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(1) FINAL REPORT. on

TAC MISSION [redacted] FF857,

AIR COMBAT TACTICS EVALUATION

F-100 F-104 F-105 F-4C Vs MIG-15/17 TYPE A/C (F-86H) (U) (8)

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(10) James C. Hare; Michael S. Mustaf
& Jeke D. Williams.

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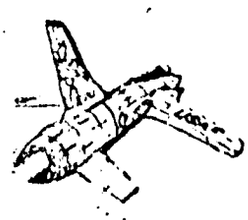

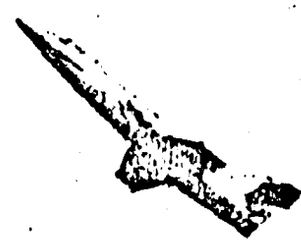

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FOREWORD

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.

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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.

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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.

TABLE OF CONTENTS

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/B 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.

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.

(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 break 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.

(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 ½ 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 1G 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

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 ½ 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.

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.

(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.

(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.

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.

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

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-86H 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.

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 low airspeed. 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

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

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

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-

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

stick kicker onset at 2G degraded F-104 capability on four passes.) In one e 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.

(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.

(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 30° 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

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.

(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

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.

(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.

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-airspeed 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:

Number of A/C	Type A/C	Dates	Sorties
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.

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 USAFE fighter units.

ANNEX A

MISSION SUMMARIES

F-86H versus F-100D

TAC Mission FF-857 ACT Evaluation - Summary

Card #	Mission	Date	Attacker	A/C #	Type	Defender	A/C #	Type	T.O. Time	Fly Time
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.

F-86H versus F-104C

TAC Mission FF-857 - ACT Evaluation - Summary

Card #	Mission	Date	Attacker	A/C #	Type	Defender	A/C #	Type	T.O. Time	Fly Time
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

F-86H versus F-105D/F

TAC Mission FF-857 ACT Evaluation - Summary

Card #	Mission	Date	Attacker	A/C #	Type	Defender	A/C #	Type	T.O. Time	Fly Time
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 L	338 525	105F 105D	A H	113 231	86H 86H	1500	0:50

F-86H versus F-4C

TAC MISSION FF-857 ACT Evaluation - Summary

Card #	Mission	Date	Attacker	A/C #	Type	Defender	A/C #	Type	T.O. Time	Fly Time
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	86	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.

ANNEX B

TEST DATA CARDS

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1.

TEST DATA 1 - TAC MISSION 857 - AC (1) 2. 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86H				
Defender		F-4C				

Maneuver Log

	Engagement #	1.	2.	3.	4.	5.
1.	Attacker					
	Type Attack	5/4H	6/4Hi	5/4Hi		
	Initial Speed/Altitude	.85/35	.85/38	.85/38		
	Terminal (3000'R) Speed/Altitude	.91/35	.91/35	.92/35		
	High Speed Yo-Yo	No	No	No		
	Roll Off	No	No	No		
	Low Speed Yo-Yo	No	No	No		
	Gun Kill?	No	No	No		
2.	Defender (Initial Speed/Altitude)	85/35	86/35	.87/37		
	Break	No	No	No		
	Attacker Over Shoot	No	No	No		
	Speed/Altitude	—	—	—		
	Scissors, # Reversals	No	No	No		
	High G Roll Over	No	No	No		
	Recovery Speed/Altitude	—	—	—		
	High G Roll Under	No	No	No		
	Recovery Speed/Altitude	—	—	—		
	Escape Achieved?	Yes	Yes	Yes		
	Gun Kill?	No	No	No		

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Attackers Comments: #1 F-86 started ATTACK from 5 o'clock high. MAX ATTAINABL. speed WAS .92. Approached from 6 o'clock slightly low. Overtake speed WAS NOT ENOUGH. F-4 could not see F-86. Range was called at 1 mile, 4000, 3000. At 3000ft. Fit started climbing left turn in AB and separated.

#2. Same as above to 3000 ft. range. Then F4 did an unloaded right roll under with min G and separated.

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

Defenders Comments. #1 Unloaded a/c + accelerated to .93 in lazy climbing turn, then accelerated to 1.0 M. Good separation — No Kill.

#2 - Slicing Roll to right - Roll under to left - 5 G turn to Right at 1.1 M. Good separation — No Kill.

#3 - Made slicing turn to left + unloaded A/C. Vertical Roll to left going down, unloaded at 1.2 M roll to right - straight wings level pullout - No kill.

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

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TEST DATA 1 - TAC MISSION 857 - ACT (1) 2 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F86H				
Defender		F4C				

Maneuver Log — Engagement #

	1.	2	3.	4.	5.
1. Attacker					
Type Attack	6/Hi	6/Hi	6/Hi	6/Hi	
Initial Speed/Altitude	.75/40	.75/40	.7/30	.7/30	
Terminal (3XC0'S) Speed/Altitude	2mi/95/35	1mi/94/32	1mi/94/20	1mi/94/20	
High Speed Yo-Yo	Noe	No	No	No	
Roll Off	No	No	No	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	No	No	No	No	
2. Defender (Initial Speed/Altitude)	.85/35	.85/33	.82/20	.82/20	
Break	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	

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Defendees Comments:

#1- When attacker was at 2 miles defender went to 1/4G AB and accelerated. Achieved mach 1.0 in 10 sec.

#2- Same except attacker came into 1 mile before we increased air speed.

#3- When attacker was at 1 mile, defender unloaded A/C, then hardturned into attacker and picked up .9, then climbed at .9

#4- Same.

Note: visability in aft quarter of F-4 is very poor, in fact Nil. Once an engagement is begun, it will be almost impossible to keep tabs on any attacker between 5-7 o'clock, and very difficult from 4-8 o'clock.

Attackers Comments:

On all attacks as soon as defender started separation maneuver, separation began to increase. In each case attacker could not maintain a closing advantage when defender started climbing spiral.

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TEST DATA 1 - TAC MISSION 857 - ACT (1) 2, X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86H				
Defender		F-4C				

Maneuver Log

Engagement #

	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	7/Hi	4/Hi	4/Hi	4/Hi	
Initial Speed/Altitude	.85/39	.86/38	.85/29	.85/26	
Terminal (3000'A) Speed/Altitude	.92/35	.92/35	.92/25	.87/25	
High Speed Yo-Yo	No	No	No	No	
Roll Off	No	No	No	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	Yes	Yes	Yes	Yes	
2. Defender (Initial Speed/Altitude)	.85/35	.85/35	.82/25	.82/25	
Break	No	No	No	No	
Attacker Over Shoot	No	No	No	No	
Speed/Altitude	—	—	—	—	
Scissors, # Reversals	—	—	—	—	
High G Roll Over					
Recovery Speed/Altitude					
Roll & High G Roll Under				Yo	
Recovery Speed/Altitude				1.0/20M	
Escape Achieved?	No	No	No	No	
Gun Kill?					

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Defenders Comments: #1 - @ 3500' attacker range, entered hard turn, Max AB, accelerated to .9 & pulled MAX avail 'G' keeping .9, attacker closed to 2400', Tracked & achieved gun kill. Attacker could not get closer than 2400'. #2 - Same as #1.

#3 - @ 3000' - 4000' attacker range entered hard turn, max A/B, accelerated slowly to .9 & converted turn to climb. Attacker closed to 2400-2500', Tracked, achieved gun kill.

#4 - Initially same as #3 but entered 4-5G diving Roll, accelerated to 1.1 M, then climbed to point range, but not before attacker achieved gun kill.

Attackers Comments: #1 - 3500 ft Range. F-4 did hard left level turn. I had no problem tracking to 2400 ft. 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 2400 feet.

#4 - Same as #3 except that F-4 did typical type separation but did not separate fast enough to preclude a gun kill at 2400 feet.

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TEST DATA 1 - TAC MISSION 857 - ACT 1 (2) 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-4C				
Defender		F-86H				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.	6.
1. Attacker						
Type Attack	5/Hi	5/Hi	5/Hi	6/Hi	6/Hi	6/Hi
Initial Speed/Altitude	.82/40	.82/40	.87/30	.72/30	.82/24	.75/24
Terminal (3000'±) Speed/Altitude	.91/35	.85/35	1.0/22	.92/22	1.2/20	.92
High Speed Yo-Yo	No	No	Yes	Yes	No	Yes
Roll Off	No	No	No	No	No	No
Low Speed Yo-Yo	No	No	No	No	No	No
Gun Kill?	Yes	Yes	Yes	Yes	Yes	Yes
2. Defender (Initial Speed/Altitude)	.85/35	.85/35	.75/20	.75/20	.75/20	.75/20
Break	No	No	Yes	Yes	Yes	Yes
Attacker Over Shoot	Yes	Yes	Yes	Yes	Yes	Yes
Speed/Altitude	220/35	220/35	220/20	220/20	220/20	220/20
Maneuvers, # 2s crosls	Yes	Yes	Yes	Yes	Yes	Yes
High G Roll Over	No	No	No	No	No	No
Recovery Speed/Altitude	—	—	—	—	—	—
High G Roll Under	No	No	No	No	No	No
Recovery Speed/Altitude	—	—	—	—	—	—
Escape Achieved?	No	No	No	No	No	No
Gun Kill?	No	No	No	No	No	No
Hard Turn	Yes	Yes	Yes	Yes	Yes	Yes

3. Exit Turns

Fuel Remain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Attackers Comments -

#1. Tracked to 2500' - ∠30° - 15° Roll off - Good separation.
Gun kill #2 - Tracked from 5000' - 1200' - ∠40° - 30°
2 Gs - Yo-Yo - gun kill. #3 - Tracked from 5000' - 2000' - Hi Yo-Yo - top at 33m astern, turn in and head-on - standoff - Gun kill.
#4 Barrel roll in to stern - tracked, topped at 44,000' on Yo-Yo. turn in. Standoff - Gun kill.
#5 - Supersonic - stern pass and tracked to 5500 - Roll under to 1.2M - Good separation - Gun kill
#6 - Started out 1½ mach - tracked to 1500' - Yo-Yo up to 10M' - turn in. Guns tracking head on. Gun kill
(Kept airspeed up at all times. Overall firing pass airspeed was .91M to 1.2M which left plenty for subsequent maneuvering.)

Defenders Comments: Defender lost too much airspeed 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 Yo-Yo maneuvers and on 6th pass he zeroed airspeed and almost spun A/C

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TEST BASE 1 - TAC MISSION 857 - ACT 1 (2) 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TH Time	Fly Time
Attacker		F-4C				
Defender		F-8H				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. Attacker	6 level				
Type Attack	83/20				
Initial Speed/altitude	83/20				
Terminal (3XC's) Speed/Altitude	No				
High Speed Yo-Yo	No				
Roll Off	No				
Low Speed Yo-Yo	No				
Gun Kill?	83/20				
2. Defender (Initial Speed/altitude)	Yes				
Breaks	Yes				
Attacker Over Shoot	83/20				
Speed/altitude	Yes				
Scissors, # Intervals	No				
High G Roll Over	—				
Recovery Speed/Altitude	No				
High G Roll under	—				
Recovery Speed/altitude	Poss.				
Escape Achieved?	Poss.				
Gun Kill?					

3. E.M. Terms

Fuel Remain	Altitude	Mach	Level Max G	A/C

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.

2 nm fr. Co-Alt Co-airspeed (.83) 2000 ft Buy F8 hard turn forced lateral separation and F-4 scissored thrice with max power. Followed by nose low roll, accelerating dive away for successful escape.

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TEST DATA 1 - TAC MISSION #37 - ~~1~~ (2) X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker	_____	F-4C	_____			_____
Defender	_____	F-8H	_____	_____	_____	_____

Maneuver Log

	Engagement #				
	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	5 level	5 level	5 level	7 Hi	7 Hi
Initial Speed'Altitude	85/35	88/39	88/35	89/40	86/38
Terminal (3X0'S) Speed/Altitude	98/32	92/36	1.1/30	1.1/32	97/34
High Speed Yo-Yo	Yes	Yes	No	Yes	Yes
Roll Off	No	No	No	No	No
Low Speed Yo-Yo	No	No	No	No	No
Gun Kill?	Poss	Yes	No	No	No
2. Defender (Initial Speed'Altitude)	85/35	85/35	85/35	85/35	90/35
Break	No	No	Yes	No	No
Attacker Over Shoot	Yes	Yes	Yes	Yes	Yes
Speed'Altitude	85/35	85/35	85/35	70/40	85/36
Scissors, # Reversals	Yes	Yes	No	Yes	Yes
High G Roll Over	No	No	No	No	No
Recovery Speed/Altitude	—	—	—	—	—
High G Roll Under	No	No	Yes	No	No
Recovery Speed/altitude			9/29		
Escape Achieved?	Yes	No	Yes	Yes	Yes
Gun Kill?	No	No	No	No	No

3. Rolling Turns

Fuel Remain	Altitude	Mach	Level Max G	A/C
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

NOTES: Describe key factors for each engagement.

All attacks were quarter stern from 35 to 40°, attack speed increased to 1.1 mach. When defender broke at 5000' and above, a limited amount of gun tracking time was available down to approx. 3000' at this time an overshoot - climb off was initiated. When defender A/C broke at 3000' it was impossible to track at any time and a roll off and climb was initiated. At no time, after the break off was accomplished and climb initiated could defender position himself to track and fire. (After the break off and climb the attacker A/C was in an advantageous position for a missile attack.) During a high side attack the attacker experienced difficulty in bringing the nose up from supersonic speeds and high dive angles.)

Note: F-8H could obtain a missile kill every time after an overshoot by the F-4. F-8H could possibly obtain a gun kill if F-8H holds mach .9 after turn reversals.

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TEST DATA 2 - TAC MISSION 857 - ACM 2 & 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	2D Time	Fly Time
Attacker		F-86H				
Defender		F4C				

Engagement #

		1.	2.	3.	4.	5.
1.	Attacker					
	Type Attack	7Hi	6/Hi	6/Hi	6/Hi	6/Hi
	Initial Speed/Altitude	.85/40	.8/39	.8/39	.83/26	.7/27
	Terminal: (Missile) Speed/Angle Off	.52/10°	.92/15°	.92/15°		
	Barrel Roll Attack	No	No	No	No	No
	Missile Kill? Range & Angle Off	Yes 5mi/2½°	Yes 5mi/4½°	No	Yes	Yes
	Terminal: Gun Attack (3000'R)	—	—	—	—	—
	High Speed Yo-Yo	—	—	—	No	No
	Roll Off	—	—	—	No	No
	Low Speed Yo-Yo	—	—	—	No	No
	Gun Kill?	No	No	No	Yes	Yes
2.	Defender - Initial Speed/Altitude	.85/35	.85/35	.85/35	.75/20	.82/20
	Hard Turn/Break	Yes	Yes	Yes	Yes	Yes
	Missile Attack Defeated	No	No	Yes	No	No
	Diving Spiral	Yes	Yes	Split S	No	No
	Vertical Rolling Scissors	No	No	No	No	No
	Attacker Over Shoot: Speed/Altitude	No	No	No	No	No
	Escape Achieved?	No	TRAIL	Yes	No	No
	Gun Kill?	No	No	No	No	No

3. S.N. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

#1 - Defender entered hard descending turn with attacker at 2-2½ miles, Attacker closed by cutting across circle — possible missile - No Gun

#3 Defender hard diving turn when attacker @ 6000'. Max 'G' + slightly steeper dive used attacker could track at less than 2 'G' For initial 20-30° of turn, then 'G' increased as range shortened to 5000'. If defender tried to translate diving speed to climbing speed attacker could 'cut' across circle to max gun range. #3 Defender - 'Split S' attacker @ 6000' Range. Initial missile & gun escape achieved by pulling attacker 'G' at 7T. If defender continues to raise nose, attacker cuts across circle & could probably achieve a missile attack - this is principally caused by the delay in defenders Mvr before achieving 2-3 mile separation.

#4 & 5 - 2 attacks by F-86 Defender, 72 to 82 In these attacks defender was unable to accelerate out of missile or gun range or prevent attacker from positioning for a Gunkill. Defender did not attempt a diving acceleration 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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TEST MATR 2 - TAC MISSION 857 - ACT 0 & 2

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-16A				
Defender		F-4C				

Maneuver 1ck

Engagement #	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	5/A.	6/A.	7/A.		
Initial Speed/Altitude	84/40	91/30	96/25		
Terminal: (Missile) Speed/Angle Off	46°	20°	20°		
Barrel Roll Attack	N.	N.	No		
Missile Kill? Range & Angle Off	N.	Yes	Yes		
Terminal: Gun Attack (3000'R)	—	—	UNK		
High Speed Yo-Yo	No	No	No		
Roll Off	No	No	No		
Low Speed Yo-Yo	No	No	No		
Gun Kill?	No	No	Yes		
2. Defender - Initial Speed/Altitude	86/35	92/25	92/20		
Hard Turn/Break	Yes	Yes	Yes		
Missile Attack Defeated	Yes	Yes	Yes		
Diving Spiral	Yes	Yes	Yes		
Vertical Rolling Scissors	N.	N.	N.		
Attacker Over Shoot: Speed/Altitude	No	No	No		
Escape Achieved?	Yes	Yes	UNK		
Gun Kill?	No	No	UNK		

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Defender Comments:

2 stern attacks initiated at 35M - attacker in blind area. Escape maneuver accomplished by max pull diving (3 to 6 G) turn to 13° 1.4 Mach, G load moderate but not enough to prevent overshoot. Attacker was observed 25 to 30° ∠ off min range 4500 ft. in first third of maneuver. 1 stern attack in blind 6 o'clock area at 30M - max pull hard turn (3-6 G) for about 120° at .94 then pull low (2.5 G) acceleration to 1.3 Mach in continued turn - turn was started 7-6M ft. range. Attacker was not observed at all.

Attacker's Comments:

#1 - Attack started at 40M with defender at 35M - not able to reach high enough mach to close properly, and ended in a tail chase. When at 700', defender turned and would not permit a shot in the 20° cone with less than 4 G's. Defender rolled away prior to closing to gun range.

#2 - Attack started at 38M with defender at 35M. When at 700' I rolled away pickled a missile shot with less than 2 G. Positive Heat, snap shot at max gun range.

#3 - Attack started at 35M with defender at 30M. Defender never saw me when I was in missile range or gun range.

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TEST DATA - 2AC MISSION 857 - AC (2) 5, 7

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86H				
Defender		F-4C				

Firepower Log

Engagement #	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	6/Hi	6/Hi	6/Hi	6/Hi	6/Hi
Initial Speed/Altitude	.82/40	.82/40	.80/39	.85/35	.85/35
Terminal: (Missile) Speed/Angle Off	.96/10°	.96/5°	.9/5/10°	.92/20°	.96/30°
Barrel Roll Attack	No	No	No	No	No
Missile Kill? Range & Angle Off	Yes/10°	Yes/10°	Yes/10°	No	No
Terminal: Gun Attack (3000'R)	Unk	Unk	Unk	Unk	Unk
High Speed Yo-Yo	No	No	No	No	No
Roll Off	No	No	No	No	No
Low Speed Yo-Yo	No	No	No	No	No
Gun Kill?	Expire Less	Expire Less	Expire Less	Yes	Yes
2. Defender - Initial Speed/Altitude	.85/35	.85/35	.85/35	.82/20	
Hard Turn/Break	Yes	Yes	Yes	Yes	Yes
Missile Attack Defeated	Yes	Yes	Yes	Yes	
Diving Spiral	36° or more	36° or more	36° or more	36° or more	36° or more
Vertical Rolling Scissors	No	No	No	No	No
Attacker Over Shoot: Speed/Altitude	—	—	—	—	—
Escape Achieved?	Yes	Yes	Yes	Yes	Yes
Gun Kill?	No	No	No	No	No

3. F.E. Turns

Pass Remain	Altitude	Mach	Level/Max G	A/E

NOTES: Describe key factors for each engagement.

Defenders Comments: #1 - Defender initiated hard descending turn, 3 'G' or more, continued diving 3-5 'G' spiral, accelerated to 1.25 M, - Attacker terminated. Hard turn was initiated when attacker was approx. 6000' Attacker was within 5°-10° of dead-astern. Attacker never got closer than 4000'. #2 - Defender reduced rate of 'G' application - lowered nose more. Attacker initially 6000 ~ 5°-10° X off. Defender maintaining 3-5 'G', accelerated to 1.4 M, in a descending rolling spiral. Bottomed out at 17,000', then terminated. Attacker miss range estimated @ 5000. This seemed to be best escape from missile attack. #3 - Essentially same as #1, but terminated @ 15000 - 1.4 M, #4 - Low Alt. descending high attack (1.3 @ 14,000) 3-5 'G' Terminated with attacker claiming closure to gun range.

Attackers Comments #1 - Started missile attack 6000' pulling 1/2 G', closed to 4000' easy tracking at 1.5-2 'G' for 60° of turn down. My speed was .96 - 1.0. After about 60° of turn 'G's increased to over 7 G + F-4 went out of missile range. #2 - Started missile attack 5/10° off 6000' - Closed again to 4/5000' then Range lock on. Missile kill - 1/2 'G' @ 5/4500' for 30° of a turn. Defender was in a split S + my 'G' increased to .935+ + over Mach to #3 same as #1 #4 F-86 able to close to gun range. Radar lock on @ .96. Able to track under 3 'G' for 180° of turn. F-86 No missile kill because of F-4 - 3G turn but F-86 could track easily at missile range. #5 - Same as #4 except F-86 able to track Gun Range for 270° turn + under 4 'G'.

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TEST DATA 2 - TAC MISSION 857 - ACM 3 4 X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TH Time	Fly Time
Attacker		F-4C				
Defender		F-86H				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	6/Hi	6/Hi	6/Hi	6/Hi	6/Hi
Initial Speed/Altitude	9/40	1.1/35	1.0/27	1.2/33	1.1/35
Terminal:(Missile) Speed/Angle Off	1.3	1.1	.95	.9	.92
Barrel Roll Attack	No	No	No	No	No
Missile Kill? Range & Angle Off	5mi 20° Yes 2G	6mi 30° Yes 2G	5mi 30° Yes 2G	5mi 45° Yes 3G	5mi 43° Yes 3G
Terminal: Gun Attack (2000'?)	—	—	Yaw	—	—
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. Defender - Initial Speed/Altitude	.91/D	.8/35	.75/20	.75/20	.75/20
Hard Turn/Break	Yes	Yes	Yes	Yes	Yes
Missile Attack Defeated G/AR	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	.6/32	.6/34	.7/28	.7/26	.7/24
Escape Achieved?	No	No	No	No	No
Gun Kill?	No	No	No	No	No

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C

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 posit.

#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° angle off, 2G's.

#3 - Never did have attacker in sight until he called 1500 feet and tracking. (This was after defeating initial missile)

#4 - Same as #1

#5 - Attacker tried to turn (after initial overshoot) with me. Had notreable attacking him, however could not climb or even maintain airspeed while attempting to gain advantage.

ATTACKERS COMMENTS:

GAR 8 attack was defeated on all passes. Recognition and position for sparrow attacks were excellent for sparrow kill. Shoulder harness locking frequently caused loss of visual sighting. Instrument hoods should be removed for better rear vision. Emphasis was placed on receiving missile envelope using best turning avail G. On third attack Hi yo-yo & roll off allowed 30° deflection shot tracking nose low from 3000 ft. to 1000 ft. with Hi-rate of closure, 9% speed on attacker. Apparent low mach on target. Steep diving reattacks at high mach were completely unsuccessful due to difficulty in dive recovery. Would be extremely useful as an escape maneuver.

