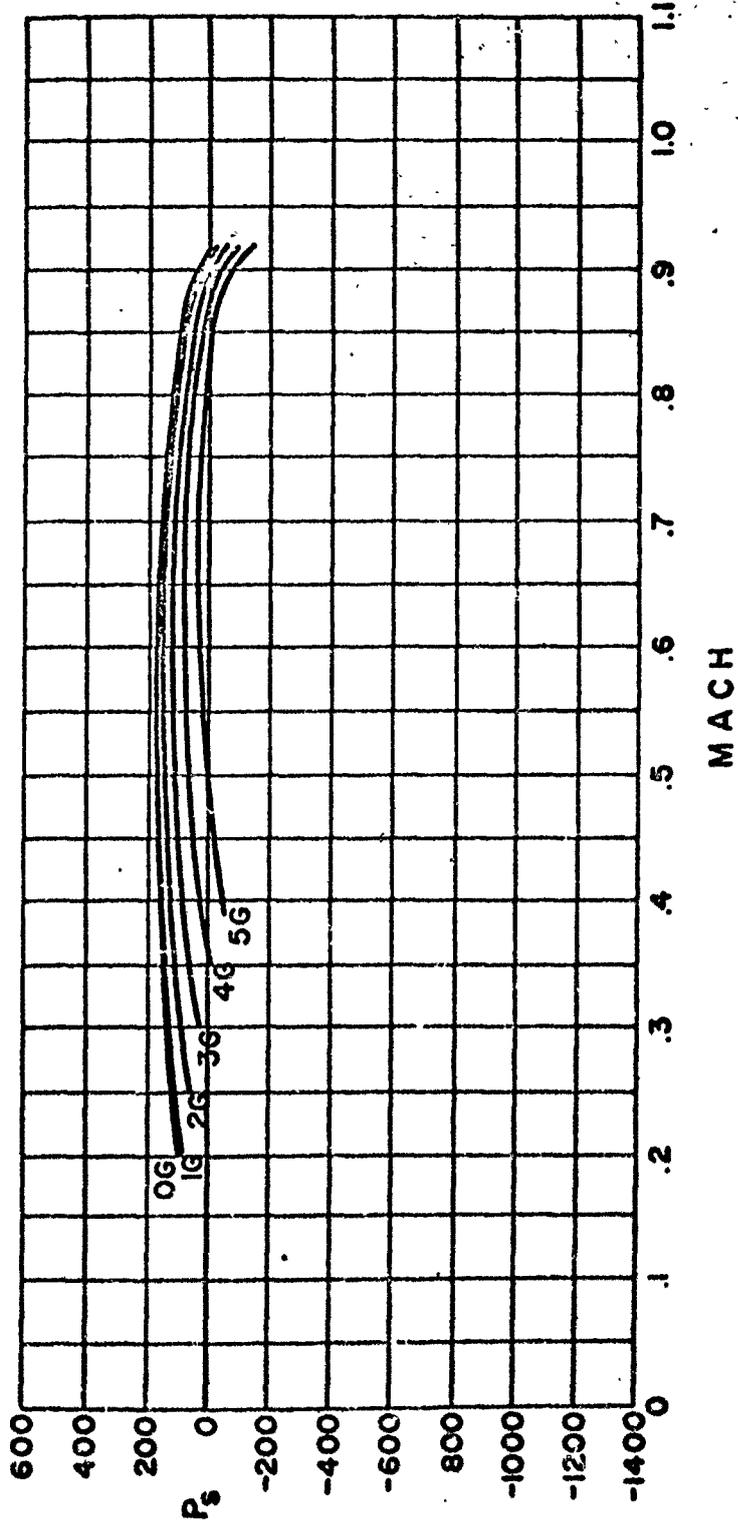


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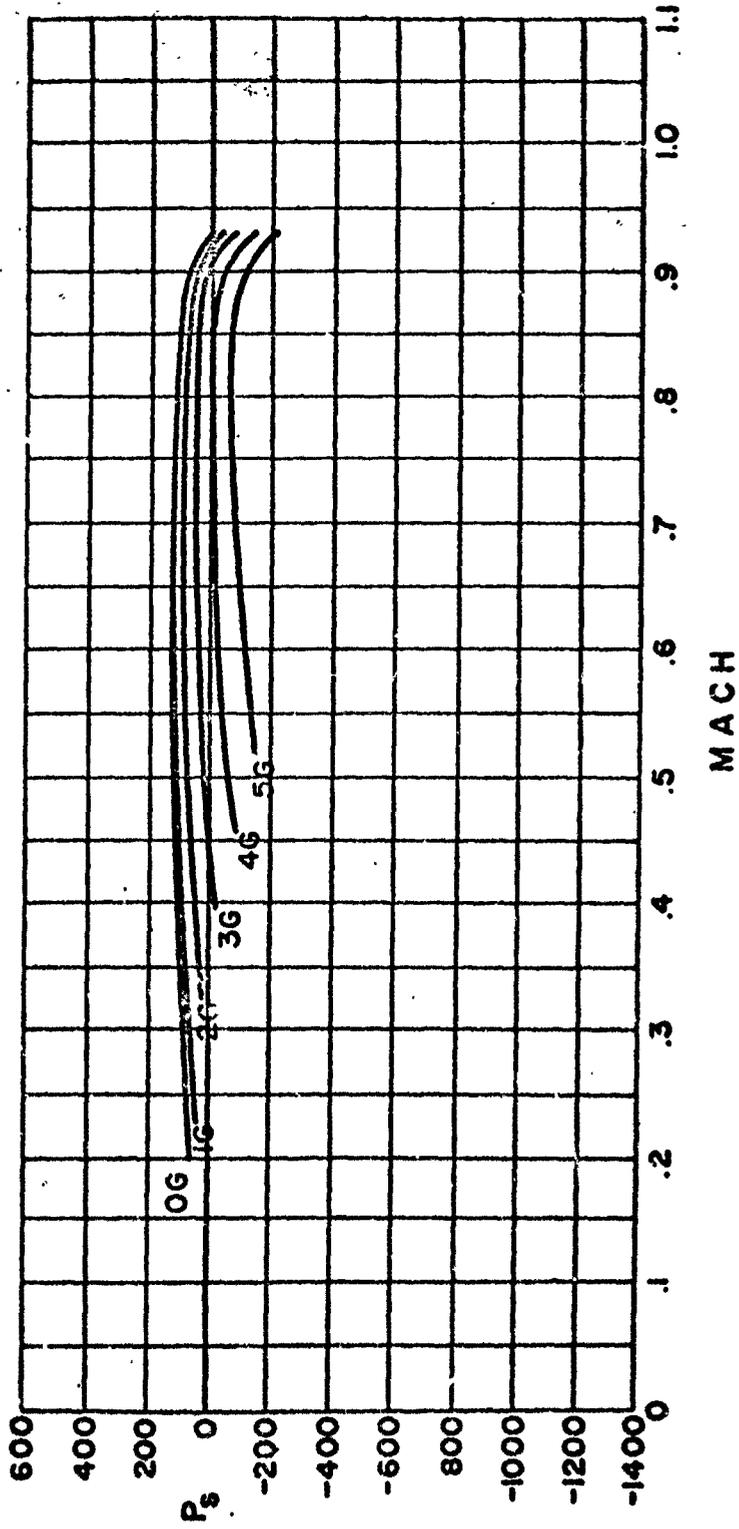