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TEST DATA 2 - TAC MISSION 837 - ACT 2 ④ 2

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker	_____	F-4C	_____			_____
Defender	_____	F-86H	_____	_____	_____	_____

Maneuver Log

	Engagement #				
1. Attacker	1. 6	2. 7	3.	4.	5.
Type Attack	STERN	STERN			
Initial Speed/Altitude	.91M 23M	.91M 23M			
Terminal:(Missile) Speed/Angle Off	.95M 10°	1.1M 10°			
Barrel Roll Attack	No	No			
Missile Kill? Range & Angle Off	No	No			
Terminal: Gun Attack (3000'R)	No	1400' 5.5G			
High Speed Yo-Yo	No	No			
Roll Off	No	Yes			
Low Speed Yo-Yo	No	No			
Gun Kill?	No	Yes			
2. Defender - Initial Speed/Altitude	.85/20	.85/20			
Hard Turn/Break	Yes	Yes			
Missile Attack Defeated	Yes	Yes			
Diving Spiral	Sw. S	Sw. S			
Vertical Rolling Scissors	No	No			
Attacker Over Shoot: Speed/Altitude	No	No			
Escape Achieved?	Yes	n/a			
Gun Kill?	No	No			

1. E.M. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

NOTES: Describe key factors for each engagement.

Attackers Comments: #1- Sidewinder kill - followed by gun attack - tracked to 1600' as defender reversed too soon - gun kill.
#2: No missile kill - gun attack with tracking down to 2300' - overshot and roll-off - gun kill.
#3: No missile kill - good tracking to 1500' - gun kill - yo-yo up.
#4: Barrel roll attack after defender broke - still not able to pull lead or track - overshot too far in barrel roll - no gun or missile kill.
#5: Vertical dive - tracked to 1600' at high G - broke off - gun kill.
#6: Defender Split S - no follow by attacker.
#7: Diving Split S - with reduced power and hi G to maximum out-sense tracking to 1200-1400' as max G increased to 5.5 Gs roll off and accelerate away - gun kill.
Defender's Comments: #1: F-86 hard turn for 30° made turn reversal too early lost F4 - caused unnecessary gun kill by F4 - F86 misjudged rate of closure by F4; #2- F86 @ .8 broke hard and down pulling about 7G - spoiled missile attack but F4 achieved gun attack. #3- F86 made hard turn - F4 tracking - F86 high G roll under - F4 lost track immediately. #4- F86 broke hard left pulling high G/2 G - spoiled F4 missile and gun attack. #5- F86 hard diving turn down - Hi G up to 7G and caused F4 negative missiles attack but F4 could achieve gun attack. #6- F86 rolled over Split S - pulling hi G load up to 7G - F4 no missile or gun kill. Good escape. #7- F86 rolled over Split S but F4 achieved gun kill but but no missile kill. F86 again pulled hi G up to 7G.

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TEST DATA 2 - TAC MISSION 857 - ACT 3, 0 E

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F4C				
Defender		F86H				

Maneuver Log

	Engagement #	1.	2.	3.	4.	5.
1.	Attacker					
	Type Attack	Hi-Sid.	Hi-Sid.	Stern	Hi-Sid.	Stern
	Initial Speed/Altitude	.91 37M	.91 32M	.87 27M	.88 23M	.89 26M
	Terminal:(Missile) Speed/Angle Off	1.1M 10°⊿	1.2M 10°⊿	1.0M 30°⊿	1.2 20°⊿	1.1 10°⊿
	Barrel Roll Attack	No	No	No	Yes	No
	Missile Kill? Range G Angle Off	Yes	No	No	No	No
	Terminal: Gun Attack (3000'R)	1.0M	1.1M	1.1M	No	No
	High Speed Yo-Yo	Yes	No	Yes	No	No
	Roll Off	No	Yes	No	Yes	Yes
	Low Speed Yo-Yo	[illegible]	No	No	No	No
	Gun Kill?	Yes	Yes	Yes	No	Yes
2.	Defender - Initial Speed/Altitude	.85/35	.8/35	.8/25	.75/22	.85/20
	Hard Turn/Break	Yes	Yes	Yes	Yes	Yes
	Missile Attack Defeated	No	Yes	Yes	Yes	Yes
	Diving Spiral	No	No	No	No	Yes
	Vertical Rolling Scissors	No	No	No	No	No
	Attacker Over Shoot: Speed/Altitude	No	Yes	Yes	Yes	Yes
	Escape Achieved?	No	No	No	Yes	Yes
	Gun Kill?	No	No	No	No	No

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

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TEST DATA 2 - TAC MISSION 837 - ACT 3 (4) X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-4C				
Defender		F-86				

Maneuver 1-x

	Engagement # 1.	2.	3.	4.	5.
1. Attacker					
Type Attack	6-7/41	5-6/41	5-6/41		
Initial Speed/Altitude	.9/40	.9/38	.9/24		
Terminal:(Missile) Speed/Angle Off	1.2/40°	1.1/30°	1.1/20°		
Barrel Roll Attack	No	No	No		
Missile Kill? Range G Angle Off	No	No	No		
Terminal: Gun Attack (3000'R)	No	No	No		
High Speed Yo-Yo	No	No	No		
Roll Off	No	No	No		
Low Speed Yo-Yo	No	No	No		
Gun Kill?	No	No	No		
2. Defender - Initial Speed/Altitude	350FL .90	350FL .90	250FL .66		
Hard Turn/Break	Yes	Yes	Yes		
Missile Attack Defeated	No	Yes	Yes		
Diving Spiral	No	No	No		
Vertical Rolling Scissors	No	No	Yes		
Attacker Over Shoot: Speed/Altitude	Yes 1/30FL	Yes 1/2900	Yes 4/220		
Escape Achieved?	Yes	Yes	Yes		
Gun Kill?	No	No	Yes		

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/G

NOTES: Describe key factors for each engagement.

Defender's Comments:

#1 With attacker at 2 miles I started right diving turn with increasing G's caused overshoot and then rolled back over but attacker's speed was maintained and escaped easily by diving and turning.

#2 With attacker at 2 miles - this time a hard turn caused overshoot quickly but when rolled out attacker went by with diving turn and pull out climbing - I was inside but could not close to gun range.

#3 With attacker at 2 miles - I hard turned left and quickly back to the right after attacker overshot. Attacker tried to get back into fight with barrel roll, but I was above and descending without [illegible] his turn, staying inside for a good gun kill.

Attacker's Comments:

#1 At 2 miles, 5-10° angle off, defender made diving turn into attack. I could track at less than 2 G's to approx 1 mile, then G built up very rapidly. I rolled out and zoomed to 45M. First missile attack was not believed successful.

#2 At 2 miles, defender made hard diving turn into attack. G for tracking was almost immediately 3+, attacker rolled with 6+ and terminated at 43 to 30 M separation. With single adversary it is difficult, if not impossible, to secure the attack visually; however, the radar in the F-4C would greatly simplify this and in fact we made an attack using radar until we visually acquired tgt at 2 miles, 12 o'clock.

#3 Low Attack - We played defender's game and tried to outmaneuver. He got a gun kill.

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TEST DATA 2 - TAC MISSION 857 - ACT 2, 4, X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86H				
Defender		F-4C				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. **Attacker**					
Type Attack	6/Hi:	6/Hi:	6/Hi:	7/Hi:	
Initial Speed/Altitude	93/25	85/25	78/25	90/23	
Terminal: (Missile) Speed/Angle Off	92/5°	93/0°	92/0°	97/15°	
Barrel Roll Attack	No	No	No	No	
Missile Kill? Range & Angle Off	No	No	No	No	
Terminal: Gun Attack (3x00'X)	No	No	No	2500' 15° 3.5G	
High Speed Yo-Yo	No	No	No	No	
Roll Off	No	No	No	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	No	No	No	Poss	
2. **Defender** - Initial Speed/Altitude	82/22	93/21	91/20	91/20	
Hard Turn/Break	Yes	Yes	Yes	Yes	
Missile Attack Defeated	Yes	Yes	Yes	Yes	
Diving Spiral	No	No	No	No	
Vertical Rolling Scissors	No	No	No	No	
Attacker Over Shoot: Speed/Altitude	No	No	No	No	
Escape Achieved?	Yes	Yes	Yes	No	
Gun Kill?	No				

3. **E.M. Turns**

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments:

#1-Defender initiated 3'G' H/B descending turn when attacker at 7000'. Built up to 5'G' & 1.1 at 17000'. Attacker closed to 5000' & was pulling 3'G' to track (30° ∠ off), then range opened rapidly.

#2-Defender initiated 2½-3'G' H/B descending turn when attacker at 5000', 'G' & Mu built to 4 & 1.2 attacker closed to 4000', 30∠ off 3 G, then defender, keeping 'G' on, rapidly separated. Terminal altitude 17M.

#3-Defender initiated 2G H/B descending turn accelerated to 1.35 Mu & 4G. When attacker was approx. 6000 attacker closed to 5000' 20°-30° ∠ off approx. 3'G'. Terminated as defender started a rapid separation.

#4-Attacker was inside 3000' when evasive maneuvers started. Attacker could have made gun kill.

Attackers Comments:

#1-Attacker called 2 mi-defender initiated shallow diving turn. Attacker closed to 5000', 3G tracking 30° ∠ off separation was accomplished.

#2-Defender delayed maneuver til range approx. 5000' closing 6 o'clock .93M. Attacker closed to 4000' still 3G's and 30° off.

#3-Similar to #1-defender's shallow diving turn to accelerate for separation precluded closing below 5000' with 30° ∠ off minimum at min. range of 5000'.

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TEST DATA 2 - TAC MISSION 857 - ACT 3, 4, 5

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86				
Defender		F-4				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. **Attacker**					
Type Attack	Hi Side	Hi Side	Hi Side	Hi Side	
Initial Speed/Altitude	8/25	8/25	8/26	8/25	
Terminal: (Missile) Speed/Angle Off	—	—	460/1°	460/20	
Barrel Roll Attack	No	No	No	No	
Missile Kill? Range G Angle Off	No	No	No	No	
Terminal: Gun Attack (3000'R)	No	No	No	No	
High Speed Yo-Yo	No	No	Yes	No	
Roll Off	20M .78	20M .77	20M .76	20M .77	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	No	No	No	No	
2. **Defender** - Initial Speed/Altitude	—	—	—	—	
Hard Turn/Break	Not Feasible				
Missile Attack Defeated	Not Feasible				
Diving Spiral	16M 1.8	16M 1.8	15M 1.4	16M 1.25	
Vertical Rolling Scissors	Not Feasible				
Attacker Over Shoot: Speed/Altitude	—	—	—	—	
Escape Achieved?	Yes	Yes	No	Yes	
Gun Kill?	No	No	Yes	No	

3. **E.M. Turns**

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments:

#1 F-4 went max power, 0 G, when F-86 closed to 4500 ft — with 20° nose low a straight away wide roll was initiated with G increasing from +2 to +6 — took 13 seconds to accel to above 1.0. Terminated at 1.3. Max G = 6.

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

#3 Max power and ½ G to 25° nose low — was slow initiating roll with G slowly building to 5 G's and speed to 1.4 — maneuver initiated at 3000 ft range with good rate of closure.

#4 Max power and 0 G to 20° nose low. Rolled 120° to right followed by 5 G roll under — Accelerating to 1.3 and escape (Time to accel 7.6 to 1.1 was 8-9 sec on all passes)

Attacker's Comments:

#1 F-4 started 0 to ½ G pushover and roll to separate. This commenced at 4500' range. The pushover caught me off guard temporarily. I rolled over but F-4 separated and I never got closer than about 3600'. The pushover and rolling reversal maneuvering made tracking difficult if not impossible.

#2 Same as #1 except that F-4 rolled in opposite direction, unloaded and separated while changing roll rate and/or direction of roll.

#3 Same as #2 to 3000' but this time F-4 rolled immediately with greater closure rate (about 450 kts) and the F-4 stopped his roll at the inverted attitude and I got a gun kill at 1800-1600 ft.

#4 Same as #3 but I cut off in a rolling turn which put me straight down after I anticipated a turn reversal which did not happen. I had to break off and recover from dive.

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TEST PAGE 2 - [illegible] MISSION 857 - ACM (2) & 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	20 Time	Fly Time
Attacker 1.						
2.		E-86H				
Defender 1.						
2.		E-4C				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. Attackers					
Type Attack	Td/Hi	Id/Hi			
Terminal (Missile) Speed/Angle Off	—	—			
	—	—			
Missile Kill? #, Range, #, Angle Off	No	No			
Terminal: Gun Attack (3000')	No	No			
High Nos/Field Separation	Yes	No			
High Speed/Low Speed Yo-Yo	No	No			
	—	—			
Gun Kill? #	No	Poss			
	—	—			
2. Defenders: Initial Speed/Altitude	.86/35	.76/20			
Hard Turn/Break	Yes	Yes			
Gun / Missile Attack Defeated?	Yes	Yes			
Defensive Split	Yes	Yes			
Reversal (Rudd/Aver)	Yes	Yes			
Scoreboard/Escape Achieved	No	No			
Gun Kill? #	No	Yes			

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Attackers Comments - #1 - Attackers on D-2 - D-2 made Rt turn. A-1+2 stayed on D-2 until D-1 started attack on A1+2 Team A1+2 turned into D-1 making D-1 escape away. No gun kills for either side. Attackers caused a Def. split however, Def. made successful escape with AB power + Mach (Speed). #2. A 1+2 made overhead vertical pass picking out D-2 - D-2 made a left turn with A 1+2 pressing in for a Prob. Gun kill. D1 made attack on A1+2 causing A1+2 to break off D#2 but not before A1 was shot down by D1. A2 did not judge D1 range quick enough to call break. Defenders Comments: #1 - A1 on D2 (on Rt side) D1+2 accelerated to kill closure rate at 4200' Range. Rt turn by D1+D2 with D1 on outside rolled hi and in on A1 forcing A1 to break off D2 and break into D1 - with No offensive positioning avail. D1+D2 effectively broke off engagement and away. #2 - A1+A2 hi rate of closure on D2 off left side at 4500-5000' D1+2 accel. to kill closure rate and D2 made left turn to decoy off A1+2 + effect defensive split. D1 when abeam A1+2 - hard roll up over + behind D2 with 1.05 Rate + 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 - TAC MISSION 857 - ACT 2.0 X

(Fill in blanks; cross out inapplicable entries)

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

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. Attackers: Type Attack	6/Lo	6/Hi			
Terminal (Missile) Speed/Angle Off	—	—			
	—	—			
Missile Kill? #, Range, O, Angle Off	No	No			
Terminal: Gun Attack (3000')	—	1.05/6			
High Mnv/Fluid Separation	No	No			
High Speed/Low Speed Yo-Yo	No	No			
	—	—			
Gun Kill? #	No	Yes			
	—	—			
2. Defenders: Initial Speed/Altitude	98/35	75/20			
Hard Turn/Break	Yes	Yes			
Missile Attack Defeated?	—	—			
Defensive Split	No	Yes			
Reversal (Under/Over)	No	Yes			
Sandwich/Escape Achieved	No	No			
Gun Kill? #	No	No			

3. E/A Types

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments:
#1 - Defender #1/2 made hard left turn at about 7000', Attacker #1/2 could not track or get into position so attacker 1/2 pulled off high. Defender #1/2 achieved escape but could not release on hard reversal.
#2 - Slight Bike pass on defender #1 then switched to defender #2. Defender #2 made a break to late causing a gun kill on him by attacker #1. Defender #1 turned into Attacker #1/2 head on pass but was unable to reverse with enough mach to do any good.
Attacker's Comments:
#1 - Attacker #1/2 subsonic attempted pass on Defender 2 (right side). Defender 1/2 left break at 3500, 7000 ft. (plus) range. Broke off.
#2 - Attacker 1/2 from hi quartering stern dropped down - closing mach 1.05 - on defender 2 tracking to 500 ft. 15° off as break to right was initiated & gun kill.

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TEST PILOT - DAC MISSION 857 - ACM 1, 2, 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Sec	IP Time	Fly Time
Attacker		F-86H				
Defender		F-104C				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. Attacker	6/4i	6/4i			
Type Attack	A/40	.89/38			
Initial Speed/Altitude	.96/35	.9/33			
Terminal (2300'A) Speed/Altitude	No	No			
High Speed Yo-Yo	No	No			
Roll Off	No	No			
Low Speed Yo-Yo	Yes	Yes			
Gun Hit?	.9/35	.85/35			
2. Defender (Initial Speed/Altitude)	No	No			
Breaks:	No	No			
Attained Overshoot	—	—			
Speed/Altitude	No	No			
Reversals, # Reversals	No	No			
High G Roll Over	—	—			
Recovery Speed/Altitude	No	No			
High G Roll Under	—	—			
Recovery Speed/Altitude	Yes	No			
Kryo Achieved?	No	No			
Gun Hit??					

3. F.E. Data

Post-Remain	Altitude	Mach	Level Time G	A/C
2300	35	.90	3.0	F-104
2200	20	.83	4.5	F-104
unk	35	.8	3.5	F-86
unk	20	.8	3.5	F-86

NOTE: Describe key factors for each engagement.

F-104 unable to cause overshoot on any turn. Tries level climbs descending turn. On last engagement F86 was at 3000' range. F104 entered tight diving spiral - F86 pulled 6 Gs - unable to track - F104 escaped during diving spiral.

F-104 unsuccessful in climbing Spiral escape.

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TEST DATA 1 - TAC MISSION 857 - ACT 1 2 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86H				
Defender		F-104C				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	7/4i	7/4i	4/4i		
Initial Speed/Altitude	.96/40	.93/37	.86/25		
Terminal (3X0'S) Speed/Altitude	.92/28	.93/27	.73/18		
High Speed Yo-Yo	No	No	Yes		
Roll Off	No	No	No		
Low Speed Yo-Yo	No	Yes	No		
Gun Kill?	Yes	Yes	Yes		
2. Defender (Initial Speed/Altitude)	.90/35	.90/36	.83/20		
Break	Yes	Yes	Yes		
Attacker Over Shoot	No	No	No		
Speed/Altitude	—	—	—		
Scissors, # Reversals	No	No	No		
High G Roll Over	No	No	No		
Recovery Speed/Altitude	—	—	—		
High G Roll Under	No	No	No		
Recovery Speed/Altitude	—	—	—		
Escape Achieved?	No	No	No		
Gun Kill?	No	No	No		

3. E.M. Turns

Pool-Remain	Altitude	Mach	Level-Half G	A/C

NOTES: Describe key factors for each engagement.

Attackers Comments: #1 Attacker started down from 40M and had no trouble staying in the turn at all times ranging down to gun fire position. # 2 Started from 37M and 8 o'clock, dropped down and low to pick up speed and then stayed with him throughout downward turn. #3 - Started at 25M and .87. Overshot and high Yo-Yo'd on outside. Defender turned toward me & climbed in AB then rolled over to the right. My turn to follow him down presented No problems.

Defenders 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 rolled over in to F86 for escape maneuver but was too late to be effective.

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TEST DATA 1 - TAC MISSION 857 - ACM 2, 3, 8

(Fill in Blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86H				
Defender		F-104C				

Maneuver Log

	Engagement #	1.	2.	3.	4.	5.
1.	Attacker					
	Type Attack	5/Hi	7/Hi	7/Hi	7/Hi	
	Initial Speed/Altitude	1.5/30	90/32	.95/35	.90/25	
	Terminal (/XCO'd) Speed/Altitude	.94/35	.80/32	.82/30	.92/20	
	High Speed Yo-Yo	No	No	No	No	
	Roll Off	No	No	No	No	
	Low Speed Yo-Yo	No	No	No	No	
	Gun Kill?	Yes	Yes	No	No	
2.	Defender (Initial Speed/Altitude)	.9/35	.9/35	.8/35	.8/20	
	Break	No	No	No	No	
	Attacker Over Shoot	No	No	No	No	
	Speed/Altitude	—	—	—	—	
	Scissors, # Reversals	No	No	No	No	
	High G Roll Over	No	No	No	No	
	Recovery Speed/Altitude	—	—	—	—	
	High G Roll Under	No	No	No	No	
	Recovery Speed/Altitude	—	—	—	—	
	Escape Achieved?	No	No	Yes	Yes	
	Gun Kill?	No	No	No	No	

3. E.W. Turns

Fuel Remain	Altitude	Mach	Level/Max G	G/G

NOTES: Describe key factors for each engagement.

#1 - F-104 tight turned nearly level where F-86 rolled at 2M range - no overshoot - F-86 able to close range and ade quate track.

#2 - F-104 broke down when F-86 at 3000'. F-104 spiralled or rolled 2 turns - tracking spoiled - closure effected very little. Subsequent pull up by F-104 gave high Gs so F-86 Stacked up to 7G's. Nice above horizon F-86 more stable. Range 3-4000' tracking until F-104 starting to open up range.

#3 - F-86 at 2M range .92 Mach 30M. F-104 tight left descending turn-range closing F-104 rolled down to spiral before range got down to 3000'. F-86 high mach wing roll. Range began to increase. F-104 stopped spiral pulled out to slightly descending dive super-sonic - getting well out of range.

#4 - F-104 at 20M, .93 Mach with F-86 at 3000', 90/20 - 104 broke down sharply and began spiral-spoiling F-86 tracking. F-86 soon entered high mach wing roll problem. His content with F-104 began in using level pull up after engagement had been terminated for give up point being F-104 don't try zoom or any pull up - level out & go.

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TEST DATA 1 - TAC MISSION 857 - ACT 1, (2) 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly-Time
Attacker		F-104C				
Defender		F-86H				

Maneuver Log

Engagement #

	1.	2.	3.	4.	5.
1. Attacker	3/M1	6 level	6 level		
Type Attack					
Initial Speed/Altitude	9/30	.7/30	.7/30		
Terminal (1X'S) Speed/Altitude	1.4/25	1.2/30	1.1/22		
High Speed Yo-Yo	No	No	Yes		
Roll Off	Yes	Yes	No		
Low Speed Yo-Yo	No	No	No		
Gun Kill?	No	Hit	Yes		
2. Defender (Initial Speed/Altitude)	.85/35	.85/35	.85/20		
Break Hard Turn	Yes	Yes	Yes		
Attacker Over Shoot	Yes	Yes	Yes		
Speed/Altitude	1.4/35	1.2/30	.85/20		
Reversals, # Reversals	No	No	No		
High G Roll Over	No	Yes	No		
Recovery Speed/Altitude	—	—	—		
High G Roll Under	No	No	No		
Recovery Speed/Altitude	—	—	—		
Escape Achieved?	Yes	Yes	No		
Gun Kill?	No	No	No		

3. T.M. Times

Fuel Remain	Altitude	Mach	Level Max G	A/G

NOTES: Describe key factors for each engagement.

Defender's Comment

Doubtful kills by F-104 because of rapid closure rate of F-104. Missiles not too productive because of inability to see F-104 starting to making pass. Range estimation by F-104 pilot poor. Actual ranges were always much greater than estimated. F-86 did not see any pass by F-104 except engagement #2 which was sighted by observer then making possible kill turn covered. More work is needed positioning F-86 for attack to provide better visual contact.