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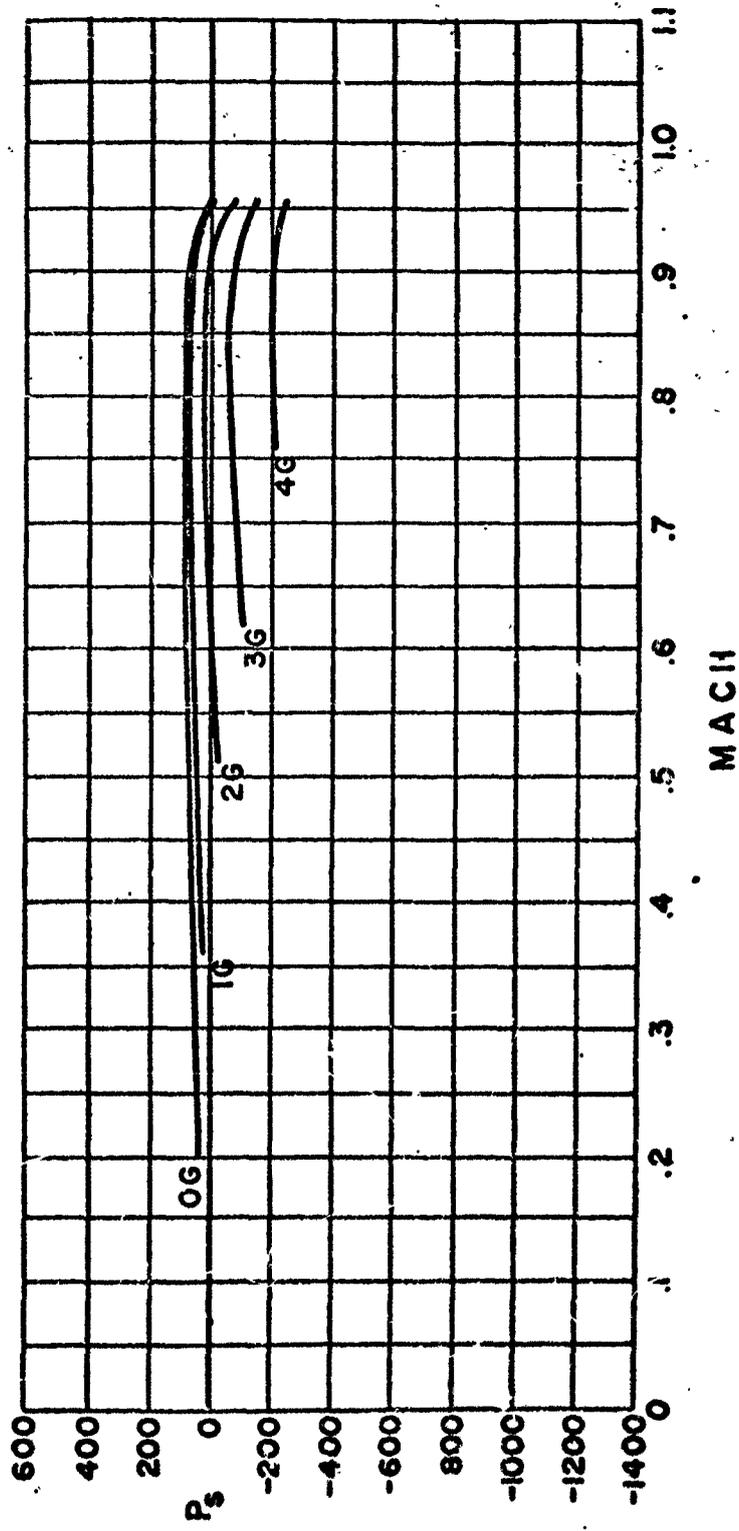


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MILITARY POWER - 35,000'