Attacker's Comment

Note 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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TEST DATA - TAC MISSION 837 - ACE 1 ⊙ 2

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-104C				
Defender		F-86H				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	7/H1	6/H1	5/H1	6/H1	
Initial Speed/Altitude	.9/40	.9/35	9/31	.89/30	
Terminal (3X: 'Z) Speed/Altitude	1.2/35	1.1/35	1.25/26	.9/25	
High Speed Yo-Yo	No	No	Yes	No	
Roll Off	No	No	No	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	Ack	Yes	Yes	No	
2. Defender (Initial Speed/Altitude)	.81/35	.81/35	.75/25	.75/25	
Break Hard Turns	Yes	Break	Yes	Yes	
Attacker Over Shoot	Yes	Yes	Yes	Yes	
Speed/Altitude	.7	.7	.65	.65	
Separation Reversal/	Yes	Yes	Yes	Yes	
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	

3. E.M. Turns

Pull-Remain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments:

#1 Attacker appeared to be tracking with defender in hard turn. Difficult to judge distance because of size of F-104. Thought attacker was out of range when actually he was 2000-3000 feet. Caused overshoot still using hard turn but was unable to close to less than 4000 feet.

#2 Could set up attacker. Attacker called break, caused overshoot, but could not gain advantage

#3 Used hard turn to cause overshoot. Still could not gain advantage while trying to follow high speed yo-yo.

#4 Used hard turn but still could not gain. I believe that by using break I could have avoided almost all kills. Difficult to judge F-104 range.

Attacker's Comments:

#1 - F-86 start hard turn at 5000 ft range. 104 attack speed 1.2 at 3000'R able to track for 3 seconds then overshot. Broke down into diving spiral and escaped.

#2 - Closed at 6 o'clock called defender to break at 1 mile. Able to track & escape.

#3 - After kill I overshot yo-yoed up to 38000 and escaped.

#4 - 86 performed hard turn at 4000'. Unable to track while in gun range. Pilot escaped OK.

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TEST DATA I - TAC MISSION 837 - ACT I (2) 3
(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly-Time
Attacker		F-104C				
Defender		F-86H				

Maneuver Key

	Engagement # 1.	2.	3.		5.
1. Attacker					
Type Attack	5/H1	4/H1	4/H1	[illegible]	5/H1
Initial Speed/Altitude	.82/35	.82/55	.9/35	.7/30	.95/30
Terminal (3X3'X) Speed/Altitude	1.1/30	.9/30	1.3/32	1.0/20	.95/21
High Speed Yo-Yo	No	No	Yes	Yes	Yes
Roll Off	No	No	No	No	Yes
Low Speed Yo-Yo	No	No	No	No	Yes
Gun Kill?	Poss	No	No	No	Yes
2. Defender (Initial Speed/Altitude)	.82/30	.72/30	.82/30	.9/20	.9/25
Sound Hard Turn	Yes	Yes	Yes	Yes	Yes
Attacker Over Shoot	Yes	Yes	Yes	Yes	Yes
Speed/Altitude	.82/30	.8/31	.76/35	.8/20	.77/20
Scissors, # Reversals	Yes	Yes	Yes	Yes	Yes
High G Roll Over	Yes	No	No	No	No
Recovery Speed/Altitude	.8/30	—	—	—	—
High G Roll Under	No	No	No	No	No
Recovery Speed/Altitude	—	—	—	—	—
Escape Achieved?	Part	Yes	Yes	Yes	No
Gun Kill?	No	No	No	No	No

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments:
#1: Started hard-ft turn when 104 was at about 3500' range. He overshot and I rolled over the top to his [illegible] o'clock but he reversed and separated in a shallow dive.
#2: Same as [illegible]. I did hard climbing turn causing 104 to overshoot. I reversed to his 6 o'clock at about 3600' range but he unloaded and separated.
#3: Attacking 104 yo-yoed high: then overshooting my hard left climbing turn. I reversed and rolled under and we got into a scissors in the vertical and horiz plane with 104 eventually [illegible] and separating in a dive. Neither got in range for a gun kill.
#4: I did hard left turn causing overshoot and he yo-yoed high. I reversed and lost sight of the 104 momentarily. Sighted him [illegible] -4000' @ 1200 o'clock.
#5: 104 approached gun range. Then did hard diving turn causing overshoot and lost sight of 104. He rolled over high to my 6.
Attacker's Comments: #1: Tracked 1.2 sec but [illegible] make kill uncertain. Escape with descending low G turn.
#2: 1.2 closing then slowed to .9. S/B and idle. Able to turn longer but could not close gun range. Escape achieved with wings level 0G accelera-tion. Defender reversed early - was close to gun range for an instant.
#3: Defender turned early and attacker yo-yoed. Defender reversed down and away and initiated re-attack. Resulted in a rolling scissors and stand-off. Attacker accelerated away. #4: No AB used until yo-yo. Defender reversed but killed airspeed - could not get in range before I escaped.
#5: Hit "square corner" - 76 yo-yoed with a roll-over, 86 lost me and continued turn, attacker @ 2 miles. Had defender seen attacker at this time it would have resulted in a head on pass.

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TEST DATA 2 - TAC MISSION 237 - ACM (I) & II

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-111H				
Defender		F-104				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. **Attacker**					
Type Attack	5/Hi	5/Hi	5/Hi	7/Hi	7/Hi
Initial Speed/Altitude	9/46	9/39	85/26	85/25	85/26
Terminal:(Missile) Speed/Angle Off	92/52	92/50	75	73	96
Barrel Roll Attack	No	No	No	No	No
Missile Kill? Range & Angle Off	No	No	No	No	No
Terminal: Gun Attack (3000'R)	Unk	—	Unk	Unk	Unk
High Speed Yo-Yo	No	No	No	No	No
Roll Off	No	No	No	No	No
Low Speed Yo-Yo	No	No	No	No	No
Gun Kill?	Yes	No	Yes	Yes	Yes
2. **Defender** - Initial Speed/Altitude	89/35	86/35	85/20	85/21	8/16
Hard Turn/Break	Yes	No	Yes	Yes	Yes
Missile Attack Defeated	Yes	Yes	Yes	Yes	Yes
Diving Spiral	No	Yes	No	No	No
Vertical Rolling Scissors	No	No	Yes	No	No
Attacker Over Shoot: Speed/Altitude	—	—	—	30/? 360	—
Escape Achieved?	No	Yes	No	Poss	No
Gun Kill?	No	No	No	No	No

3. **E.M. Turns**

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments:

#1- Turned at 2 miles to spoil missile attack, steadily increasing turn. Attacker tracked through entire maneuver.

#2- At missile launch range defender rolled off and down and escaped.

#3- Lost sight of attacker at six o'clock. Made a hard turn then reversed and away and down. Defeated missile attack but definitely lost to gun attack.

#4- Made a hard climbing turn after attacker was in to 3000'. By dropping boards and pulling up hard was able to get the F-111 to overshoot. Gun attack was effective prior to overshoot. [illegible] the scissors for 3 turns before losing out again.

#5- Tried a straight pull-up. Was not effective at all.

Attacker's Comments:

#1- 104 turned away from attack. I decreased range during reversal and gun kill was easy at 1000 ft. max 4½ G's.

#2- 104 separated and avoided gun attack by unloading down. Commenced this at 2 miles.

#3- 104 did not see me at 6 o'clock. Started hard turn at [illegible]. I closed & tracked thru reversal and dive with calls and was in range all the time.

#4- 104 started climbing turn when I was at 5000 ft. I closed and then we got into scissors with me calling out into his 6 o'clock at 100-300 ft range.

#5- 104 did hard climbing turn. I stayed within 3000 ft. tracking all the way.

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TEST DATA 2 - TAC MISSION 857 - Acft 1 & 2

(Fill in blanks across out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-8CH				
Defender		F-104C				

Maneuver Log

Engagement #

		1.	2.	3.	4.	5.
1.	Attacker					
	Type Attack	5M;	5/H;	7/H;		
	Initial Speed/Altitude	88/39	90/39	80/25		
	Terminal:(Missile) Speed/Angle Off	.93	—	—		
	Barrel Roll Attack	No	No	No		
	Missile Kill? Range & Angle Off	5M 15° Yes 3C	No	No		
	Terminal: Gun Attack (3000'R)	91/25	No	No		
	High Speed Yo-Yo	No	No	No		
	Roll Off	No	No	No		
	Low Speed Yo-Yo	No	No	No		
	Gun Kill?	Yes	No	No		
2.	Defender - Initial Speed/Altitude	89/25	89/35	89/20		
	Hard Turn/Break	No	Yes	No		
	Missile Attack Defeated	n/a	Yes	Yes		
	Diving Spiral	No	Yes	Yes		
	Vertical Rolling Scissors	No	No	No		
	Attacker Over Shoot: Speed/Altitude	No	No	No		
	Escape Achieved?	No	Yes	Yes		
	Gun Kill?	Yes	No	No		

3. E.M. Tests

Fuel Remain	Altitude	Mach	Level/Max G	A/S

NOTES: Describe key factors for each engagement.

#1 Level turn when attacker was within 1 mile maintaining mach 90. When within gun range started a diving spiral but was too late to be effective.

#2 - Diving spiral when attacker at 10 mi. Fired to Mach 1.1 and opened up separation.

#3 - Diving spiral to the left. Attacker came in at high angle off (50°).

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TEST DATA 2 - TAC MISSION 837 - ACT (3) 4 5

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Base	TO Time	Fly Time
Attacker		F-86				
Defender		F-104				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. Attacker					
Type Attack	7/H.	7/H.	5/H.	5/H.	
Initial Speed/Altitude	.85/40	.85/40	.85/35	.85/25	
Terminal: (Missile) Speed/Angle Off	—	—	—	—	
Barrel Roll Attack	No	No	No	No	
Missile Kill? Range & Angle Off	No	No	No	No	
Terminal: Gun Attack (3000'R)	Yes	No	Yes	No	
High Speed Yo-Yo	No	No	No	No	
Roll Off	No	No	No	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	Yes	No	No	No	
2. Defender - Initial Speed/Altitude	.78/33	.98/35	.93/20	.93/20	
Hard Turn/Break	Yes	No	Yes	No	
Missile Attack Defeated	Yes	Yes	Yes	Yes	
Diving Spiral	No	Yes	No	Yes	
Vertical Rolling Scissors	No	No	No	No	
Attacker Over Shoot: Speed/Altitude	—	—	—	—	
Escape Achieved?	No	Yes	No	Yes	
Gun Kill?	No	No	No	No	

3. E.M. Turn

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments:

#1- When attacker was within 10000' started hard turn with low speed (280 Kts) due to malfunctioning kicker was unable to get over 2½ G's on aircraft. Gun kill was achieved when within gun range. Unloaded acft and attempted a diving spiral escape but was too late. broke off at 2000 - attacker at 2400'.

#2- When attacker within missile range started a "O G" acceleration to MACH 1 then a left diving spiral escape at 1.2 MACH and 4½ G's. Escape effective. Broke off at 23,000'. Acceleration to MACH 1 was within 5 sec.

#3- Same as #1. Malf. kicker prevented max G-loading. Gun kill. Terminated at 17000' 240 Kts.

#4- Same as #2. This escape prevented attacker from closing within 4200'. Terminated at 10,000', 1.05 MACH max G-4.5.

Attacker Comments:

#1- F-104 started left turn level at launch range. Was limited to 2½ G's due to kicker. I closed to 2400' and got gun kill with 5 G on F-86.

#2- F-104 unloaded in ¼ left roll and separated.

#3- F-104 did hard right turn again limited by kicker. I closed tracking to 1600 ft. for gun kill decreasing mach from .96 to 265 kts.

#4- F-104 unloaded in diving right turn with 4½ Gs to avoid missile attack. I closed to 4200 ft. but could not get to within gun range.

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TEST DATA 2 - TAC MISSION 857 - ACT 1 (2) 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		710AC				
Defender		7-86				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. Attacker					
Type Attack	7/H1	5/LO	5/Lvl	8/H1	
Initial Speed/Altitude	.9/40	1.0/20	.88/20	.9/15	
Terminal:(Missile) Speed/Angle Off	maneuvering	began at	5000'	range	
Barrel Roll Attack	No	No	Yes	No	
Missile Kill? Range G Angle Off	—	—	—	—	
Terminal: Gun Attack (3000'±)	No	No	No	No	
High Speed Yo-Yo	No	No	Yes	No	
Roll Off	No	No	No	No	
Low Speed Yo-Yo	No	Yes	No	No	
Gun Kill?	No	No	No	No	
2. Defender - Initial Speed/Altitude	.83/35	.83/35	.75/15	.75/20	
Hard Turn/Break	Yes	Yes	Yes	Yes	
Missile Attack Defeated	Yes	Yes	Yes	Yes	
Diving Spiral	No	No	No	No	
Vertical Rolling Scissors	No	No	No	No	
Attacker Over Shoot: Speed/Altitude	Yes	Yes	Yes	Yes	
Escape Achieved?	Yes	Yes	Yes	Yes	
Gun Kill?	No	No	No	No	

Defender's Comments: 7.

#1 Defender broke left when attacker called 3 mi range - caused overshoot breaking slightly toward at M .83. Reversed - not in position or range for missile or gun attack. Attacker entered climbing RT banking on defender losing visual contact. Defender maintained contact but [illegible] and angle off was too great for missile launch. Defender's mach dropped off.

#2 Defender broke right into attacker at 4000' range - caused overshoot - reversed - attacker performed diving left turn until out of gun range. Defender at too high an angle off for missile launch.

#3 Defender broke left into attacker at under 3 mi range - reversed after attacker overshoot. Climbing left turn by attacker resulted in defender able to cut across circle and position for possible missile launch with doubtful success due to angle - 30° off. Terminal with defender at 23000', 140 Kts, 1½ Gs, attacker 12 o'clock at 35000', 1.5 Gs, M .95.

#4 Defender at 20000' accelerated from .75 to .80 M as attacker closed to 3000-4000' range - broke left and [illegible] - caused overshoot - reversed but attacker broke down and right, picked up separation too rapidly for any successful defender attack.

Attacker's Comments:

#1 Defender kept attacker in sight and broke whenever he heard the 5000' call. This spoiled the gun tracking solution and maneuvering for an attack was not successful.

#2 [illegible] Defender [illegible] caused defender to lose sight of the attacker after break off but was unsuccessful.

#3 At 3 mi attacker [illegible] attack and [illegible] from 7 o'clock. [illegible] defender was [illegible] a [illegible] from [illegible] quarter but did not have attacker in sight. Missile kill [illegible] valid (in this instance [illegible] did not [illegible] until attacker called the second attack. Defender [illegible] left at outside of gun range and attack was [illegible] as soon as defender [illegible] this evasive action. Escape maneuver was a [illegible] ahead. Separation was more than adequate for a gun attack; however, had I not pulled into the sun I could have been subject to missile attack at max missile range i.e. I was at 35000' - .95 mach defender was at 23000', 150 Kts and 10 o'clock.

#4 High side attack, broke off after overshoot.

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TEST DATA 2 - IFC MISSION 857 - ACT 2 (5) 2

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-104				
Defender		F-96H				

Maneuver Log

Encounter #	1.	2.	3.	4.	5.
1. Attacker	6/Hi	5/Hi	6/Hi		
Type Attack					
Initial Speed/Altitude	95/39	90/40	90/35		
Terminal:(Missile) Speed/Angle Off	—	—	—		
Barrel Roll Attack	No	No	No		
Missile Kill? Range & Angle Off	No	No	No		
Terminal: Gun Attack (.X0'E)	No	No	No		
High Speed Yo-Yo	No	Yes	No		
Roll Off	No	No	No		
Low Speed Yo-Yo	No	No	No		
Gun Kill?	No	No	No		
2. Defender - Initial Speed/Altitude	85/35	95/35	85/20		
Hard Turn/Break	Yes	Yes	Yes		
Missile Attack Defeated	Yes	Yes	Yes		
Diving Spiral	No	No	No		
Vertical Rolling Scissors	No	No	No		
Attacker Over Shoot: Speed/Altitude	83/35	80/37	82/20		
Escape Achieved?	Yes	Yes	Yes		
Gun Kill?	No	No	No		

3. Kill Data

Pool Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

#1. F-96 at 35K + .95 Mach, F-104 attack at 39K, .95 achieved 1/2 dead astern, defender start hard turn at 5300 ft. Unable to track tgt while in gun range. Attacker achieved escape without gun or missile kill.

#2 - 96 at 35K + .95 Mach, 10 t quarter stern attack from 4000, 90. Defender started defensive turn at 4500 ft. Unable to track while on gun range. Attacker reduced power and speed brakes. Overshot and defender reversed - got in scissors 2 reversals. F-104 achieved escaped down and away. F-96 could have obtained favorable gun position if F-104 had continued with reversal & scissors.

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

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TEST DATA 2 - TAC MISSION 857 - ACT 3, 4, X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-104				
Defender		F-86				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. Attacker					
Type Attack	7/HI	7/HI	5/HI	5/HI	
Initial Speed/Altitude	.9/40	.85/35	.9/38	.85/28	
Terminal:(Missile) Speed/Angle Off	No	No	No	No	
Barrel Roll Attack	No	No	No	No	
Missile Kill? Range G Angle Off					
Terminal: Gun Attack (3000'R)	No	No	No	No	
High Speed Yo-Yo	No	No	No	No	
Roll Off	No	No	No	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	No	No	No	No	
2. Defender - Initial Speed/Altitude	85/35	.85/35	.85/35	.75/20	
Hard Turn/Break	H/T	H/T	H/T	H/T	
Missile Attack Defeated	Yes	Yes	Yes	Yes	
Diving Spiral	No	No	No	No	
Vertical Rolling Scissors	No	No	No	No	
Attacker Over Shoot: Speed/Altitude	Yes	Yes	Yes	Yes	
Escape Achieved?	Yes	Yes	Yes	Yes	
Gun Kill?	No	No	No	No	

3. H.H. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments:

#1 Defender went into right turn .85M, 3.5 Gs. Attacker overshot, defender anticipated and reversed to almost abeam attacker, but diving breakaway downward left enabled escape by attacker.

#2 & 3 Similar to #1 except defender did not initiate 3G turn until attacker down to 3-4000'. Defender attempted earlier reversal on indication of overshoot. Resulted in better position to follow attacker in breakaway escape maneuver, but separation and angle off was achieved by attacker.

#4 Defender at 20M, .75 mach, [illegible] right turn to keep attacker in sight, estimated 3000' range. Defender then increased Gs to 5.5 and turned 30° to cause overshoot. Defender [illegible] [illegible] [illegible] because I knew what attacker [illegible] [illegible]. Attacker used the same separation and escape methods as previously.

Attacker's Comments:

#1. Defender broke at 7000' range. Effect [illegible] diving spiral escape effectively. Defender with 5G [illegible] to track for gun attack.

#2. Defender made hard turn (3G) when attacker was at 7000', was able to track for very short time (2 sec at [illegible] range 3000' but [illegible]). Same escape as #1 was effective. Terminal speed 1.1M.

#3. Defender made hard turn when attacker was at 7000'. Attack speed 1.0 was unable to track any more than 1-2 sec and no closer than 2000'. Same escape maneuver effective as #1 & #2.

#4. I was diving at 30° and at 4000' range when defender effected hard turn. Attack speed was .98M. Was able to track for 2 sec. was within 3000' but it would have been a fleeting shot at best. Again a successful escape with same maneuver. Apparent that anytime he saw me within 7000' but out of gun range he could nullify any gun attack with my rate of closure being so high.

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TEST DATA 2 - TAC MISSION 857 - ACT 3, 4, X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86				
Defender		F-104				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. **Attacker**					
Type Attack	Stern	Stern	Quarter Stern	Stern	
Initial Speed/Altitude	.8/25	.8/25	.8/25	.85/25	
Terminal:(Missile) Speed/Angle Off	5/10°	5/10°	20°	5°	
Barrel Roll Attack	No	No	No	No	
Missile Kill? Range G Angle Off	Yes	Yes	No	No	
Terminal: Gun Attack (3000'R)	Prob	Yes	Yes	No	
High Speed Yo-Yo	No	No	No	No	
Roll Off	No	No	Yes	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	Yes	Yes	Yes	No	
2. **Defender** - Initial Speed/Altitude	.8/20	.8/20	.8/22	.8/20	
Hard Turn/Break	Break	Break	Hard Turn	Break	
Missile Attack Defeated	Yes	Yes	Yes	Yes	
Diving Spiral	No	Yes	Yes	No	
Vertical Rolling Scissors	No	No	No	No	
Attacker Over Shoot: Speed/Altitude	No	No	Yes	Yes	
Escape Achieved?	Yes	No	No	Yes	
Gun Kill?	No	No	No	No	

3. **E.M. Turns**

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments:

#1. F-86 called 5000' range. I broke left and down - rolled inside, complete 360 - Initial roll very rapid. Eased off but should not have. Altitude consumed rapidly. 80 pull out made. F-86 tracked successfully during pull out. Max G 5.5 Mach

#2. I broke hard and hard but did not get nose down - did not use rapid rolling capability of airplane to maximum. F-86 was tracking with radar lock on. Max G 5.

#3. Similar to #2 - Pilot did not use as much enthusiasm as needed - A/C has much greater capability. This engagement could be compared to a pilot who might be placed into combat with minimum experience.

#4. F-104 made attack - called defender approx. 2 mi. - F-86 made hard break. F-104 pulled max 5.7 G and fell to outside - turn continued - contact lost - no contest.

Attacker's Comments:

#1. F-86 at 5000' range when 104 broke hard left down. After reaching vertical position F-104 began to roll. On pull out by F-104 - the F-86 was able to close to gun range track and kill - but on initial break F-86 had little or no chance for gun kill. F-86 was in vertical dive and was pulling 7+ G and at stick [illegible].

#2. F-104 broke hard then immediately converted to diving spiral. F-86 was able to track in gun range throughout the maneuver closing to 1000' - F-86 was able to track at over "4" G close range at Mach .90.

#3. Same as #2 except F-104 initially only made a hard turn.

#4. F-86 became defender and F-104 attacker. F-86 broke hard left and slightly down - When F-104 was at 5000' range - F-86 pulling about 7 G.

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TEST DATA 1 - TAC MISSION 257 - ACM 2 v. 1

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly-Time
Attacker		F-5E-H				
Defender		F-104C				

Engagement #

Maneuver Log	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	7/HI	4/HI	3/HI	7/HI	
Initial Speed/Altitude	.86/25	.86/25	.86/25	.86/25	
Terminal (3X0'A) Speed/Altitude	.94/20	.94/20	.96/20	.96/20	
High Speed Yo-Yo	No	No	Yes	No	
Roll Off	No	No	Yes	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	Prob	No	Yes	No	
2. Defender (Initial Speed/Altitude)	350/20	350/20	325/22	350/21	
Break	No	No	Yes	Yes	
Attacker Over Shoot	No	No	No	No	
Spee'/Altitude	—	—	—	—	
Scissors, # Intervals	—	—	Yes	—	
High G Roll Over	No	No	No	No	
Recovery Speed/Altitude	—	—	—	—	
High G Instrument Rising Spiral	No	Yes	No	Yes	
Recovery Speed/Altitude	1.3/15M	1.2/10M	260 KTS 25M	V.1 20M	
Escape Achieved?	Ass	Yes	No	Yes	
Gun Kill?	No	No	No	No	

3. E.M. Turns

Pool-Lemain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments:

#1: Attacker came in about 20° off the tail. At 3000' range I tried a neg G quarter roll straight away escape. Attacker tracked in to 2200' prior to my separation.

#2: Same as #1 Except at 3000' range dropped flaps rolled hard 110° and spiralled away. Lost the attacker immediately.

#3: At about 3000' range I broke up and into the attack. Attacker tracked for a few seconds then overshot and yo-yoed high for re-attack. No contact.

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

Attacker's Comments:

#1: Was able to track and get to within 2200' gun range before negative G's forced sight to lose tracking.

#2: Called it @ 3000' range and target started right turn and spiral down. This 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 presented 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.

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TEST DATA 3 - TAC MISSION 037 - ACT 2 3, X

(Fill in blanks; cross out inapplicable entries)

Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker 1.					
2.	F-8C				
Defender 1.					
2.	F-104				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. **Attackers**					
Type Attack	7/Hi	7/Hi	37/Hi		
Terminal (Missile) Speed/Angle Off	—	—	—		
________	—	—	—		
Missile Kill? #, Range, G, Angle Off	No	No	No		
Terminal: Gun Attack (3000')	—	—	—		
High Mem/Fluid Separation	No	No	No		
High Speed/Low Speed Yo-Yo	No	No	No		
________	—	—	—		
Gun Kill? #	Yes	Yes	Yes		
________	—	—	—		
2. **Defenders**: Initial Speed/Altitude	.95/35	.95/35	.90/.20		
Hard Turn/Break	Yes	Yes	Yes		
Missile Attack Defeated?	Yes	Yes	Yes		
Defensive Split	Yes	Yes	Yes		
Reversal (Under/Over)	No	No	No		
Sandwich/Escape Achieved	No	No	No		
Gun Kill? #	No	No	No		

3. **E.M. Turns**

Fuel Remain	Altitude	Mach	Level/Max G	A/S

NOTES: Describe key features for each engagement.

#1 - Attackers at 3000 range. F-104's must enter diving spiral escape to preclude gun kill. Defensive split allows attackers time to maneuver to effect gun kill. E-8C achieved gun kill.

#2 & 3 - Were similar, except more lateral separation. Effective defensive split was not achieved, unable to offer support. If F-104 does not immediately depart the scene F-8C can achieve kill.

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KEY DATA 2 - [redacted] - ACT 2 (4) X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	ID Time	Fly Time
Attacker 1.						
2.		F-104				
Defender 1.						
2.		F-16				

Maneuver Log

	Engagement #				
1. Attackers	1.	2.	3.	4.	5.
Type Attack	4 level	4 level			
Terminal (Missile) Speed/Angle Off	—	—			
_____	—	—			
Missile Kill? #, Range, &, Angle Off	—	—			
Terminal: Gun Attack (3000')	.92	.92			
High Nm/Fluid Separation	Yes	Yes			
High Speed/Low Speed Roll	No	No			
_____	—	—			
Gun Kill? #	Yes	Yes			
_____	—	—			
2. Defenders: Initial Speed/Altitude	27/35	27/35			
Hard Turn/Break	Yes	Yes			
Missile Attack Defeated?	Yes	Yes			
Defensive Split	Yes	Yes			
Reversal (Under/Over)	No	No			
Sandwich/Escape Achieved	No	No			
Gun Kill? #	No	No			

3. K.E. Types

Fuel Remain	Altitude	Mach	Level/Nm G	A/C

NOTES: Describe key factors for each engagement.

Attackers initiated the attack from 4 o'clock level 5 miles. The defenders could not keep both attackers in sight. #1 called off range and angle. Defenders made a defensive split at about 2 mile.

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TEST DATA 1 - TAC MISSION 837 - AC (1) 2 3 4

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		E-86H				
Defender		E-105D				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. Attacker	4/Hi	4/Hi	5/Hi	7/Hi	
Type Attack					
Initial Speed/Altitude	.8/40	.75/38	.75/38	.8/30	
Terminal (3000'A) Speed/Altitude	.97/20/5	.5/15/4	.7/24/3	.7/21/4	
High Speed Yo-Yo	Yes	No	Yes	Yes	
Roll Off	No	No	Yes	Yes	
Low Speed Yo-Yo	No	No	Yes	Yes	
Gun FJ..?	No	Yes	Yes	Yes	
2. Defender (Initial Speed/Altitude)	.9/35	.9/35	.95/35	330/25	
Break	No	Yes	Yes	Yes	
Attacker Over Shoot	No	No	No	No	
Speed/Altitude	—	—	—	—	
Scissors, # Reversals	No	No	No	No	
High G Roll Over	No	No	Yes	No	
Recovery Speed/Altitude	—	—	200/30	—	
High G Roll under	No	No	No	No	
Recovery Speed/Altitude	—	—	—	—	
Escape Achieved?	Yes	No	No	No	
Gun still?	No	No	No	No	

3. E.E. Type

Fuel Remain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

#1 — Defender started turn @ Approx 6-7000' High. Yo-Yo initiated but defender left area and called off pass.

#2 Just a tracking situation — Slight Yo-Yo's used. Nose up and down approximately 20° from tracking pass to cut off defender. Kill would be a probable. Range estimation 3000-2500' with defender increasing range.

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

Same as above except @ lower alt. and lower A/S. Both Hi & Lo speed Yo-Yo utilized. Defender rolled under thru the vertical. But as he slowed down a good tracking situation developed. Range 1500-1000'.
Note: Defender flew wrong A/C until approx. 2000' Range.

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TEST DATA 1 · TAC MISSION 357 · ACT (1) 2 3
(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F86H				
Defender		F105D				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. Attacker					
Type Attack	7/4i	5/4i	7/6i		
Initial Speed/altitude	98/40	89/40	86/24		
Terminal (1XXX'S) Speed/altitude	97/38	96/39	95/35		
High Speed Yo-Yo	Yes	Yes	No		
Roll Off	Yes	Yes	Yes		
Low Speed Yo-Yo	No	No	Yes		
Gun Kill?	Yes	No	Yes		
2. Defender (Initial Speed/altitude)	.9/35	.9/35	330K/25		
Area	.9/33	95/33	Discontinued 320 Engagement		
Attacker Over Shoot	No	Yes			
Speed/altitude	—	350/28			
Scissors, # Reversals	No	No			
High G Roll Over	No	No			
Recovery Speed/altitude	—	—			
High G Roll Under	Yes	Yes			
Recovery Speed/altitude	200k/22	1.0/15			
Escape Achieved?	No	Yes			
Gun Kill?	No	No			
	No AB	AB			

3. E.M. Data

Fuel Pounds	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Defenders Comments: #1 - Made slight nose-low breakdown to 250 k, then hard roll underneath. He came up beside me after roll out but I had 200 k - We then Quit. I did not use AB #2 Got burner + broke into the attack, then came out of AB + gave max performance "stop", he came up beside me so I turned into + under him, got burner + Split S'd away getting good separation. He said I was moving away very good. Then I pulled up into the sun, 45° AB climb from Mach 1 + about 15 M — He came up well behind me, I zoomed max performance, turned back down into him but he cut me off easily. #3 Did not have time to complete; it looks a lot better as I got down to 5000 lbs - loaded with 4000 lbs. Attackers Comments: On 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 over-the-top maneuver. Max G during flight 6.25 + - 1.0. (Usually 2-4 G's - never exceeded wing roll (Mach .97) lowest speed approx. 140 IAS.

I feel that a minor overshoot can be turned to the advantage of the F86 by getting the target a/c to commit to a split and the attacker using a vertical roll maneuver.

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TEST DATA I - TAC MISSION 857 - ACT (1) 2, 3
(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly-Time
Attacker		F-86				
Defender		F-105D				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. Attacker					
Type Attack	5/41	7/41	7/41	5/41	
Initial Speed/Altitude	.9/38	.85/37	330/26	330/25	
Terminal (3X0'G) Speed/Altitude	.92/32	.90/25	390/20	350/20	
High Speed Yo-Yo	Yes	Yes	No	Yes	
Roll Off	No	Yes	No	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	No	Yes	Yes	Yes	
2. Defender (Initial Speed/Altitude)	.9/35	.9/33	330/20	330/20	
Break	Yes	Yes	Yes	Yes	
Attacker Over Shoot	No	No	No	No	
Speed/Altitude	—	—	—	—	
Scissors, # Reversals	No	Yes	Yes	No	
High G Roll Over	No	Yes	No	No	
Recovery Speed/Altitude	—	—	—	—	
High G Roll Under	Yes	No	No	Yes	
Recovery Speed/Altitude	200/20	.9/15	.9/15	250/10	
Escape Achieved?	No	Yes	No	No	
Gun Kill?	No	No	No	No	

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Defender's Comments: All maneuvers were started with a defensive turn out attack.
#1. On first maneuver entered a hard turn and went into a high [illegible], ending very [illegible] with no escape.
#2. From hard turn, entered [illegible] [illegible] attacker out. From there went into a high G roll under and range distance increased rapidly - 15-30 seconds and was out of range.
#3. Hard turn then reversed [illegible] [illegible], but not effective.
#4. Engagement same as #3.
Attacker's Comments: The hard turn tends to generate an overshoot, although not quite as pronounced against the F-102. The tendency to overshoot is easily countered with the high speed yo-yo, [illegible] and a whole new attack must be initiated if the [illegible] high. It is felt that a better counter to the [illegible] speed brakes and actually follow the F-105 around the Hi-G turn, thus providing more tracking and shooting time. By staying close, 1000-1500', many chances to fire are provided [illegible].
During engagement #2, F-105 was effective in escape following a Hi-G roll under, increasing the range from [illegible] to 6000' in about 15 to 20 sec.

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ZONE RAPA 1 - TAC MISSION 857 - ACT 1 2 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	2D Time	Fly Time
Attacker		F-105D				
Defender		F-86H				

Maneuver Log

Engagement #

	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	Lag	Lead	3/Lead		
Initial Speed/Altitude	1.15/35	1.1/20	1.1/20		
Terminal (3000'A/ Speed/Altitude	1.0/35	.9/20	1.0/20		
High Speed Yo-Yo	Zoom	Yes	Yes		
Roll Off	Yes	Yes	Split S (#)		
Low Speed Yo-Yo	No	Yes	—		
Gun Kill?	No*	No	No		
2. Defender (Initial Speed/Altitude)	355/35	335/20	335/20		
Break	Yes	Yes	Yes		
Attacker Over Shoot	Yes	Yes	Yes (#)		
Speed/Altitude	—/40	—/23	330/20		
[redacted], # Reversals	Yes	Yes	Yes		
High G Roll Over	Yes	—	—		
Recovery Speed/Altitude	—	—	—		
High G Roll under	No	No	No		
Recovery Speed/altitude	—	—	—		
Escape Achieved?	Yes	—	Yes		
Gun Kill?	Partial	Yes	No		

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

3. F-86 Down

Pool Remain	Altitude	Mach	Level Max G	A/C

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 runaway, the attacker was forced to roll under & the defender almost got a kill before the 105 RAN away.

2 Pressed the attack pulling 6 G's but could not track even @ 6G so I yo-yo'd high at about 9 M. 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 circle of pursuit & tried one Yo-Yo then RAN & easily got away by not staying longer in the 86's environment.

Remarks: 105 Attacker didn't get 1.2M but get close enough to it to see that we still cannot track him in the break, & we cannot press the attack at all if we are to get away safely after giving up on the attack.

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TEST DATA 1 - TAC MISSION 357 - ACT 1 (2) 3
(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F105D				
Defender		F-86				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. Attacker					
Type Attack	6 Level	6 Level	6 Level	6 Level	
Initial Speed/altitude	.9/38	.9/24	.9/40	.9/25	
Terminal (3X0°A) Speed/Altitude	1.25/35	.98/20	1.2/35	.98/20	
High Speed Yo-Yo	Yes	No	No	No	
Roll Off	No	Yes	Yes	Yes	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	No	Pass	Prob	Yes	
2. Defender (Initial Speed/altitude)	35/.85	20/330	35/.85	20/330	
Break	Yes	Yes	Yes	Yes	
Attacker Over Shoot	Yes	Yes	Yes	Yes	
Speed/altitude	↓	↓	↓	↓	
Scissors, # Reversals	Rev	Rev	Rev	Rev	
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?	Yes	No	Yes	No	

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Attacker's Comments:

1. High Yo-Yo - Too late and not effective. F-86 reversed and got behind.

2. Snap Shot - Roll off. F-86 could not follow ie. losing range.

3. Three Seconds of tracking then overshot, followed with a Hi G roll which killed airspeed. F-86 closed into range and got kill.

4. Good tracking - would have made kill - unloaded and Roll-off at 9m - Hit .99 immediately. F-86 had snap shot but was not closing.

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TEST DATA I - DAC MISSION 857 - ACT 1 (2) 3

(Fill in Blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO That	Fly Time
Attacker		F-105F				
Defender		F-86				

Maneuver Log

Engagement #

	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	6/Level	6/Level	6/Level		
Initial Speed/Altitude	1.12/35m	1.11/35m	1.10/20m		
Terminal (3XG'S) Speed/Altitude	1.02/35m	.92/25m	.93/23m		
High Speed Yo-Yo	Yes	Yes	Yes		
Roll-off Reversal	Yes	Yes	Yes		
Low Speed Yo-Yo	—	—	—		
Gun Kill?	No	No	No		
2. Defender (Initial Speed/Altitude)	.85/35	85/35	.85/20		
Hard Turn	Yes	Yes	Yes		
Attacker Over Shoot	Yes	Yes	Yes		
Speed/Altitude	.7	.7	.7		
Effects. # Reversals	Yes	Yes	Yes		
High G Roll Over	No	No	No		
Recovery Speed/Altitude	—	—	—		
High G Roll under	No	No	No		
Recovery Speed/altitude	—	—	—		
Escape Achieved?	Yes	Yes	Yes		
Gun Kill?	No	No	No		

3. E.M. Turns

Pull Remain	Altitude	Mach	Level Max G	A/C

NOTES: Describe key factors for each engagement.

Attacker's Comments:

1. Had lock on but did not get into effective gun range before had to break off. Reported holding altitude & mach and after getting some separation zoomed and reversed to try for another pass. Ended up at about 45° from bird on 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, met defender about 45° off from bird on pass, but had much lower airspeed.
3. Tried to track into fire position. Used 5.5 Gs but could not track. Broke off and attempted a reversal into defender. No success, so I broke.

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TEST DATA 2 - TAC MISSION #5? - ACM (2) 4v4 X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-16A				
Defender		F-15C				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	6/Hi	7/Hi	Unk-Ovh		
Initial Speed/Altitude	80/40	78/40	82/22		
Terminal:(Missile) Speed/Angle Off	.9/0°	.9/15°	.82/5°		
Barrel Roll Attack	N/A	N/A	N/A		
Missile Kill? Range & Angle Off	Yes	Unk	Unk		
Terminal: Gun Attack (3000'±)	.85/28	87/20	325/18		
High Speed Yo-Yo	No	No	Yes		
Roll Off	No	No	Yes		
Low Speed Yo-Yo	No	No	N/A		
Gun Kill?	Yes	Yes	Yes		
2. Defender - Initial Speed/Altitude	.85/36	86/36	330/20		
Hard Turn/Break	Yes	Yes	Yes		
Missile Attack Defeated	Unk	Unk	Unk		
Diving Spiral	Yes	Yes	N/A		
Vertical Rolling Scissors	No	Yes	N/A		
Attacker Over Shoot: Speed/Altitude	No	Yes	N/A		
Escape Achieved?	N/A	No	N/A		
Gun Kill?	No	No	N/A		

3. F.M. Turns

Pool Remain	Altitude	Mach	Accel/Decel	

NOTES: Describe key factors for each engagement

Attackers Comments: #1 Missile [illegible] dive. F-105 started 2+G turn [illegible] + I cut off turn + got a gun kill, then a missile kill during the Def. escape maneuver. #2 - I launched from 5 o'clock high in about 15° dive + 1000' range. Def. made hard diving turn left + again I closed in + cut off + got a gun kill going down through about 2000'. Then I overshot in the vert. scissors + Def. slid to my 6 o'clock but could not have tracked + he snapped due to adverse G's. #3 Had on at 22N + I did hard climbing right turn above Def. + he crossed below me so I rolled into his 6 o'clock + got a gun kill. Nats Target ID was just about impossible on all attacks until inside missile launch range.

Defenders Comments: #1 - Started into defensive turn ending in diving spiral with Burner escape. #2 Started with defensive turn into diving spiral. Pulled up into a Vert. scissors + Flushed F-16 out front. In attempt to track A/C entered a partial snap underneath + so had to release controls + try a diving burner escape which was effective. #3 Passed within 15° A-off + 1000' went into burner + pulled up to turn into Attacker. I could have kept going in burner + escaped, however attempted another Yo-Yo + did nothing but enable Attacker to do a Roll off into attack position.

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TEST DATA 2 - TAC MISSION 857 - ACT (2) - X
(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86				
Defender		F-105D				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. Attacker					
Type Attack	4/41	7/41	Head On		
Initial Speed/Altitude	.9/40	.8/25	.9/28		
Terminal:(Missile) Speed/Angle Off	.95/40	.85/60	None		
Barrel Roll Attack	No	Yes	No		
Missile Kill? Range & Angle Off	No	No	No		
Terminal: Gun Attack (3000'R)	No	No	3000'/.9		
High Speed Yo-Yo	No	Yes	No		
Roll Off	No	No	No		
Low Speed Yo-Yo	No	No	No		
Gun Kill?	No	Yes	No		
2. Defender - Initial Speed/Altitude	.9/35	330/20	.9/22		
Hard Turn/Break	Yes	Yes	Yes		
Missile Attack Defeated	Yes	Yes	Yes		
Diving Spiral	Yes	[illegible]	Yes		
Vertical Rolling Scissors	No	No	No		
Attacker Over Shoot: Speed/Altitude	300/20		—		
Escape Achieved?	Yes	after Kill	Yes		
Gun Kill?	No	No	No		

3. F.M. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Attacker's Comments:

1. On two engagements F-105 managed to get nose straight down and by means of vertical spiral defeat F-86 tracking capability. Problem for F-86 was compounded when mach built up to .96 and wing roll was encountered. Approaching mach 1 nose of F-86 gets heavy and pilot must start recovery procedures (throttle back and boards out if necessary.)

2. Intense tracking by F-86 at too high a rate of closure causes overshoot by F-86.

Defender's Comments:

1. Defender kept attacker at greater than 40° angle off in hard descending turn at .9 mach. Attacker closed to gun range. Defender broke (tightened turn) suddenly with attacker at 3000' range and forced overshoot. Defender immediately pulled down to vertical and began accelerating diving spiral. Attacker followed. Defender effected separation and leveled out at 5000' and .95 mach for escape.

2. Defender began defensive level turn at 330 KIAS 20,000'. Attacker closed to gun range and effected kill at 1500'-800' (Defender misjudged distance). Defender broke at this time, down and entered diving spiral escape as described above.

3. Attacker and defender both began rolling pull up turns into each other when line abreast. Defender lost sight of attacker during maneuvering (Defender in A.B. throughout). Attacker reidentified high at 5 o'clock. Defender escaped using diving spiral to .95 at 5000'.

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TEST DATA 2 - TAC MISSION 837 - ACT 2/(3)/4

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	a/c #	Date	TO Time	Fly Time
Attacker		F-105D				
Defender		F-8H				

Maneuver Log

Passes #	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	7/Hi	7/Hi	5/Hi		
Initial Speed/Altitude	95/40	95/25	1.1/38		
Terminal: (Missile) Speed/Angle Off	1.3/10°	.98/15°	—		
Barrel Roll Attack	No	No	No		
Missile Kill? Range G Angle Off	6000'/10°/1.4G Yes	3000'/15°/1.5G Yes	Too far/1.2G No		
Terminal: Gun Attack (3000'R)	3M/2G	300k/20°	—		
High Speed Yo-Yo	No	No	Yes		
Roll Off	No	No	Yes		
Low Speed Yo-Yo	No	Yes	Yes		
Gun Kill?	Yes	Yes	No		
2. Defender - Initial Speed/Altitude	9/35	300k/20	9/35		
Hard Turn/Break	Break 3500	No	—		
Missile Attack Defeated	No	No			
Diving Spiral	No	No			
Vertical Rolling Scissors	No	No			
Attacker Over Shoot: Speed/Altitude	1.1/33	Yes			
Escape Achieved?	No	No	Yes		
Gun Kill?	No	Yes	No		

High 'G' Roll Under — Yes

High 'G' Roll Over — Yes

3. E.M. Tapes

Pool Remain	Altitude	Mach	Lever/Max G	A/C

NOTES: Describe key factors for each engagement.

#1 Attacker initiated high mach descending sixteen attack. Defender missed pre-briefed terminal missile (2 NM range) radiocall and did not begin break until after gun kill. Break caused attacker to immediately overshoot so attacker rolled opposite to inverted and began spiraling supersonic escape. Defender performed high G roll under in anticipation of attacker overshoot + downward escape, but attacker achieved separation.

#2 Attacker initiated steep 9 o'clock attack; defender lost sight of attacker after missile kill. Attacker pulled into defenders turn but lost overtake speed doing this so did low speed Yo-Yo & closed to defenders low 6 o'clock position for kill. Defender observed attacker at 1000' and did an immediate high G roll over, forcing attacker overshoot and obtained gun kill from 250'-1000' range as attacker attempted escape.

#3 Both A + D lost sight of each other several times due to maneuvering, distance + clouds. After initial head on pass attacker zoomed then rolled under for cut off. Supersonic low speed Yo-Yo. After 2ND Yo-Yo Attacker was 7000' above + behind Def. who had lost sight of him. Att. had 180 KCAS so dropped nose for simulated missile launch, then dove for escape velocity rather than flutter down for a gun attempt, since at this point defender spotted him and began low speed climb.

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TEST DATA 2 - TAC MISSION 857 - ACT 3 (4) 5

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	IP Time	Fly Time
Attacker		F105D				
Defender		F-86				

Engagement #

Recovery Log	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	6/141	Head On			6/141
Initial Speed/Altitude	93/40	90/27			.75/42
Terminal (Missile) Speed/angle Off	1.22/35	1.13/25			.94/30
Barrel Roll Attack	No	No			No
Missile Kill? Range & Angle Off	—	—			Yes
Terminal: Gun Attack (3000'?)	No	No			—
High Speed Yo-Yo	Yes	Yes			No
Roll Off	No	No			No
Low Speed Yo-Yo	No	No			No
Gun Kill?	No	No			No
2. Defender - Initial Speed/Altitude	.85/35	.85/25		7105	.63/35
Hard Turn/Break	Yes	Yes			Half Roll Split
Missile Attack Defeated	Yes	Yes			No
Diving Spiral	No	Yes			No
Vertical Rolling Scissors	No	No			No
Attacker Over Shoot: Speed/Altitude	Yes	—			No
Escape Achieved?	Yes	Yes			No
Gun Kill?	No	No			No

3. K.E. Terms

Fuel Remain	Altitude	Mach	Level/Max G	A/B

NOTES: Describe key factors for each engagement.

1. Attacker launched simulated missile with range available at 0800. Pressed for gun attack. Defender broke; attacker yo-yoed high. Defender reversed at 1.1-.75 mach, did not get descending attacker. Loss of guns; attacker broke off and separated. Defender could not reattain gunner missile kill position.

2. Attacker attempted high-speed yo-yo reversal after head on pass. Defender used diving roll and spiral to assume gun attack position. Attacker half-rolled away.

3. F105 defended, and attempted split S escape. Attacker tracked 10-15 seconds, -1-1.5 G, for unsuccessful AIM-9B launch position during defender escape. Defender lost in clouds.