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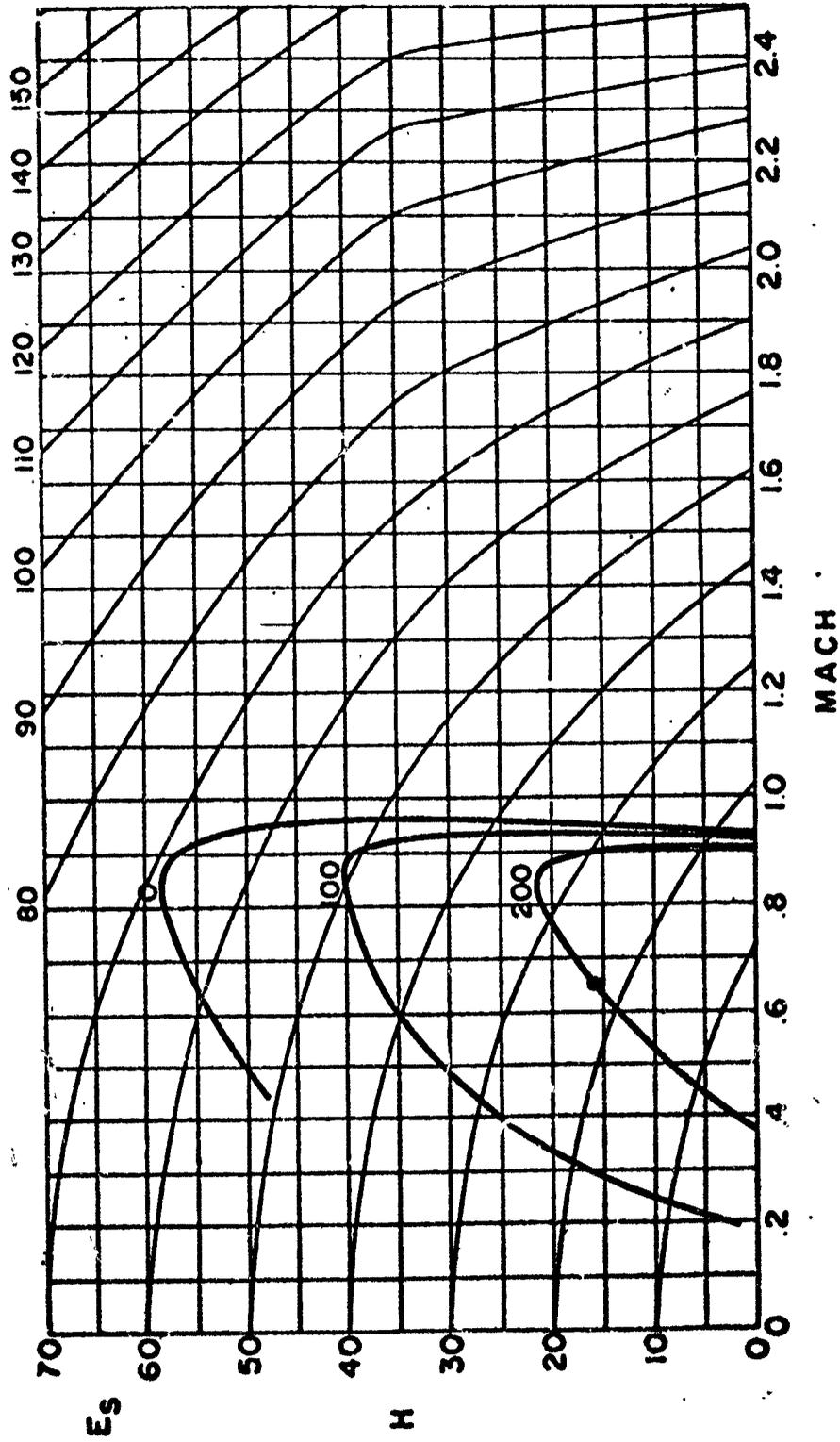


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ENERGY RATE MAXIMUM POWER 16

MIG-17

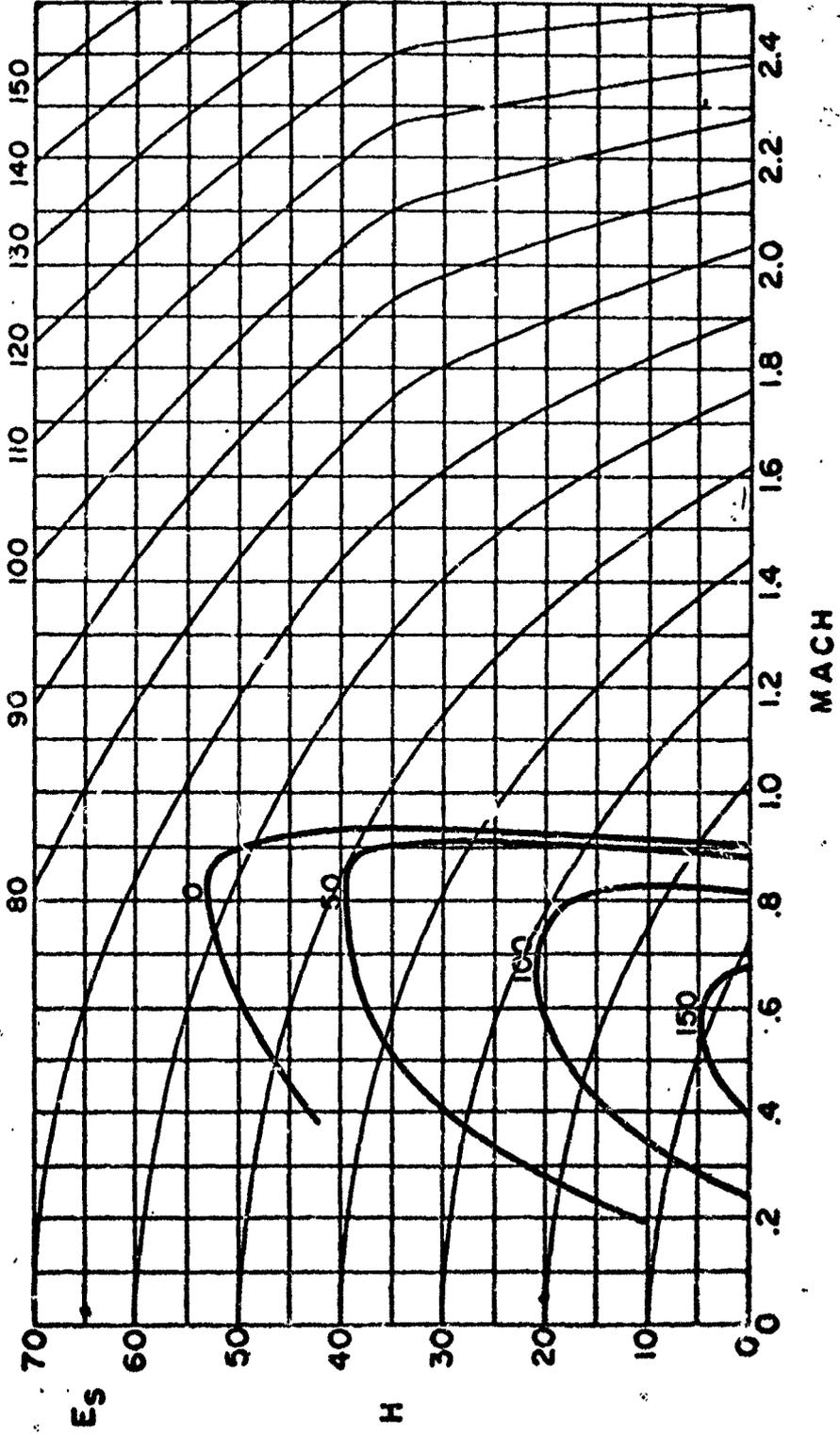


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ENERGY RATE MILITARY POWER · 16

MIG-17



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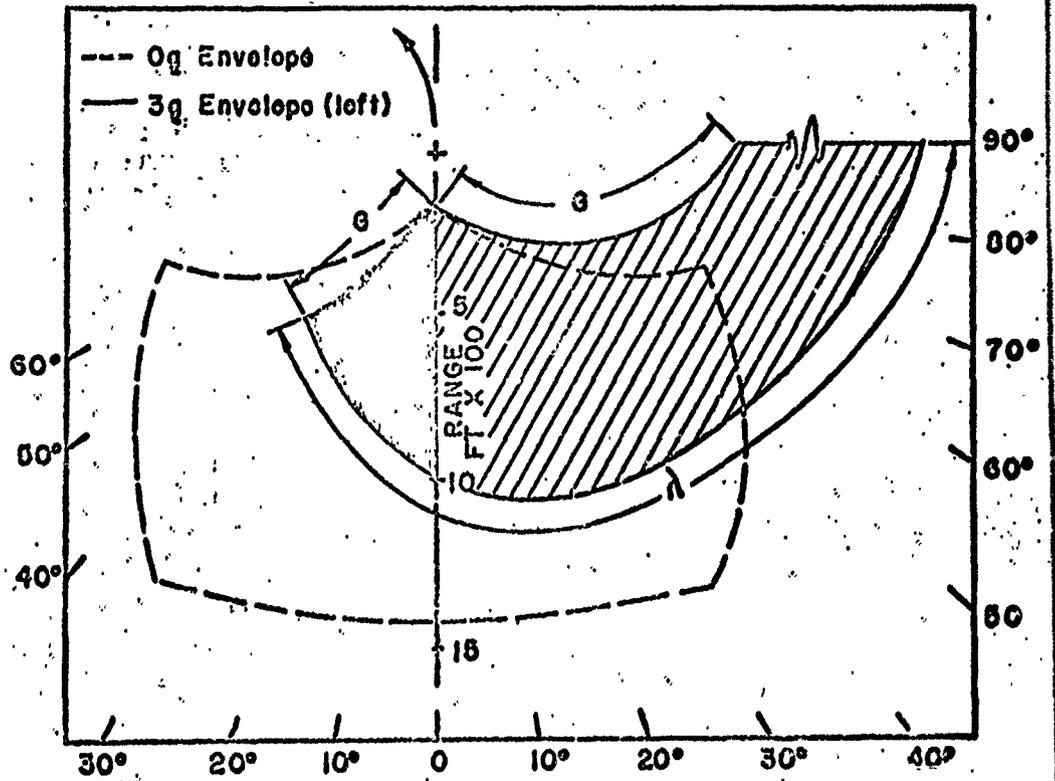
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ANNEX H