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TEST DATA 2 - TAC MISSION 857 - ACT (2) X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	20 Time	Fly Time
Attacker 1.						
2.		F-105D				
Defender 1.						
2.		F-86H				

Maneuver Log	Engagement # 1.	2.	3.	4.	5.
1. Attackers					
Type Attack	6Hi	6/10			
Terminal (Missile) Speed/Angle Off	1.27/5°	.91/2°			
_____	—	—			
Missile Kill? #, Range, G, Angle Off	—	—			
Terminal: Gun Attack (3000')	1.0/20	.9/28			
High Nos/Flat Separation	Yes	No			
High Speed/Low Speed Re-To	No	No			
_____	—	—			
Gun Kill? #	Yes	Yes			
_____	—	—			
2. Defenders: Initial Speed/Altitude	.86/35	.86/30			
Hard Turn/Break	Yes	Yes			
Missile Attack Defeated?	—	Yes			
Defensive Split	Yes	Yes			
Reversal (Under/Over)	No	No			
Sandwich/Escape Achieved	No	Yes			
Gun Kill? #	Yes	No			

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C

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 yo-yo'd then slid behind #1 F-105 and achieved kill at 2000-1500 ft. #2 F-86 got to 6 o'clock on #2 F-105 - did not get a kill because of wing roll (95°) even though he was in 3000-2000'.
#2 - Yr. 1 F105 started left turn and #1 F86 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 6 o'clock. I broke up left. #2 F-105 unloaded and separated.
F-105 Comments: Good 105 missile attack at 1.26 mach. 86's did a hard turn but not hard enough & #2 closed to a kill on #4. Then #1 closed & got a kill on #4 as #2 rolled down & out. The point is that we could not switch from 4 to 3 on the attack because #2 was sticking #4. The sandwich works well, though by #2 staying right on the #4 & sucking him down if #2 can't get a kill going by. The sandwich occurs fast & was easy to perform if the defender makes a hard turn & not a break. We (105's) could not switch as briefed because #3 separated from #4, so we had to stay after & kill #4.

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TEST DATA 1 - TAC MISSION 857 - ACT (1) (2) 3

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	IP Time	Fly Time
Attacker		F-86H				
Defender		F-100D				

Maneuver 1c4

Engagement #

	1. 86H	2. 86H	3. 100D	4.	5.
1. Attacker					
Type Attack	5/Hi	5/Hi	5/Hi		
Initial Speed/Altitude	.85/35	85/30	.90/30		
Terminal (3000'A) Speed/Altitude	30M	35M	—		
High Speed Yo-Yo	Yes	Yes	Yes		
Roll Off	Yes	Yes	No		
Low Speed Yo-Yo	Yes	Yes	No		
Gun Kill?	Yes	Yes	No		
2. Defender (Initial Speed/Altitude,	.85/35	.85/30	.85/30		
Break:	Yes	Yes	Yes		
Attacker Over Shoot	Yes	Yes	No		
Speed/Altitude	200/3c	200/3c	—		
Scissors, # Reversals	Yes	Yes	No		
High G Roll Over	No	No	No		
Recovery Speed/Altitude	—	—	—		
High G Roll Under	No	No	No		
Recovery Speed/altitude	—	—	—		
Escape Achieved:	No	No	Yes		
Gun Kill?	No	No	No		

3. E.M. Turns

Pool Remain	Altitude	Mach.	Level Max G	A/C

NOTES: Describe key factors for each engagement.

#1 - Able to Force F-86H to overshoot in vertical plane, but F86 pulled up out of fight & rolled off behind F-100.

#2 - Ditto

#3 - Hi Speed Yo Yo attempted when F100 unable to stay in F86H plane of flight. F86 able to pull up and out zoom F-100 then roll-off to a position behind F-100. F-100 made 95 diving spiral for separation.

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TEST DATA 1 - TAC MISSION 857 - AC (1) 2, 3
(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86H				
Defender		F100 D				

Maneuver Log

	Engagement #: 1	2	3	4	5
1. **Attacker**	F86	F86	F86	F100	
Type Attack	6/Hi	7/Hi	7/Hi	7/Hi	
Initial Speed/Altitude	.92/37	.85/35	.85/30	.85/23	
Terminal (3X0'?) Speed/Altitude	.95/33	.92/30	.80/30	250/27	
High Speed Yo-Yo	Yes	No	Yes	No	
Roll Off	Yes	No	Yes	No	
Low Speed Yo-Yo	No	No	Yes	No	
Gun Kill?	Yes	Yes	Yes	No	
2. **Defender** (Initial Speed/Altitude)	.9/35	.8/30	.8/30	.8/20	
Break	Yes	Yes	No	No	
Attacker Over Shoot	Yes	No	Yes	No	
Speed/Altitude	.85/35	.88/30	.9/30	—	
Scissors, # Reversals	No	No	No	No	
High G Roll Over	No		No	No	
Recovery Speed/Altitude	—	—	—	—	
High G Roll Under	No	No	No	No	
Recovery Speed/Altitude	—	—	—	—	
Escape Achieved?	No	No	No	No	
Gun Kill?	No	No	No	No	

3. E.M. Turns

Fuel Remain	Altitude			A/C

NOTES: Describe key factors for each engagement.

#1 - Broke left when 86 at 3000' @ 7 o'clock - Reversed at 200 IAS - 86 hi speed yo-yo'd + pulled off to my 6 o'clock position.

#2 - Started defensive turn when it was at 45° ∠ off @ 4-5000'. 86 was able to stay inside turn radius since I started turn when he was still too far out.

#3 86 made hi side attack. 100 turned hard into 86 at 3000' causing overshoot. 100 reversed at 250 IAS. 86 hi speed yo-yo'd + 100 rolled down + into 86 + dove for separation.

#4 - 100 made hi side attack on 86. 86 turned hard into attack + zoomed straight up. 100 not able to track during pull up; but could track when 86 came over top + started down. 86 then pulled up hard into 100 (vert rolling scissors). 100 dove away successfully.

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TEST DATA 1 - DAC MISSION 857 - ACT (1) 2, X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86				
Defender		F-100				

3. E.M. Terms

Fuel Remain	Altitude	Mach	Level/Max G	A/C

Maneuver Log

Engagement #

	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	5/11.	5/11.	6/10	6/10	
Initial Speed/Altitude	.75/35	.75	.9/24	.9/24	
Terminal (IJXO'A) Speed/Altitude	.9	.97	.9/25	.9/25	
High Speed Yo-Yo	No	Yes	Yes	Yes	
Roll Off	No	No	No	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	No	No	No	Yes	
2. Defender (Initial Speed/Altitude, Hard Turn	95/30	.9/25	95/25	95/25	
	Yes	Yes	Yes	Yes	
Attacker Over Shoot	Yes	Yes	No	Yes	
Speed/Altitude	150/22	150/10	—	UNK	
Reversals, # Intervals	Yes	Yes	No	Yes	
High G Roll Over	No	No	No	No	
Recovery Speed/Altitude	No	No	No	No	
High G Roll Under	No	No	No	No	
Recovery Speed/Altitude	No	No	No	No	
Escape Achieved?	Yes	Yes	Yes	No	
Gun Kill?	No	No	No	No	

NOTES: Describe key factors for each engagement.

#1- Attacker did not attempt to yo-yo but maintained plane of turn- defender achieved an overshoot (1000-1500') and half-rolled into attacker, lit burner at 10° G and achieved 6-800' separation.

#2- Attacker yo-yo'd when he saw he was going to overshoot. Defender carried hard turn into vertical and achieved an overshoot in vertical plane two vertical rolls were accomplished for repositioning then F-100 dove for separation. It appears that if the dive for separation is commenced with both aircraft committed at less low that F-86 will stop with the F-100 for initial separation. Once under - defender fanned with rudder and rolled during separation and attacker was unable to track.

#3- Attacker started 1500' at 6:00 ; defender broke. Attacker yo-yo'd & did not overshoot. Attacker burbled and lost mach- permissible defender achieved separation.

#4- Attacker started 3000' at 6:00 - defender did a hard turn & achieved overshoot in vertical. Defender attempted to maneuver to 6:00 low to start separation. Separation was not attained and all during low G dive and subsequent pull-up, F-86 tracked. At 40-50° pitch, defender did 2 high G roll going up and attacker overshot high - we quit there because of low fuel.

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TEST DATA I • DAC MISSION 837 • ACT I (2) II

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-100D				
Defender		F-86H				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.	6.
1 Attacker						
Type Attack	5/Hi	6/level	5/Hi	6/Low	Nose/Tail	6/Lo
Initial Speed/altitude	.88/35	1.05/30	1.05/30	.95/30	.90/30	.97/30
Terminal (3XC0'A) Speed/altitude	.90/37	.95/32	.90/35	.80/26	.250/35	.89/30
High Speed Yo-Yo	No	No	No	No	No	No
Roll Off	No	No	No	No	Yes	No
Low Speed Yo-Yo	No	No	No	No	Yes	Yes
Gun Kill?	No	No	No	Yes	No	Yes
2. Defender (Initial Speed/altitude)	.83/35	.83/30	.83/30	.83/30	.85/30	.85/30
Break / HARD TURN	Yes	Yes	Yes	Yes	Yes	Yes
Maintain Gun Shot	Yes	Yes	Yes	Yes	Yes	Yes
Speed altitude	1.3/1	.7/34	.85/26	.70/27	200/35	.87/30
Scissors, # Reversals	No	No	No	No	Yes	No
High G Roll Over	No	No	No	No	No	No
Recovery Speed/altitude	—	—	—	—	—	—
High G Roll Under	No	No	No	No	No	No
Recovery Speed/altitude	—	—	—	—	—	—
Escape Achieved?	Yes	Yes	Yes	No	Yes	No
Gun Kill?	No	No	No	No	Yes	No

3. E.M. Data

Fuel Remain	Altitude	Mn.	Level Max G	A/C

NOTES: Describe key factors for each engagement.

#1 Broke off attack + climbed away when unable to track.

#2 Unable to track - F86 broke left.

#3 Snapshot when F86 broke.

#4 Tracked to 3000' in hard turn then F86 broke.

#5 - Pulled up + rolled off above + behind. 86 - 86 pulled 100 into vert. rolling scissors 100 dove away starting at 30° DBS. 86 able to achieve Gun kill

#6 Tracked to 1700' in hard turn then 86 broke harder.

Note: in dive away 100 waggled wings + fishtailed which prevented 86 from tracking.

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FTC/AFA-1 - TAC MISSION 837 - ACT 1, (2) 2

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-100				
Defender		F-86H				

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. Attacker					
Type Attack	VH	7/4	6/40	6/40	
Initial Speed/Altitude	95/35	9/30	9/30	9/30	
Terminal (3000'R) Speed/Altitude	2'30	32/30	35/30	85/25	
High Speed Yo-Yo	No	No	No	No	
Roll Off	No	No	Yes	No	
Low Speed Yo-Yo	No	No	No	No	
Gun Kill?	Yes	Yes	Yes	No	
2. Defender (Initial Speed/Altitude)	85/30	95/25	95/25	15/25	
Break/Hard Turn	Yes	Yes	Yes	Yes	
Attacker Over Shoot	Yes	Yes	Yes	Yes	
Speed/Altitude	7/30	7/30	7/10	2oc/2?	
Scissors, # Reversals	Yes	Yes	Yes	No	
High G Roll Over	No	No	Yes	Yes	
Recovery Speed/Altitude	—	—	Unc	9/25	
High G Roll Under	No	No	No	No	
Recovery Speed/Altitude	—	—	—	—	
Escape Achieved?	No	No	No	Yes	
Gun Kill?	No	No	No	Yes	

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

#1 - F-86 used hard turn instead of break due to underestimation of F-100 airspeed/G capability with max. power. F-100 tracked to 1000' overshot and effectively dove for separation.

#2 - F-86 used hard turn up to vertical, F-100 tracked to 1000' overshot & effectively dove for separation.

#3 - F-86 climbed hard up - F-100 tracked to 200' overshot high. F-100 attempted another pass from a roll-off, but F-86 turned hard into attack and achieved maximum overshot. F-100 effectively dove for separation.

#4 - F-86 broke, F-100 dissipated energy, unable to track - F-86 did hi G roll and maneuvered to F-100 6 o'clock. F-86 tracked through entire dive for separation.

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TEST DATA 2 - TAC MISSION 857 - ACT 2, 5, 8

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F-86H				
Defender		F-100D				

Maneuver Log

	Engagement #	1.	2.	3.	4.	5.
1. Attacker	Type Attack	6/Hi	5/Hi	6/Hi		
	Initial Speed/Altitude	.85/29	.85/29	.95/21		
	Terminal:(Missile) Speed/Angle Off	.92/20	.95/20	.95/5		
	Barrel Roll Attack	Yes(2)	No	No		
	Missile Kill? Range & Angle Off	No	No	No		
	Terminal: Gun Attack (3000'R)	Unk	Unk	Unk		
	High Speed Yo-Yo	No	No	No		
	Roll Off	No	No	No		
	Low Speed Yo-Yo	No	No	No		
	Gun Kill?	Yes	Yes	Yes		
2. Defender - Initial Speed/Altitude		.85/26	.92/24	.94/23		
	Hard Turn/Break	Yes	Yes	Yes		
	Missile Attack Defeated	Yes	Yes	Yes		
	Diving Spiral	No	No	No		
	Vertical Rolling Scissors	No	Yes	No		
	Attacker Over Shoots Speed/Altitude	.80/22	.80/22	No		
	Escape Achieved?	N/A	No	N/A		
	Gun Kill?	No	No	No		

3. R.N. Tapes

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

Defender Comments #1-Defender did not attempt to achieve Hi mach advantage. Sidewinder attack nullified - 1st BJ causing attacker to exceed angle off & shift + then 'G' limit. If Attacker is detected inside max range, escape will be difficult. If F100 turns with max mach, 86H can cut off & prevent F-100 from achieving separation. If straight ahead separat. is attempted, this will ingrane chances of missile kill. Followup Gun attack - Attacker tracked from 3000 - 800', Consequently overshot slightly with defender @ 600 (low). Defender unable bring pipper up to tgt, because airspeed had dropped to 340 kts. #2 Start same as #1 - but Def. had .92M's. Attacker took longer to close. Following Gun attack successful. Eventual overshoot @ 800. Got into 'stalemate' Vertical Rolling scissors. When Def. disengaged - attempted to achieve longit. separation he was shot down again. (Att. could have avoided overshoot by using hi Speed Yo-Yo) #3 F100 Sidewinder Unsucc. Defender countered given attack with hard turn, followed by break as Attacker reached 3000'. Attacker used Hi Speed Yo-Yo to reposition for 2nd Gun Pass. Def. airspeed 340 kts. #4 Above 1/4 engagement 26 M. Attacker .9, Def (F100) .96M as 86H turned 100° (60°), 100 could have moved out of missile RANGE. However 100 turned to allow 86 to close (1000') then 100 turned down (6 G's) spoiling 86's tracking solution. Disengagement would have been diff. for 100.

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TEST DATA 2 - TAC MISSION 837 - ACT 2 (3) X

(Fill in blanks; cross out inapplicable entries)

	Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker		F100D				
Defender		F-86H				

Maneuver Log

Engagement #	1.	2.	3.	4.	5.
1. Attacker					
Type Attack	1.1/20	6/20			
Initial Speed/Altitude	.95/40	.9/25			
Terminal:(Missile) Speed/Angle Off	1.15	1.0			
Barrel Roll Attack	Yes	No			
Missile Kill` Range G Angle Off	No	No			
Terminal: Gun Attack (3000'R)	—	No			
High Speed Yo-Yo	No	No			
Roll Off	No	No			
Low Speed Yo-Yo	No	No			
Gun Kill?	No	No			
2. Defender - Initial Speed/Altitude	.85/37	.80/25			
Hard Turn/Break	Yes	Yes			
Missile Attack Defeated	Yes	Yes			
Diving Spiral	Yes	No			
Vertical Rolling Scissors	No	No			
Attacker Over Shoot: Speed/Altitude	No	Yes			
Escape Achieved?	Yes	Yes			
Gun Kill?	Yes	Yes			

3. E.M. Turns

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement.

#1 Attacker lost sight of defender during diving spiral due to low viz.

#2. Attacker unable to press for missile attack - Pressed for Gun attack - Unable to track - Overshot. Defender broke hard, did a high barrel roll and maneuvered to 6:00 and achieved a Gun kill.

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TEST DATA 3 - TAC MISSION 857 - ACT

(Fill in blanks; cross out inapplicable entries)

Pilot	A/C Type	A/C #	Date	TO Time	Fly Time
Attacker 1.		E-86H			
2.		E-86H			
Defender 1.		F-100D			
2.		F-100D			

Maneuver Log

	Engagement # 1.	2.	3.	4.	5.
1. **Attackers**					
Type Attack	7:H1	6/L0			
Terminal (Missile) Speed/Angle Off	—	—			
—	—	—			
Missile Kill? #, Range, G, Angle Off	NO	NO			
Terminal: Gun Attack (3000')	.95/25	UNK			
High Mon/Fluid Separation	YES	NO			
High Speed/Low Speed Yo-Yo	YES	YES			
—	—	—			
Gun Kill? #	YES	YES			
—	—	—			
2. **Defenders**: Initial Speed/Altitude	.9/30	.8/30			
Hard Turn/Break	YES	YES			
Missile Attack Defeated?	YES	YES			
Defensive Split	YES	NO			
Reversal (Under/Over)	YES	YES			
Sandwich/Escape Achieved	NO	NO			
Gun Kill? #	YES	YES			

3. **E.M. Turns**

Fuel Remain	Altitude	Mach	Level/Max G	A/C

NOTES: Describe key factors for each engagement. #1 - F100's DEF. F-86H ATT.

#1 - DEF'S SPLIT @ 3000'. ATT 1+2 SWITCHED TO D-2 AS HE REVERSED. D-1 LOST SIGHT OF FIGHT, + MADE DIVING SEPARATION (LOMN). D-2 WAS IN FRONT OF D-1, SO ATT SWITCHED TO D-1. D-1 WAS SHOT DOWN, BUT D-2 MADE SUCCESS. GUN PASS ON A-2.

#2 (F-100 ATT, F-86-DEF) D-1+2 MADE RT DEF. TURN WITH WG MAN 1500' @ 6:00. A-1 SCORED GUN KILL ON D-2 (D-1 DID NOT SEE A 1+2) A-1+2 EVENTUALLY OVER-SHOT, AND WENT INTO DESCENDING TURN, ACCELL. TO M1.0 - D-2 GOT SHOT DURING THIS HI SPEED TURN.

#3 - NOSE 1/4 - F-100'S WENT DOWN, BUT LOST MACH ADV. WITH HI 'G' LOADS. F-86'S EMPLOYED LO SPEED YO YO'S TO MOVE TO GUN RANGE. F-100'S ONLY CHANCE IN THIS SITUATION IS STRAIGHT AWAY ESCAPE WHICH TAKES A LONG TIME.

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ANNEX C

PILOT FLYING EXPERIENCE

PILOT FLYING EXPERIENCE

PILOT	AIRCRAFT	TOTAL TIME	TOTAL JET	TOTAL UE AIRCRAFT
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

ANNEX D

F-105 ACCELERATION COMPUTATION

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F-105 ACCELERATION COMPUTATION

Using energy maneuverability terms and Ps values obtained from current Ps-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:

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

Es = 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:

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

differentiating with respect to time (T)

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

or $$\frac{dV}{dt} = a = \frac{g}{V}\left(Ps - \frac{dH}{dt}\right)$$

assuming an average acceleration:

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

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

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.

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

the time to accelerate to .95 is then:

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

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 ½ 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 ½ G loading is approximately 320, hence: $a = \frac{32.2}{854} (320 + 100) = 15.8'/sec^2$

and $t = \frac{1010 - 706}{15.8} = 19.2$ 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 ½ G diving acceleration must be begun before the attacker has closed to 7000' range.

ANNEX E

PARTICIPATING TEAM

POST MISSION SUMMARIES

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

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. The104 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.

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+).

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

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 sprial 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 initated 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.

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

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.

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

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 ½ "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 ½ "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.

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 overshot.

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 <u>not</u> 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.

(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.

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:

(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 ½ "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

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.

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.

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 horisontal 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

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 plane, with about 3000-4000' separation. The object is to force the attacker(s) to

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".

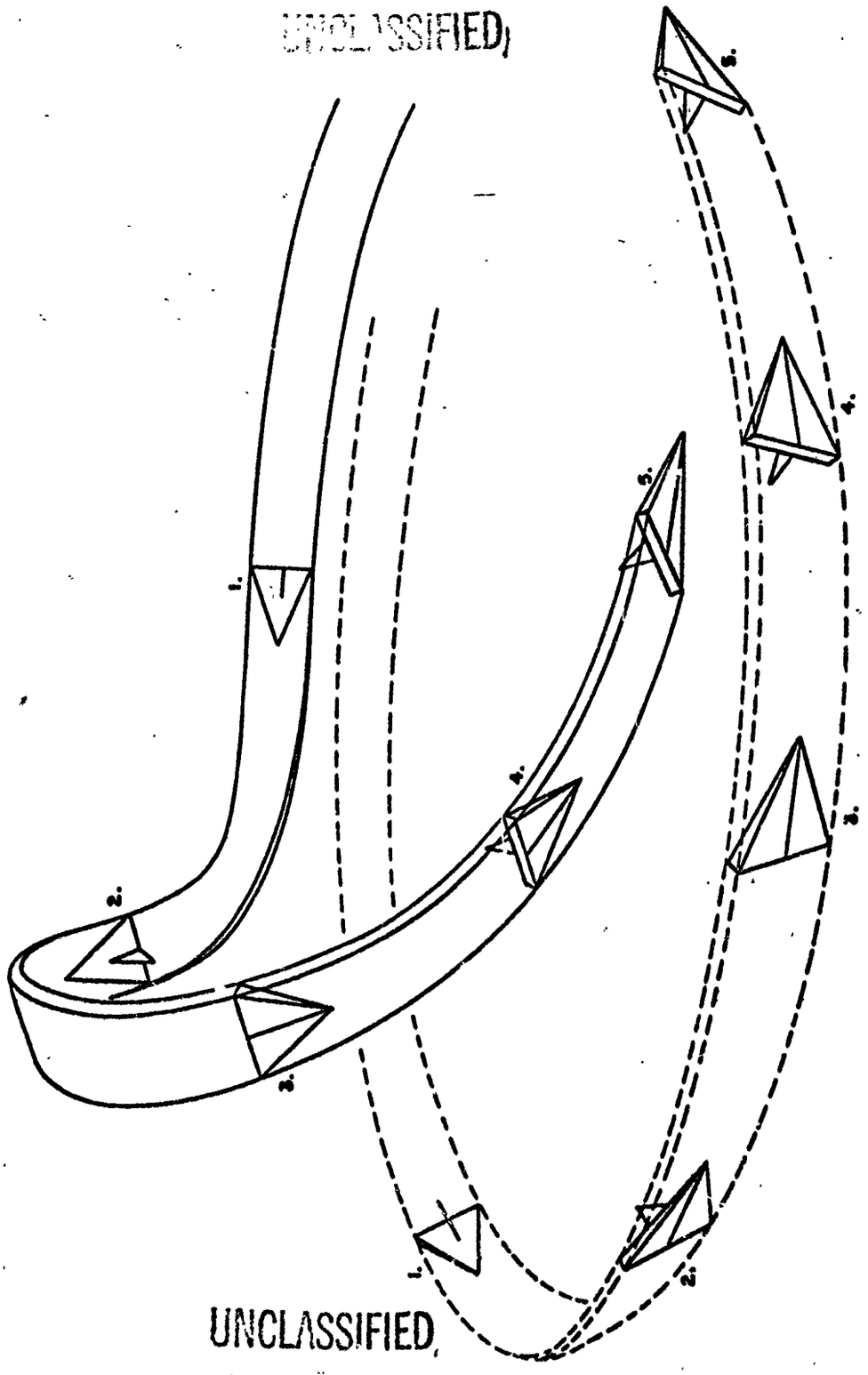

Figure 1

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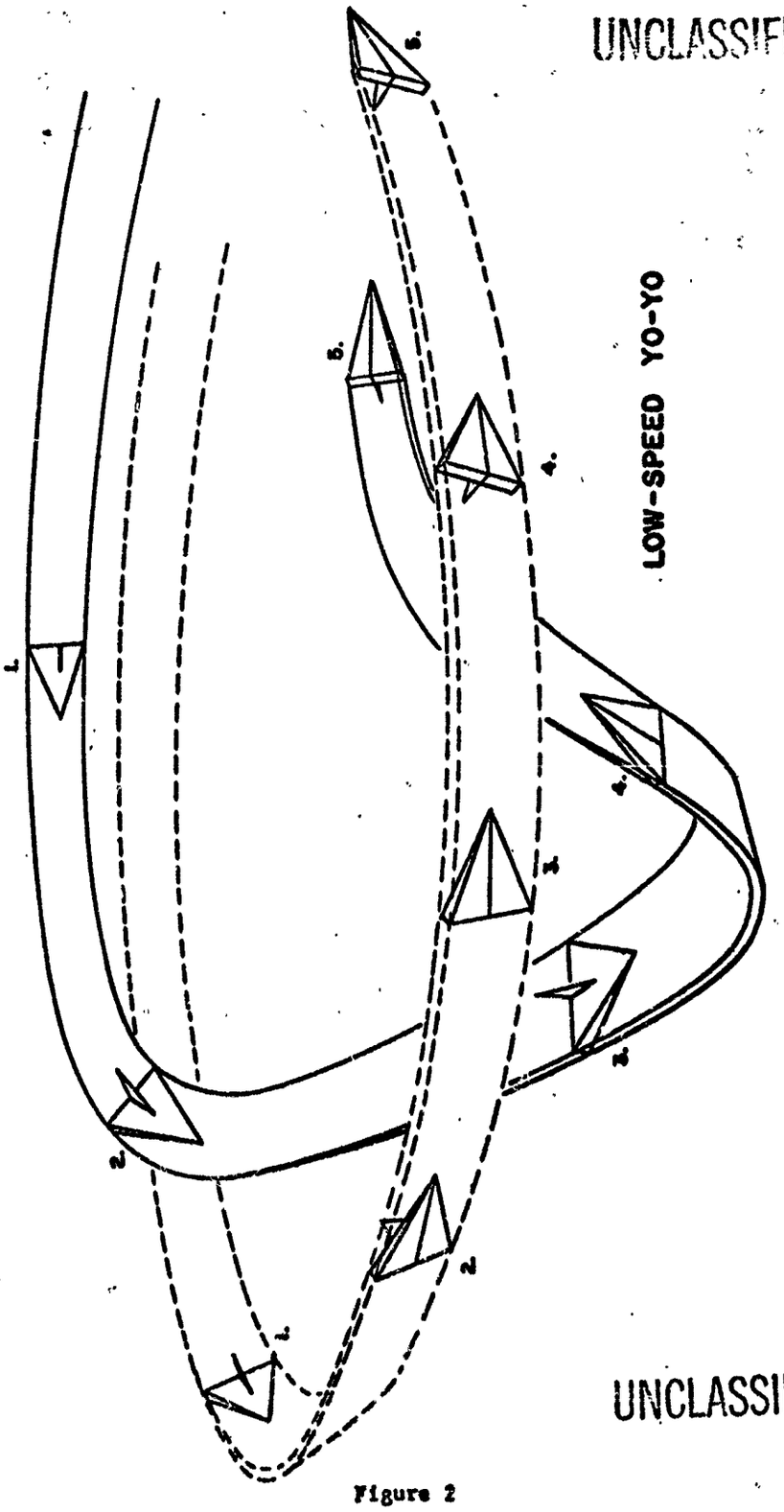

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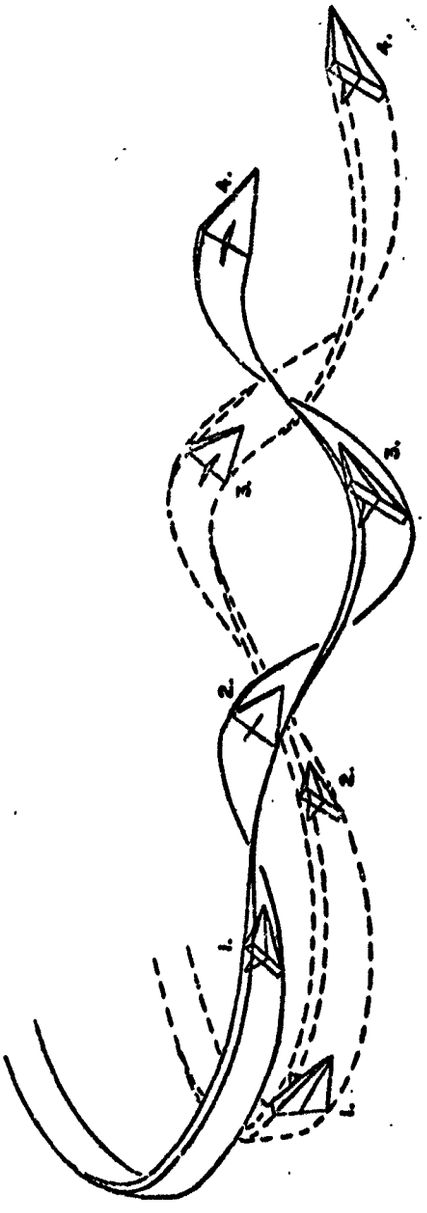
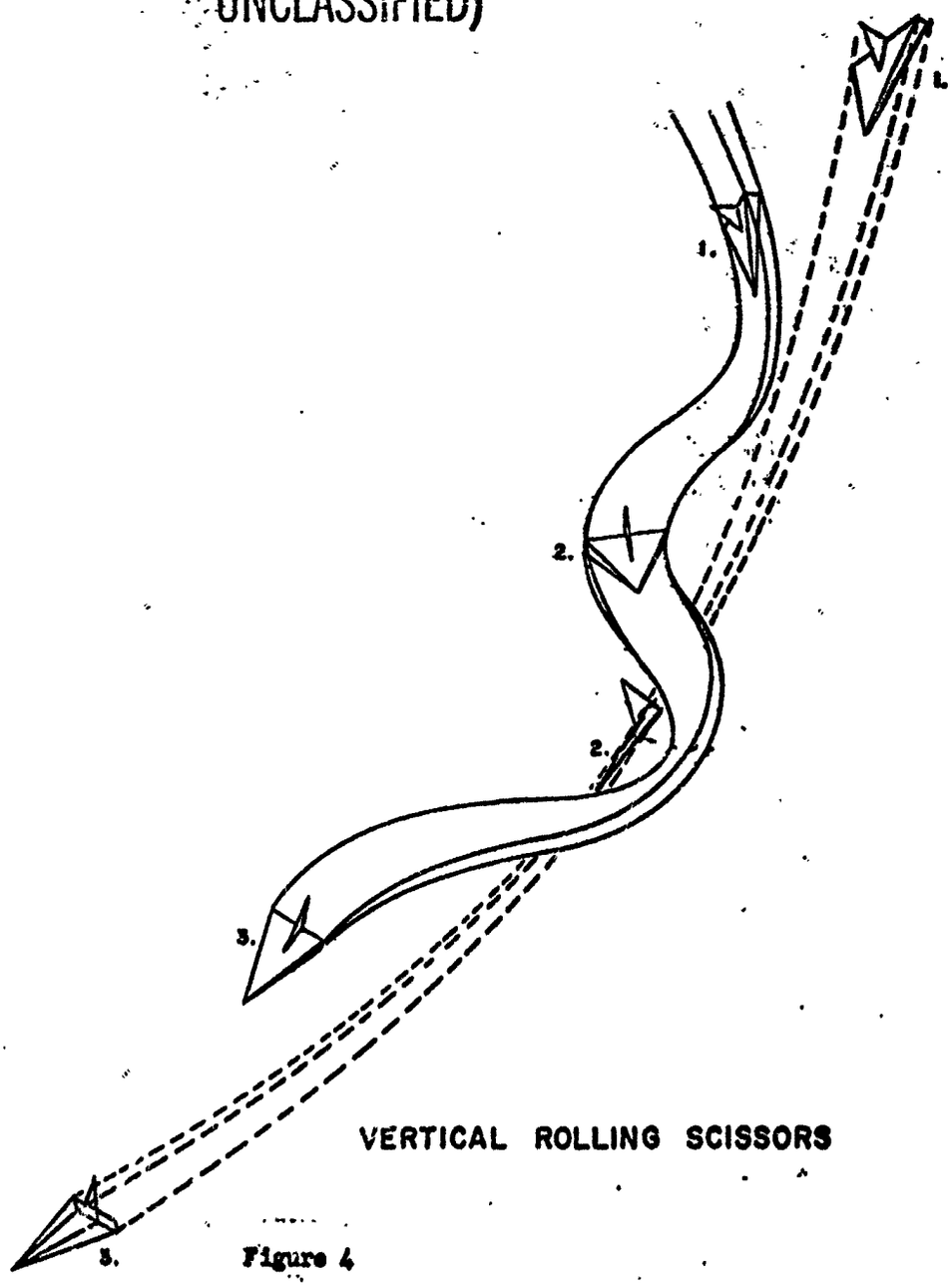
Figure 2



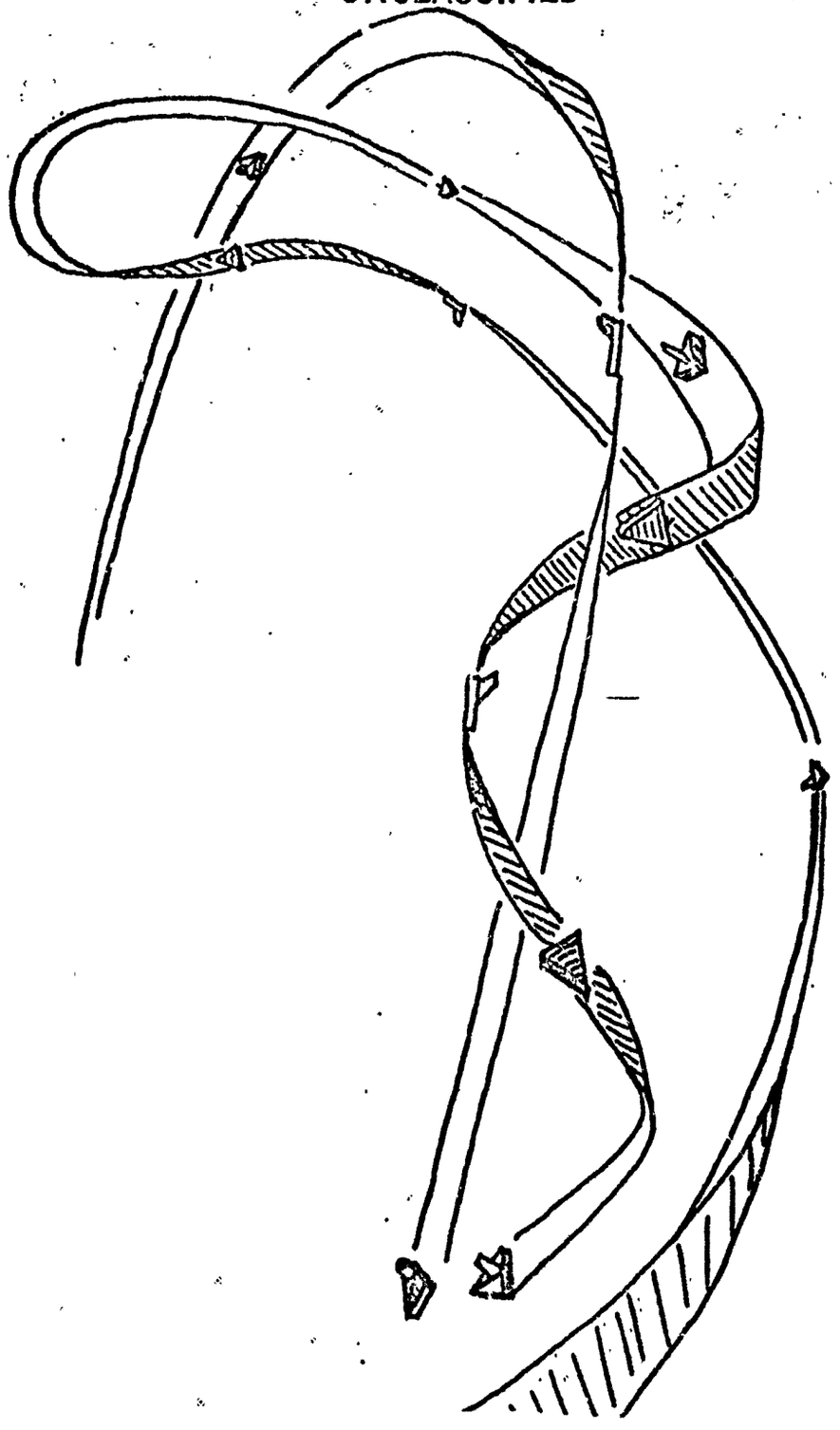
SCISSORS

Figure 3



VERTICAL ROLLING SCISSORS

Figure 4



BARREL-ROLL ATTACK

Figure 5

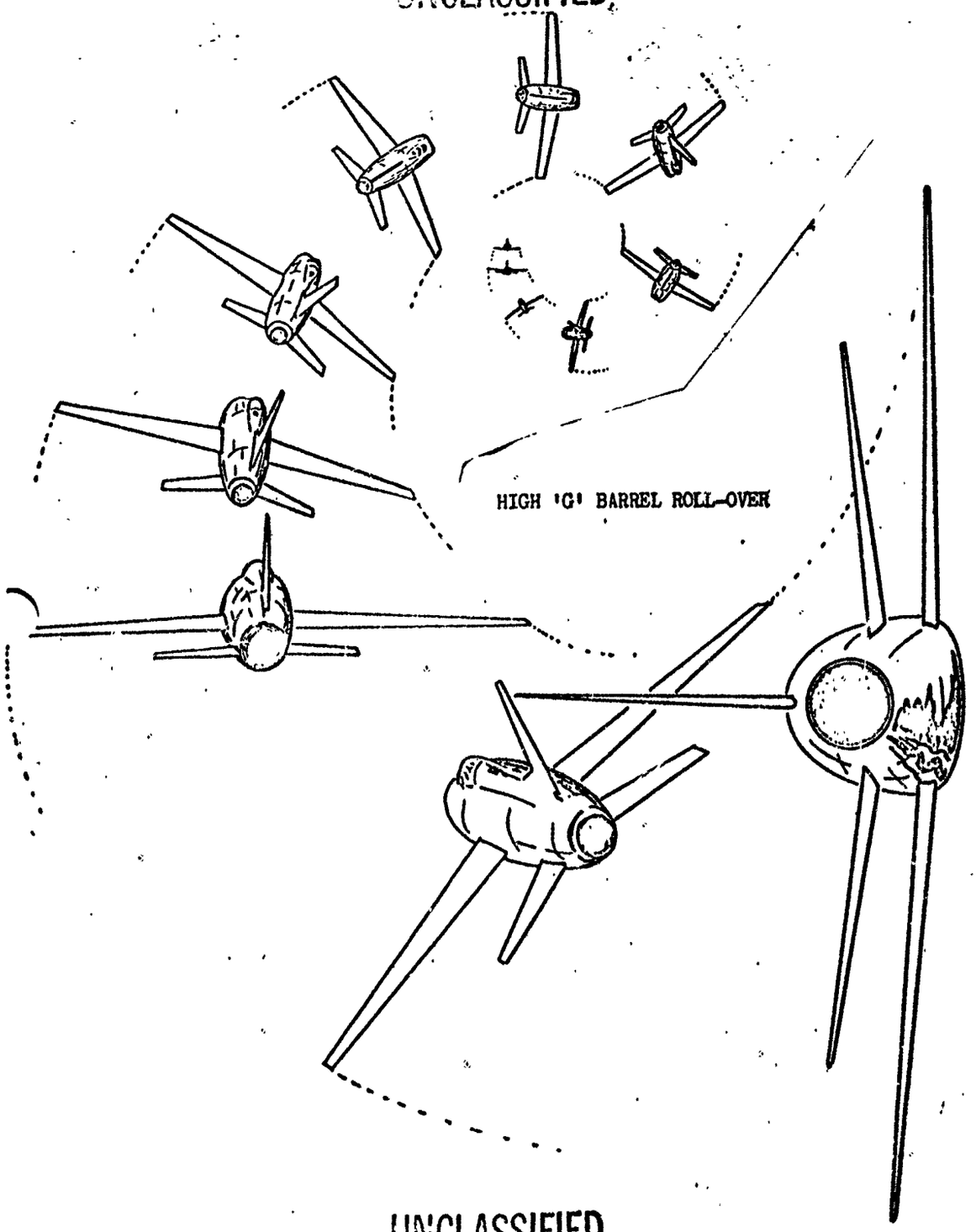
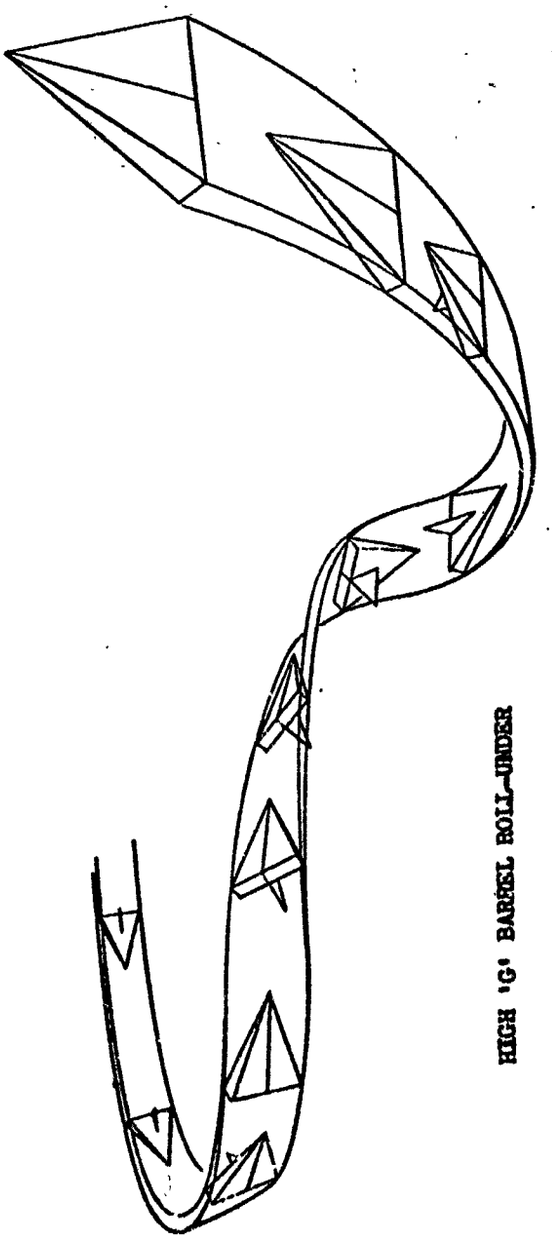


Figure 6



HIGH 'G' BARREL ROLL-UNDER

Figure 7

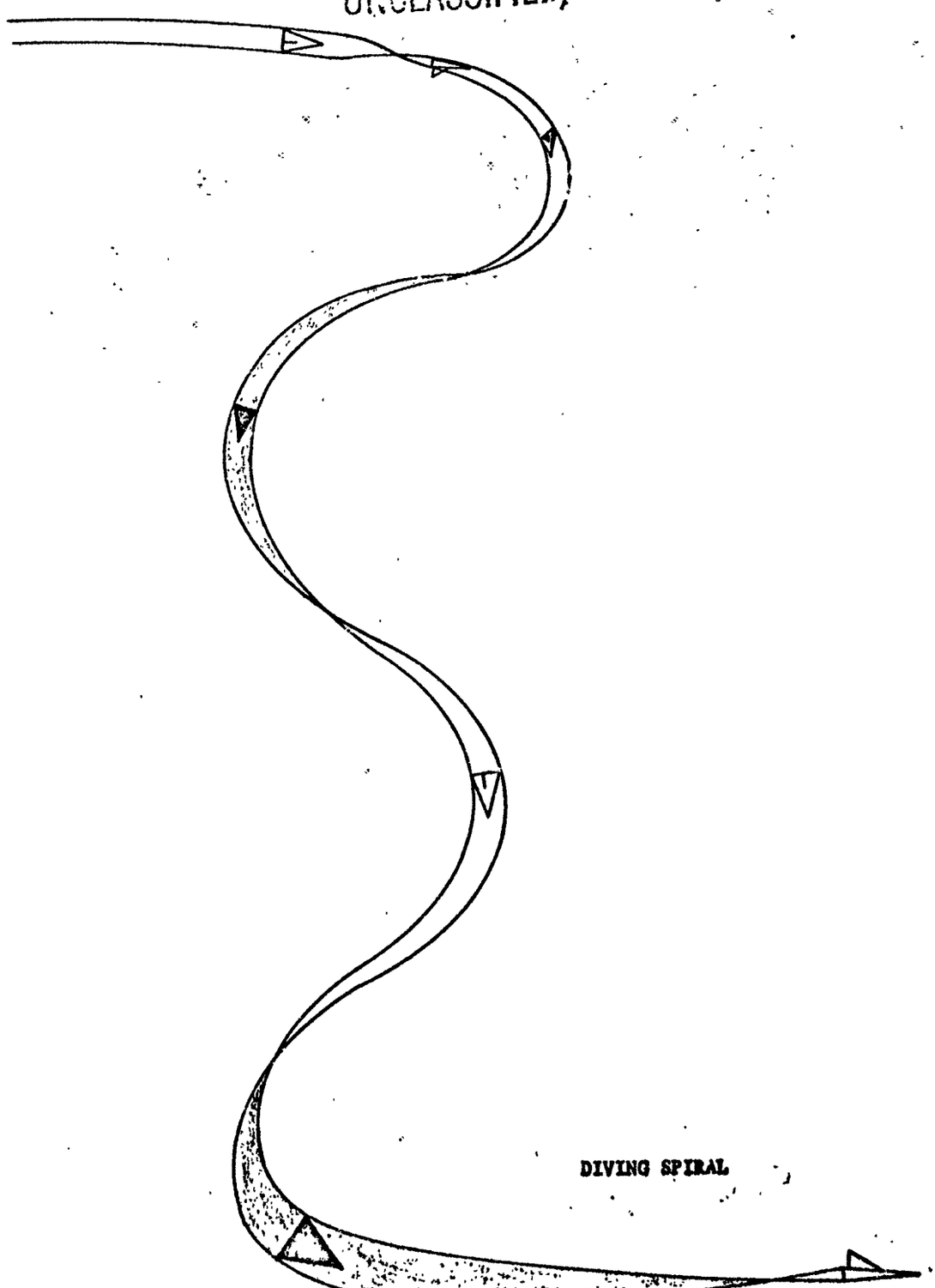


Figure 8

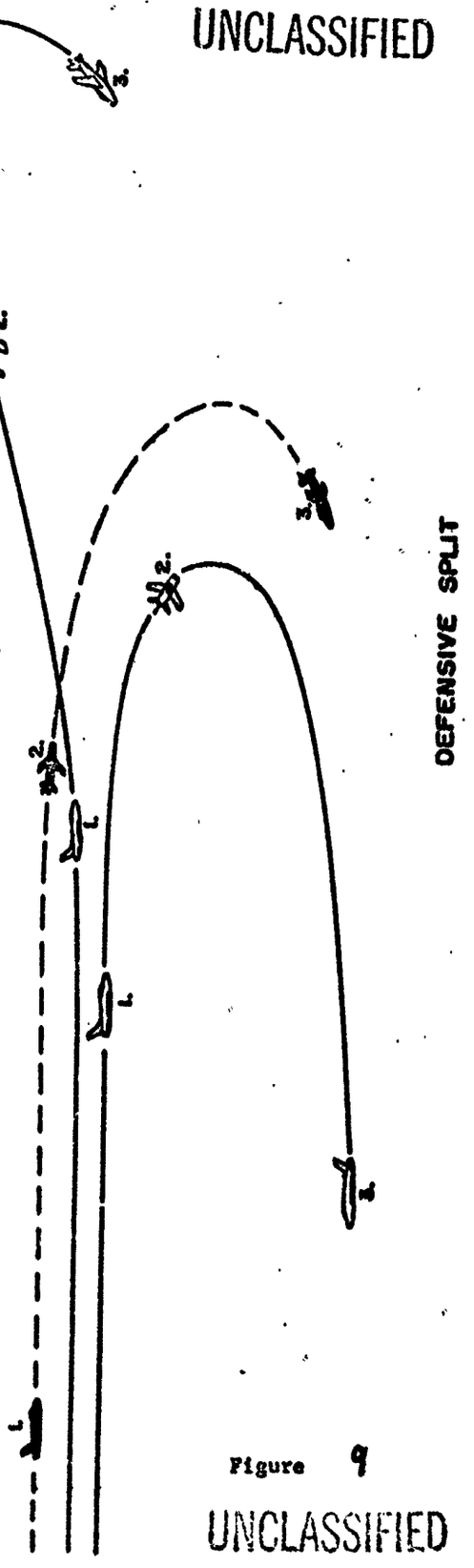


Figure 9

ANNEX G

ENERGY MANEUVERABILITY

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

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.