AIM-9/B MANEUVERING ENVELOPES

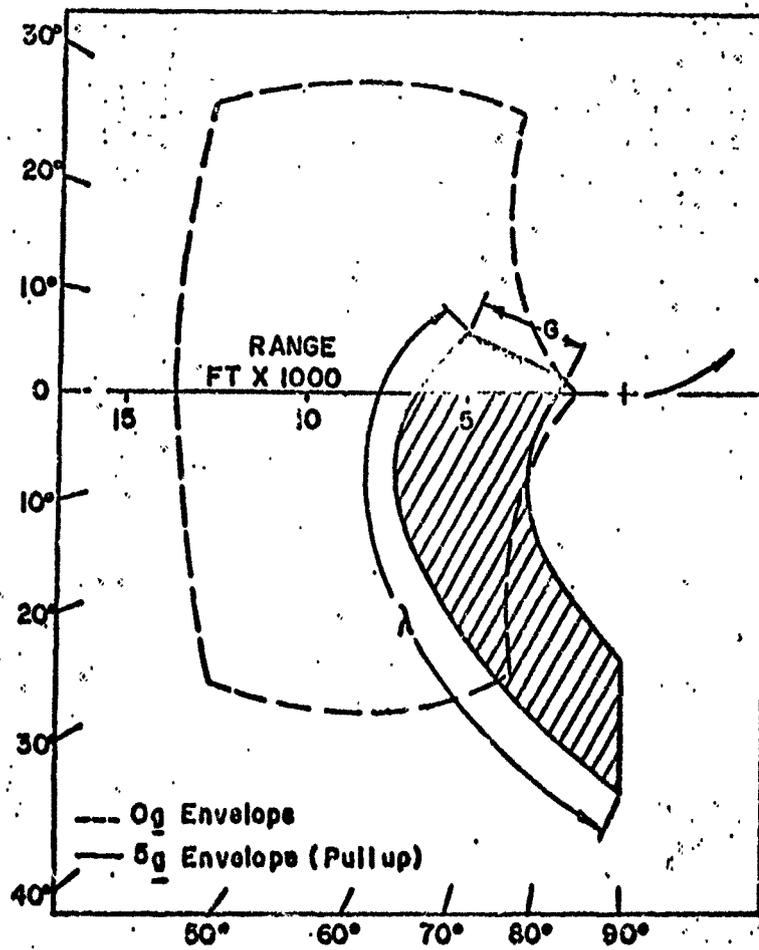
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TGT - 1.0 MACH
ATTACK - 1.0 MACH
ALTITUDE - 35000'
TGT MANEUVER - 3g LEFT TURN