TABLE 1

Type Aircraft	Altitude	True Mach	Power Setting	Recorded Max G	Predicted Max G	Fuel Remaining/#
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	2.8	2.3	3500

SECRET

Type Aircraft	Altitude	True Mach	Power Setting	Recorded Max G	Predicated Max G	Fuel Remaining/#
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

SECRET

Type Aircraft	Altitude	True Mach	Power Setting	Recorded Max G	Predicted Max G	Fuel Remaining/#
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'.

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 looses energy and is equivalent to the specific excess powar 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 th fighter must lose speed and/or altitude or it must relax the G load.

Es = Specific Energy = $h + \frac{V^2}{64.4}$

Es Units in feet

h = height in feet

V = velocity in feet per second (true airspeed)

Ps = Specific excess power = energy rate

Ps 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 Ps 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 Ps of 220 and the MIG 21 has a negative Ps 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 Ps of 100 ft/sec. This Ps 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.

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.

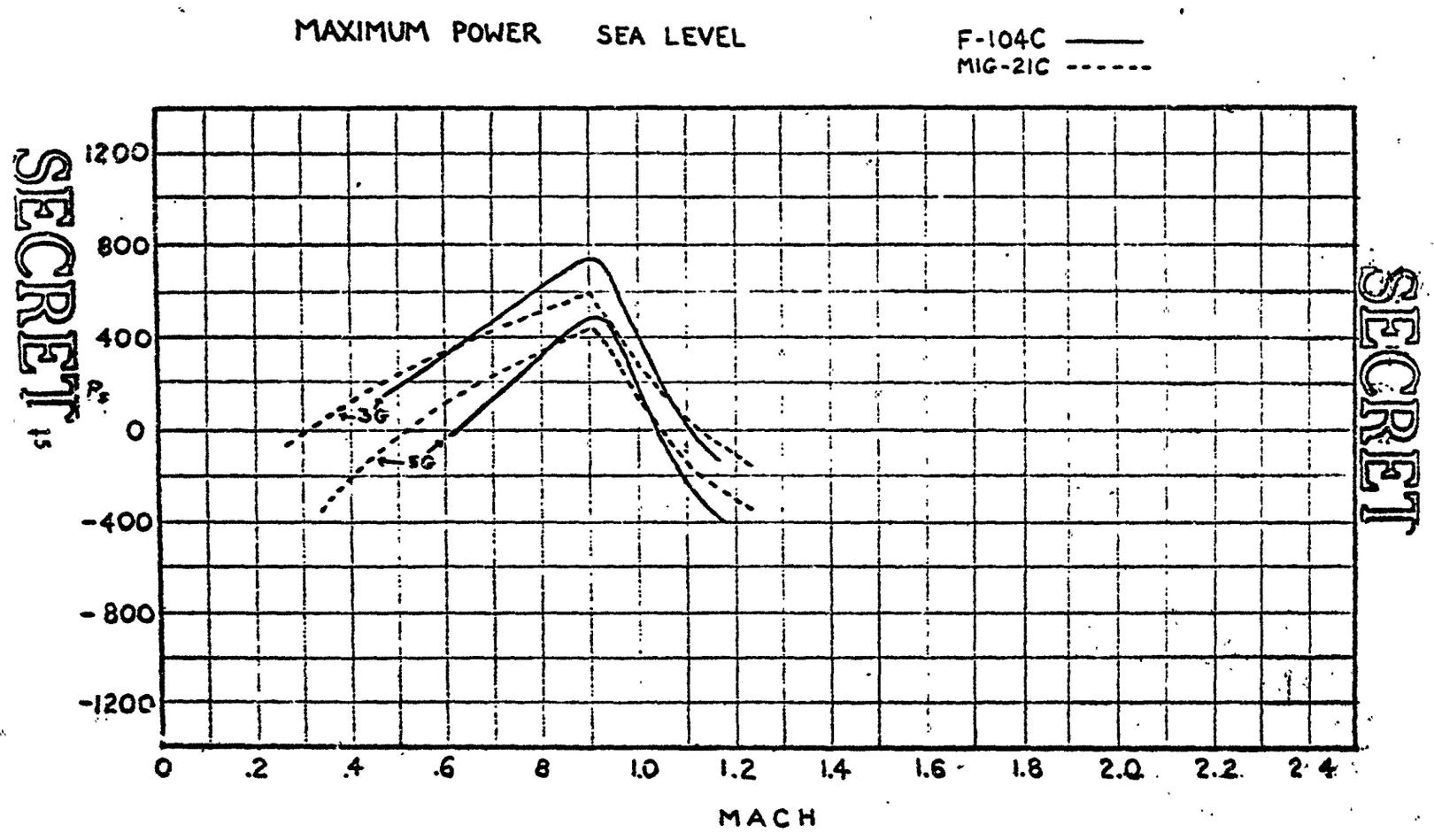


Figure 10

H-V DIAGRAM MAXIMUM POWER 1 G

F-104C ——
MIG-21C - - - - -

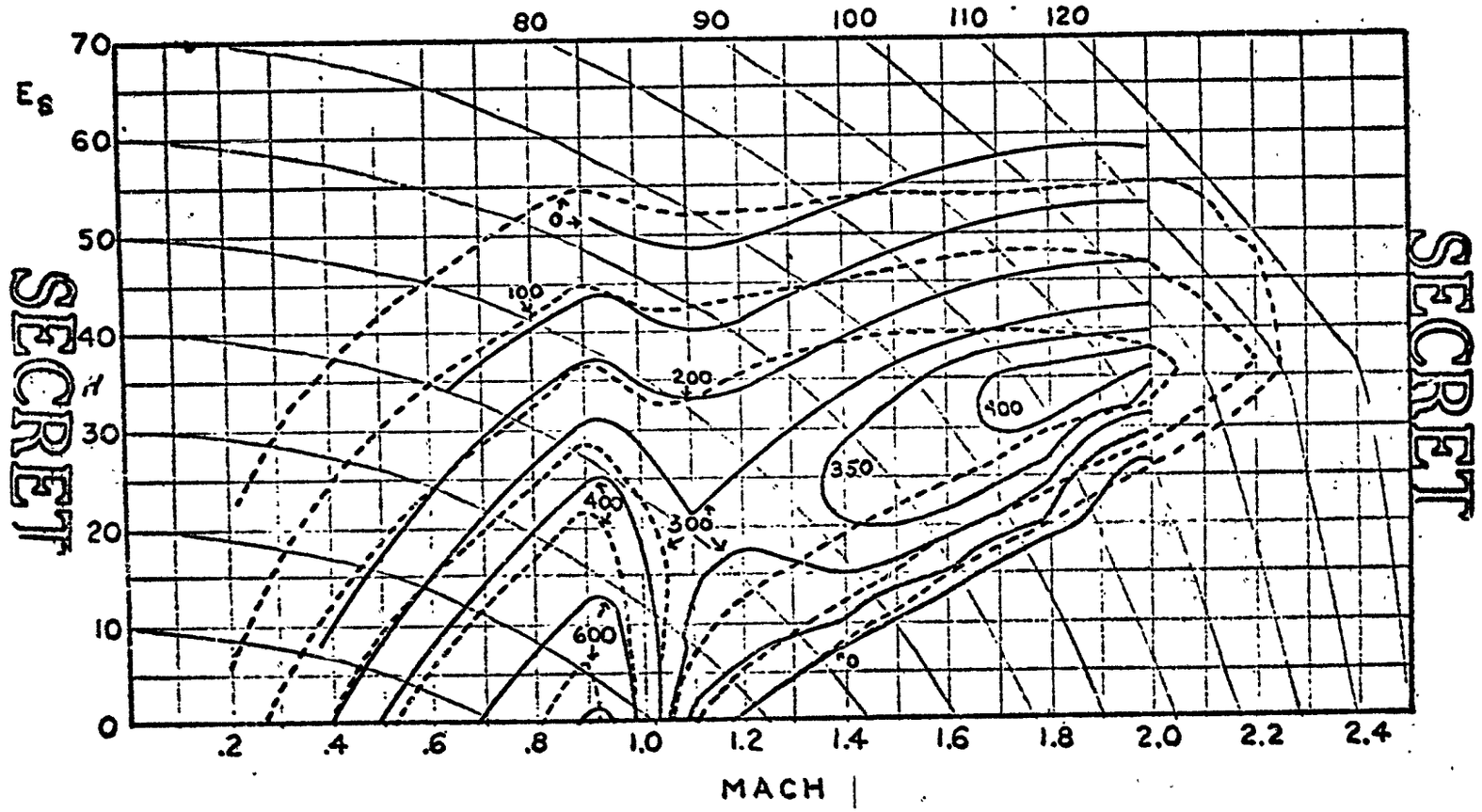


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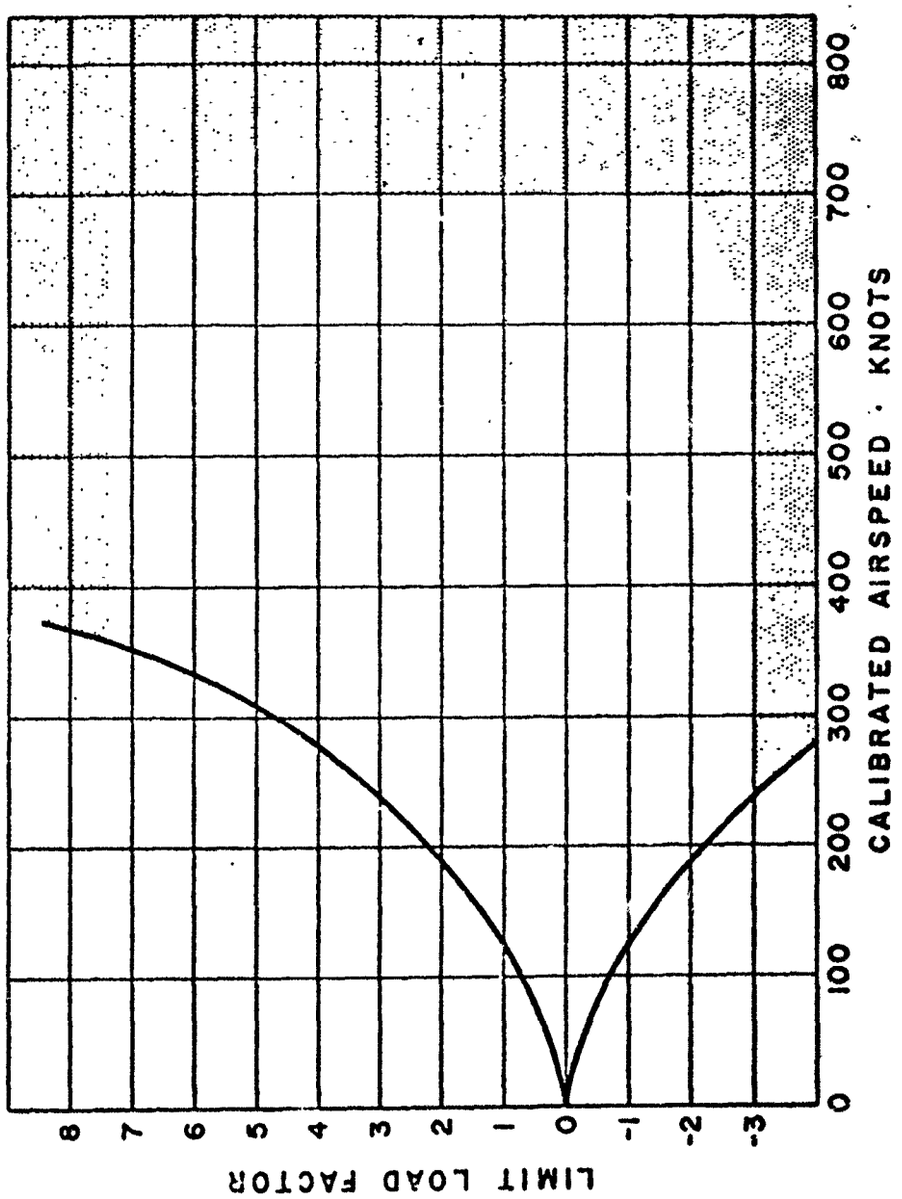
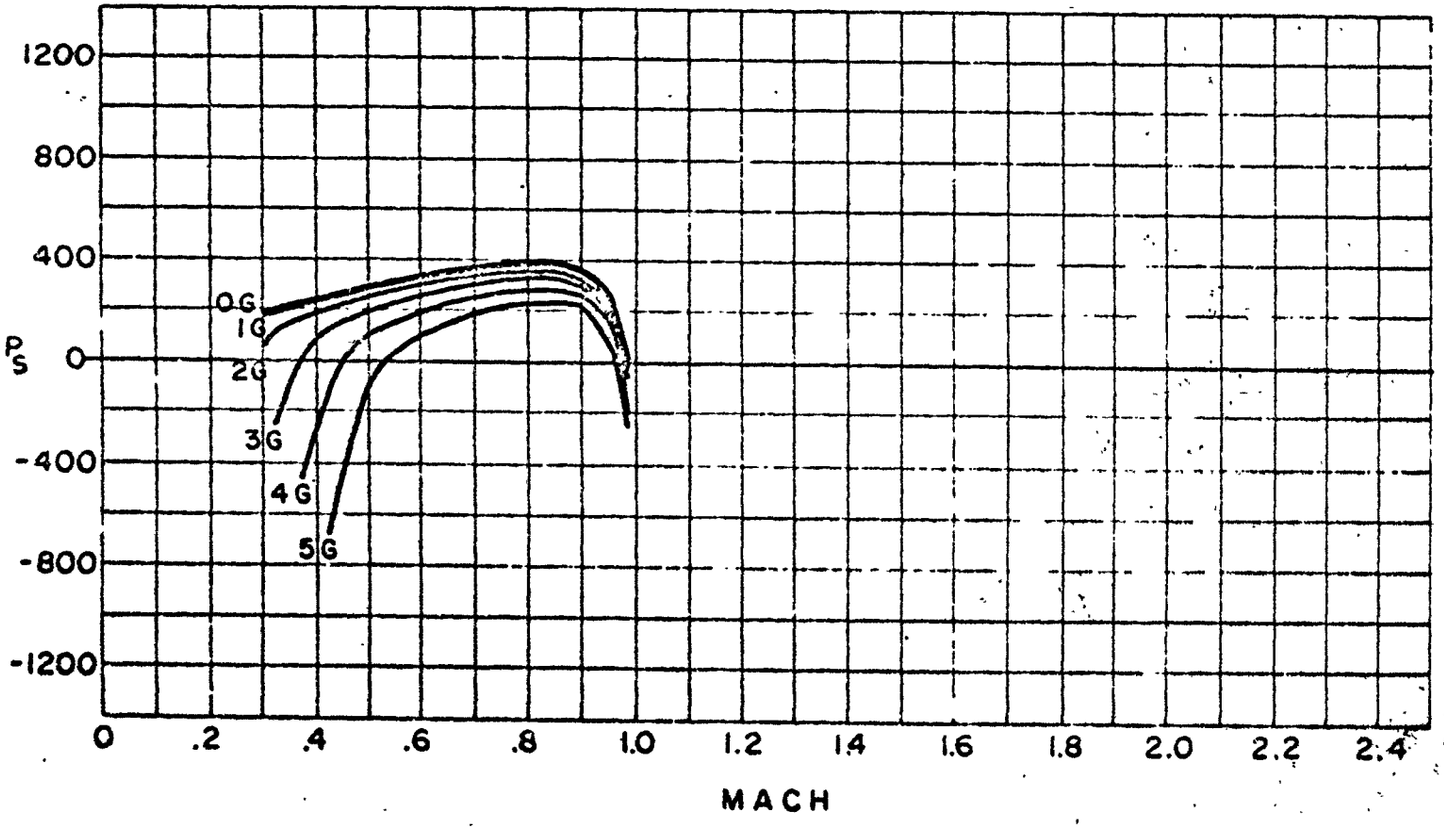
Figure 11

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



MAXIMUM POWER · SEA LEVEL

F-100D



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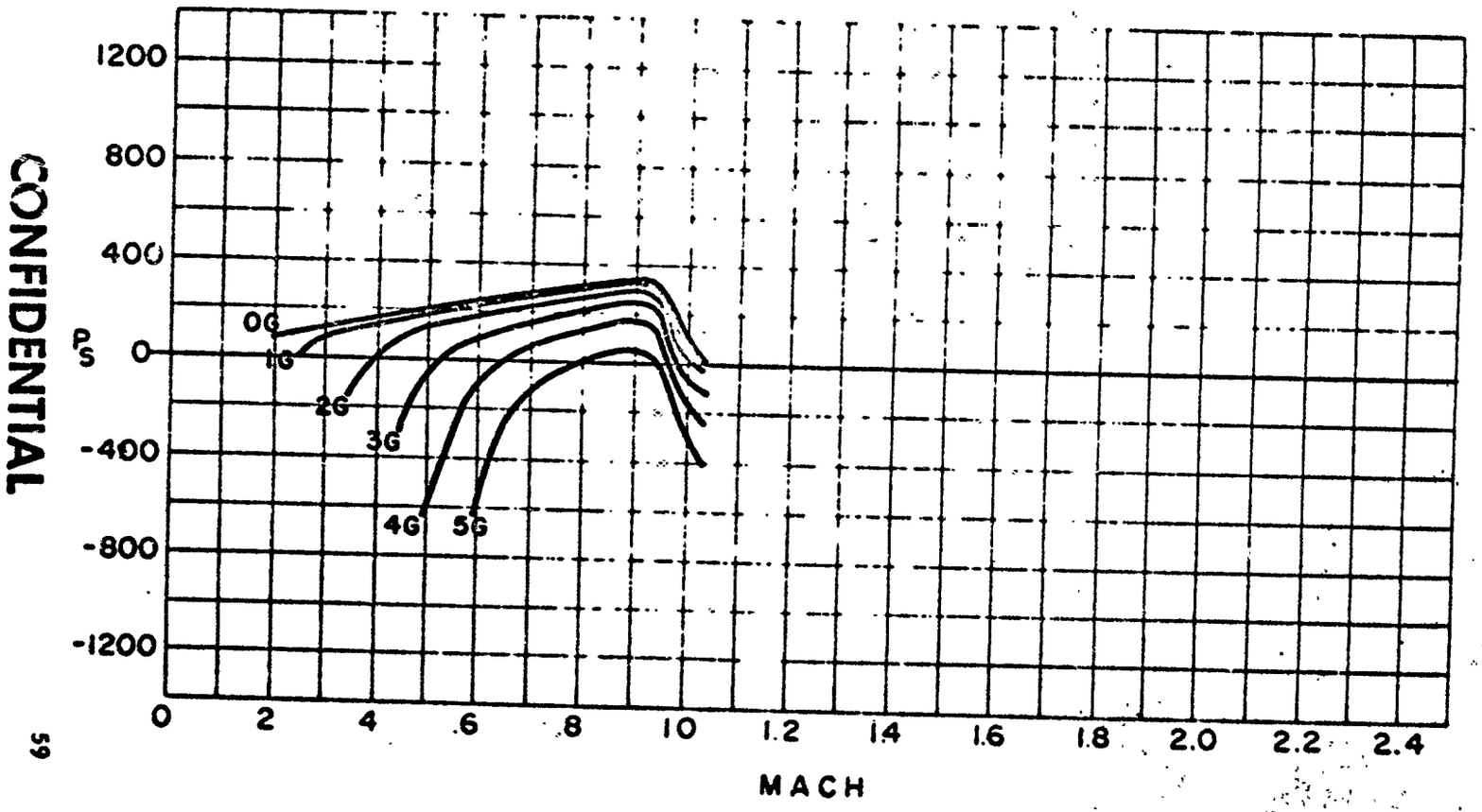
MAXIMUM POWER · 15,000'