SECRET



TGT - .9 MACH
ATTACK - 9 MACH
ALTITUDE - 35000
TGT MANEUVER - 5g PULL UP

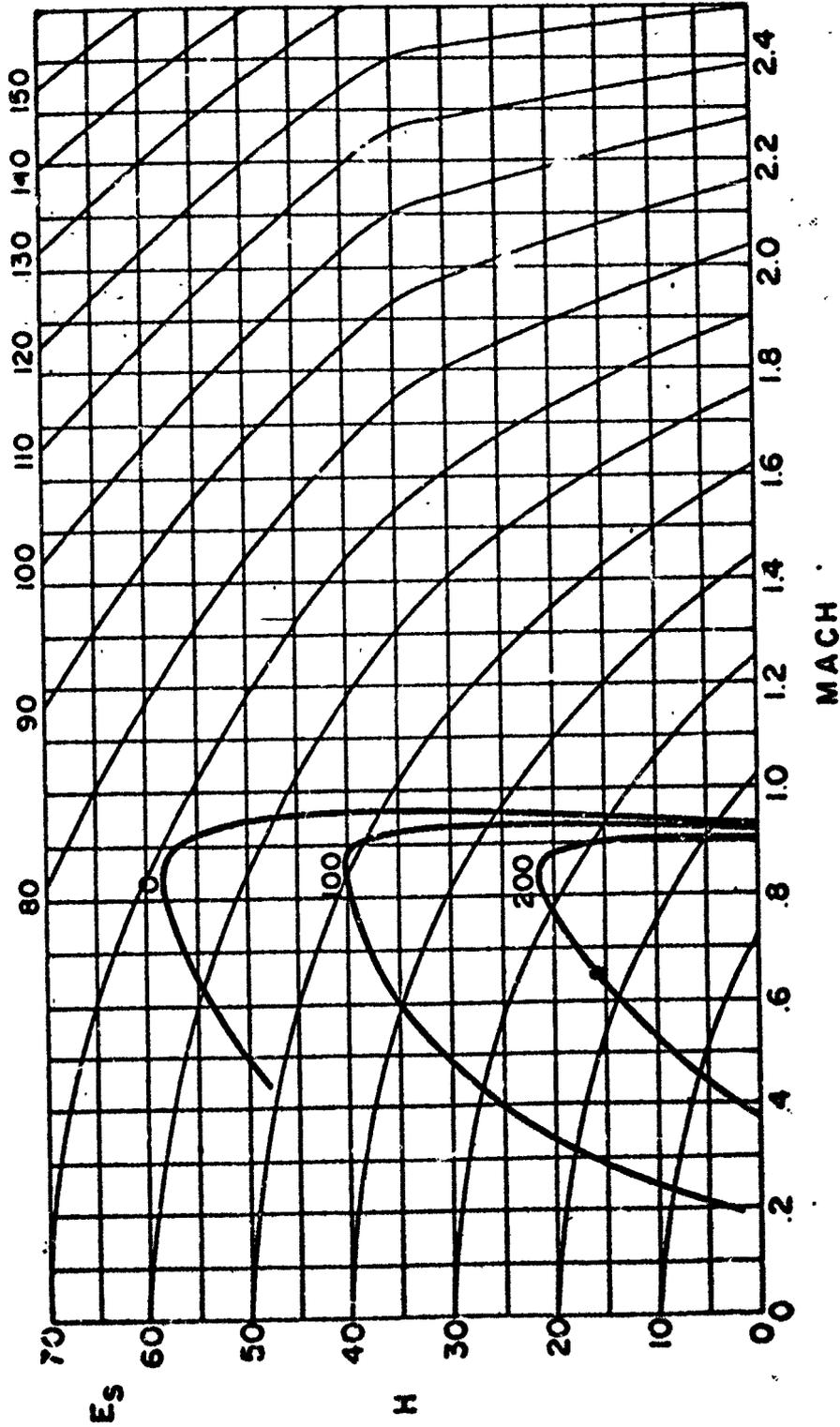
Figure 20

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ENERGY RATE MAXIMUM POWER 1G

MIG-17



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Distribution:
1 cy ea FZR Wq (except 479th which got sep)
1 cy CEAC,
1 cy Carl Mersch, Maryland ANG.

SUPPLEMENTAL

INFORMATION

128
132
125
122
120

01



DEPARTMENT OF THE AIR FORCE
USAF WEAPONS SCHOOL (ACC)
NELLIS AIR FORCE BASE, NEVADA

14 November 1995

MEMORANDUM FOR DTIC

FROM: USAF WS/DCO
4325 Tyndall Ave
Nellis AFB NV 89191-6075

ERRATA
AD-973500

SUBJECT: Release of USAF Weapons School Publication

Publication titled, Final Report: TAC Mission EF 857 Air Combat Tactics Evaluation, AD 372 500 was declassified on 6 October 1995 and is cleared for public release. POC is 1t Lt Angelene Barton at DSN 682-4972.

James D. Cantwell
JAMES D. CANTWELL, Lt Col, USAF
Deputy Commandant

ERRATA