— F-100D



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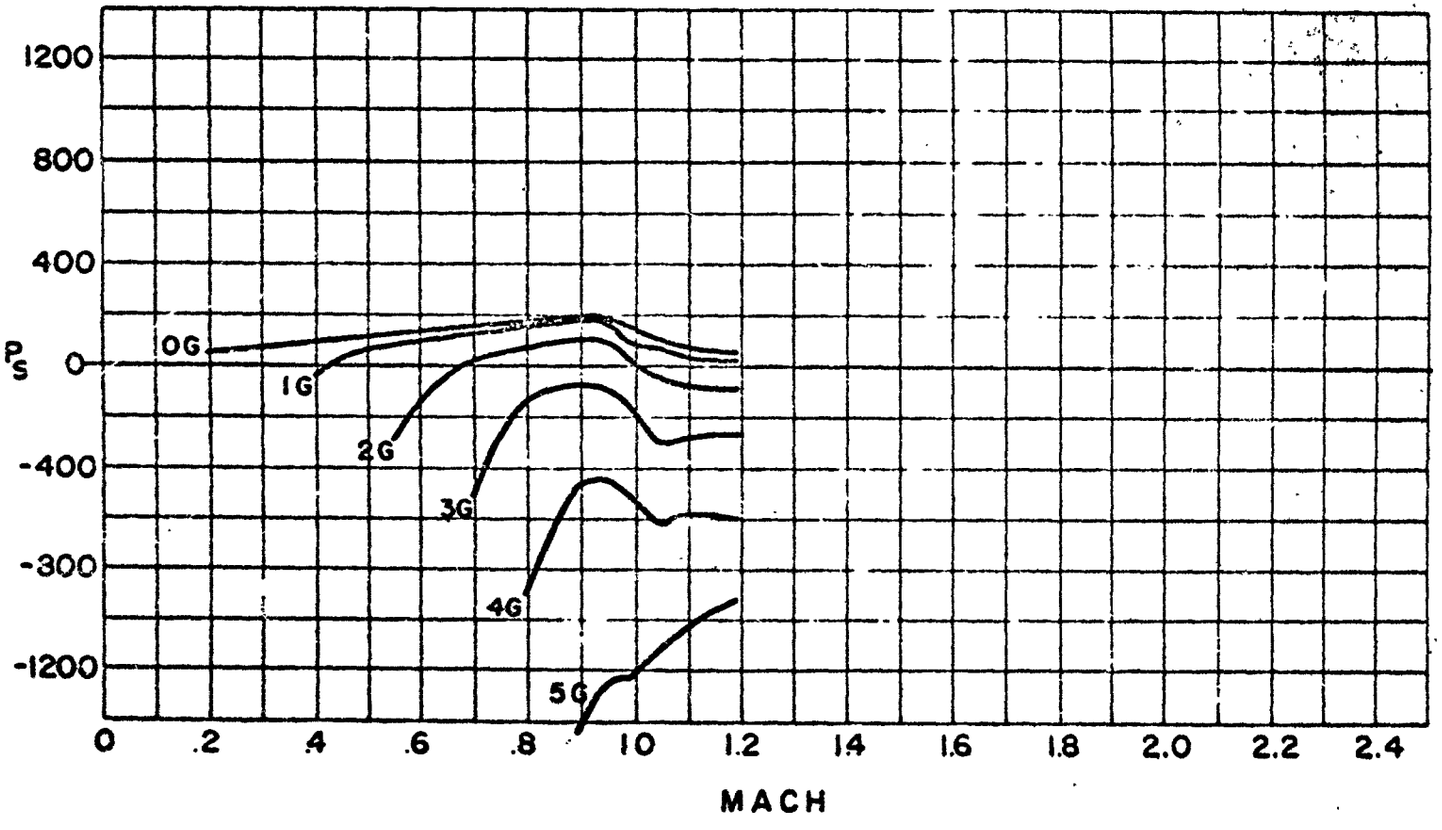
MAXIMUM POWER · 35,000'

— F-100D



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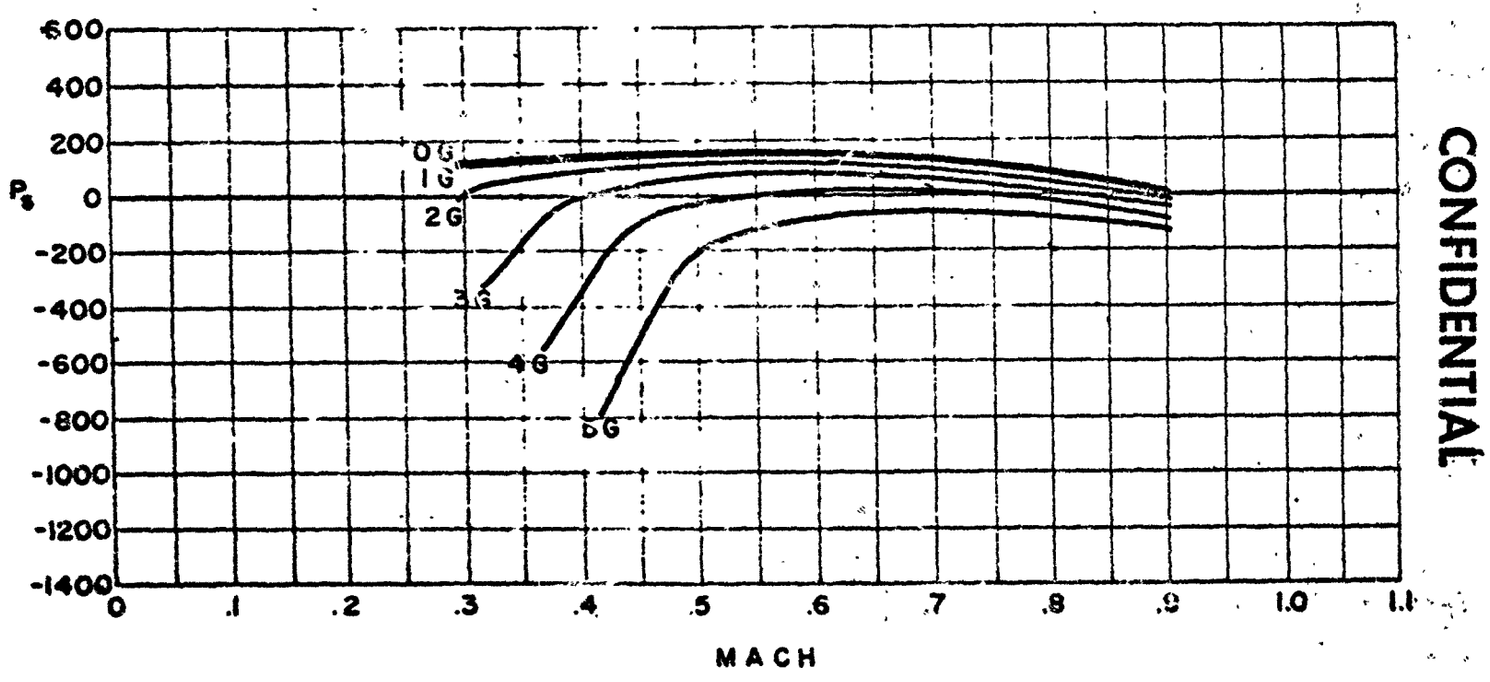
MILITARY POWER · SEA LEVEL

F-100D



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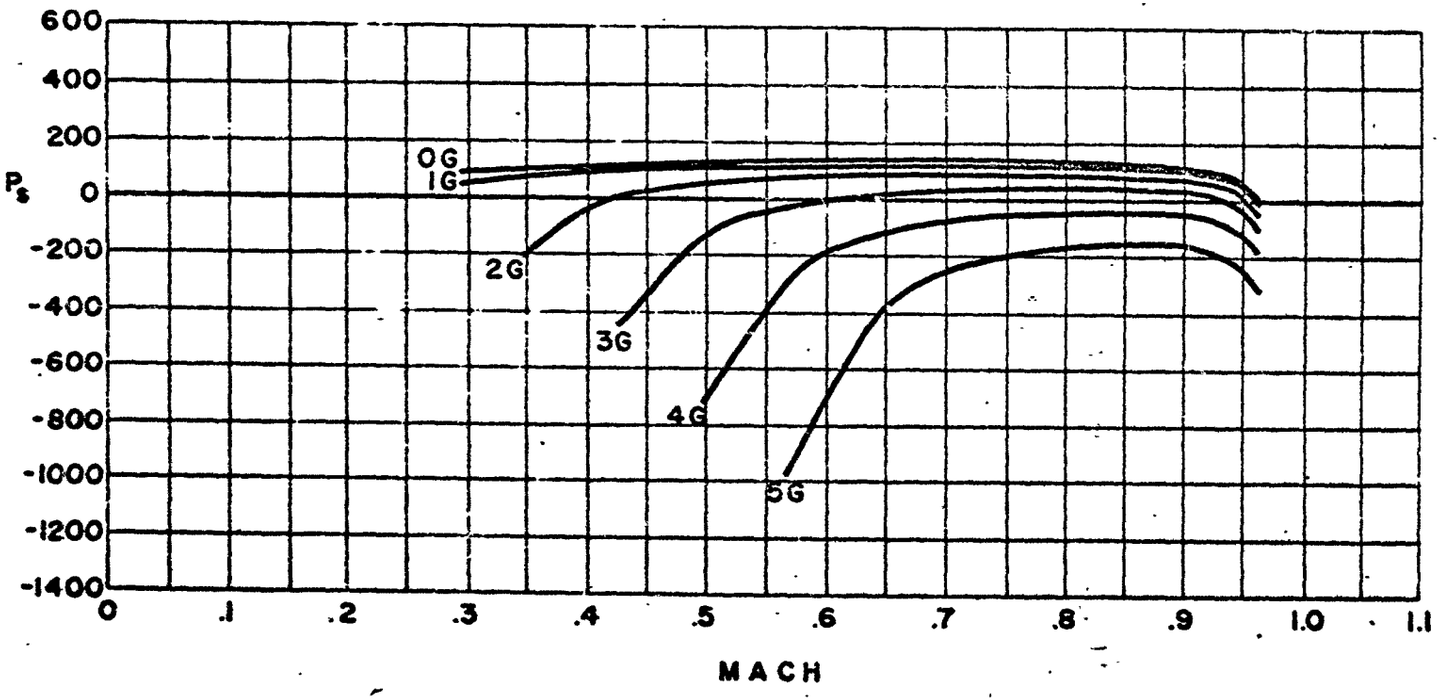
MILITARY POWER · 15,000'

F-100D



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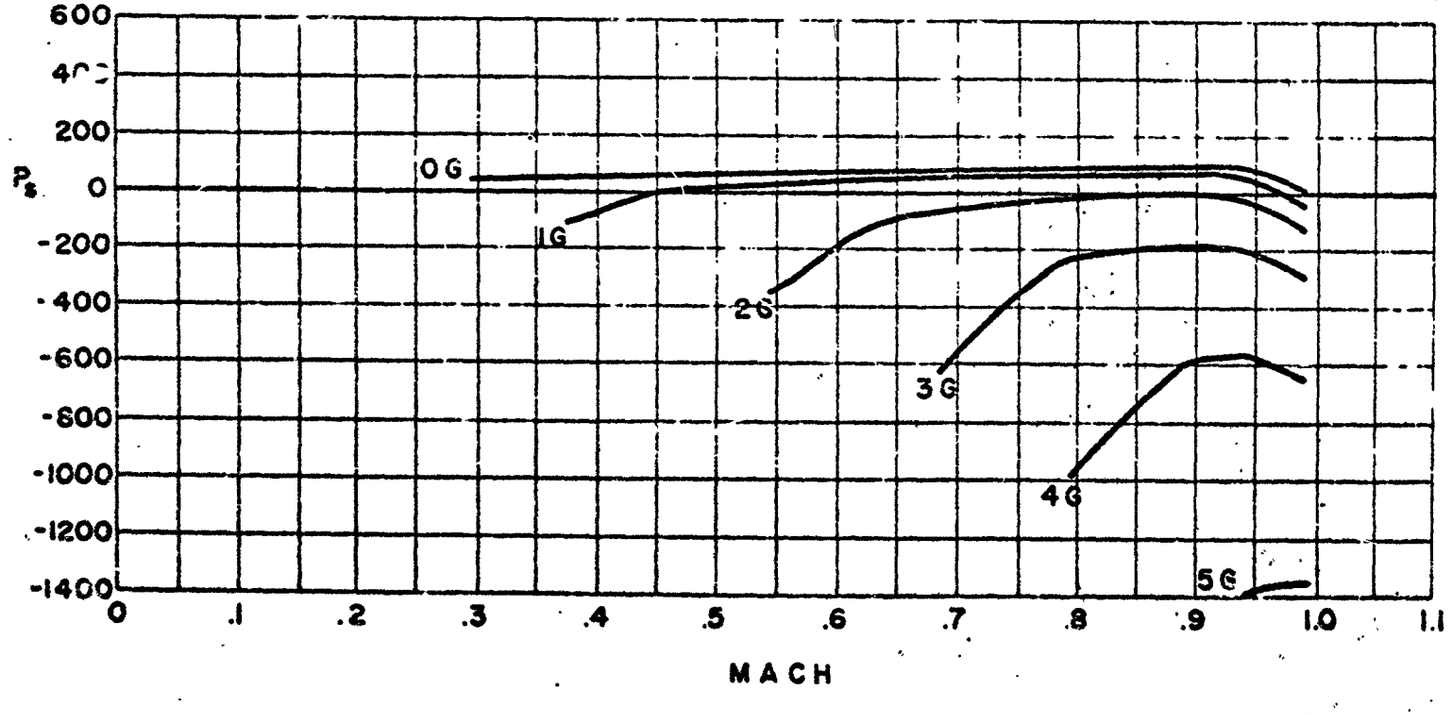
MILITARY POWER · 35,000'

F-100D



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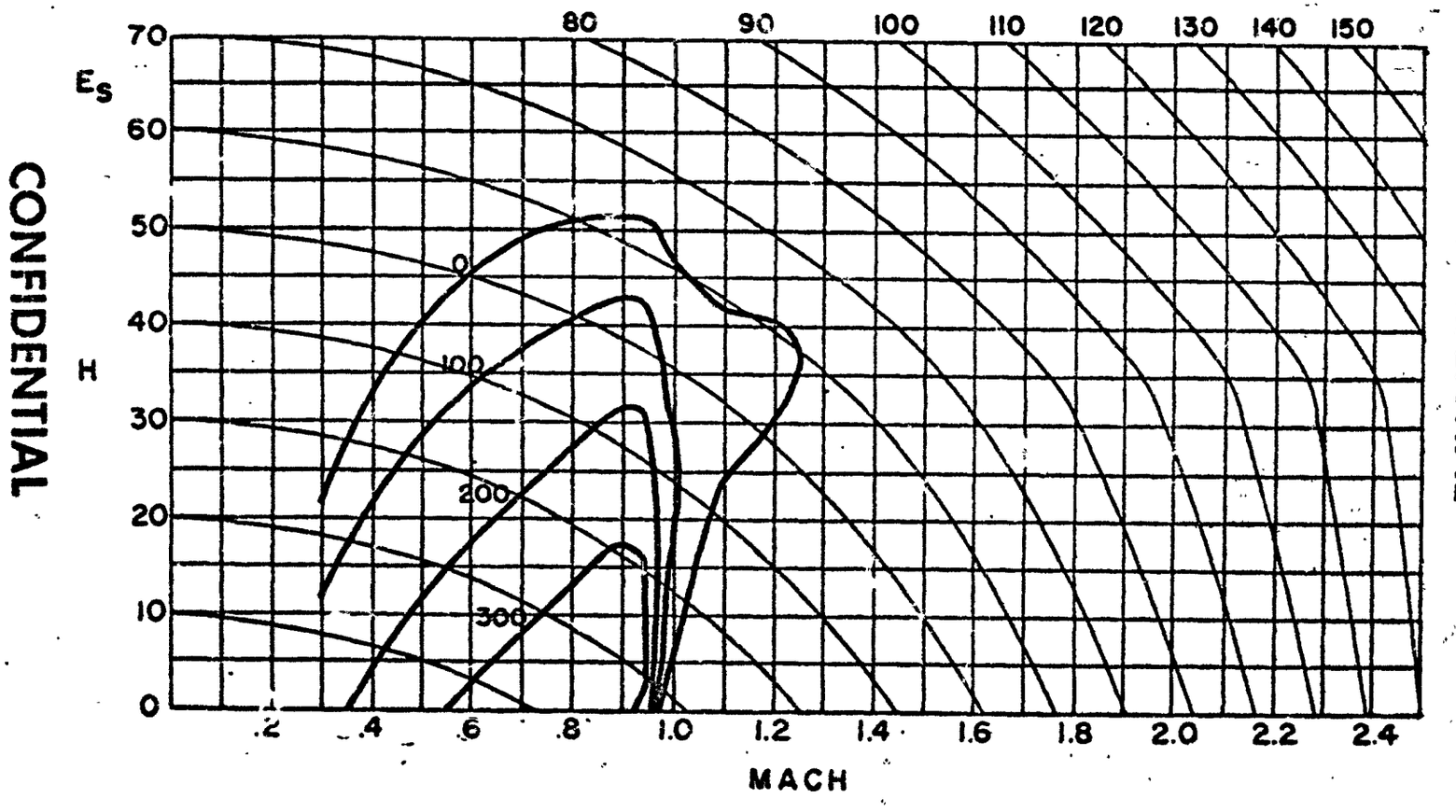
MAXIMUM POWER · 1G F-100D



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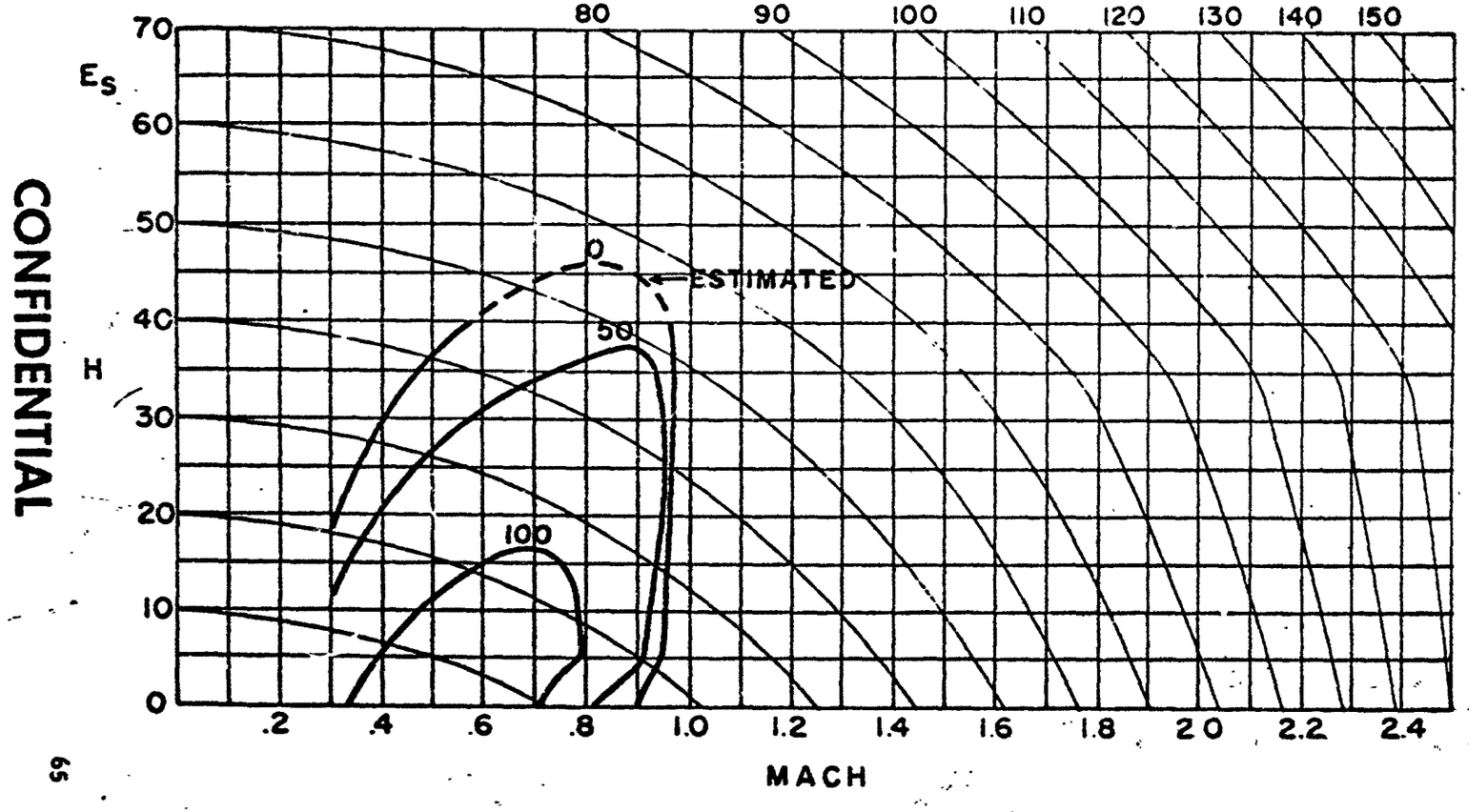
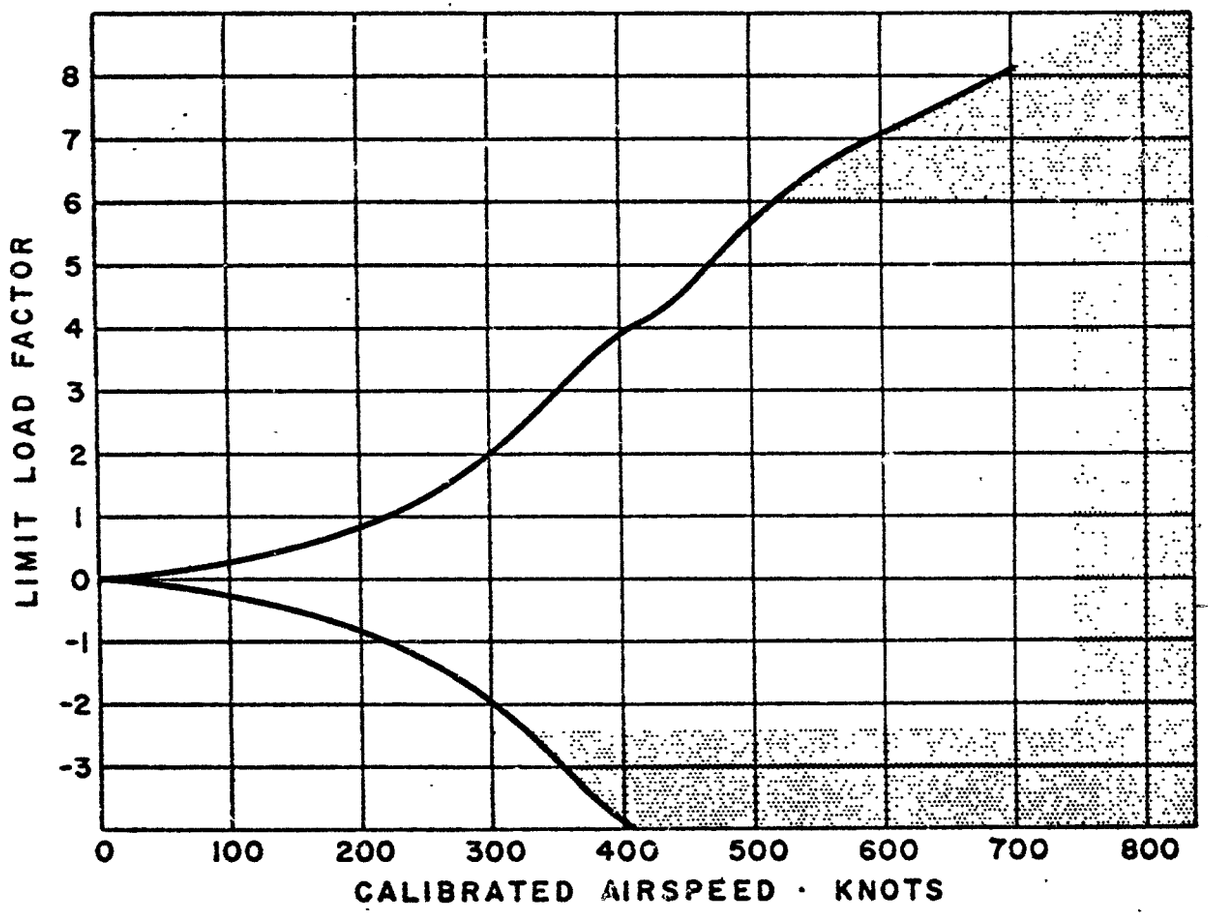
MILITARY POWER · IG

F-100D



CONFIDENTIAL

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

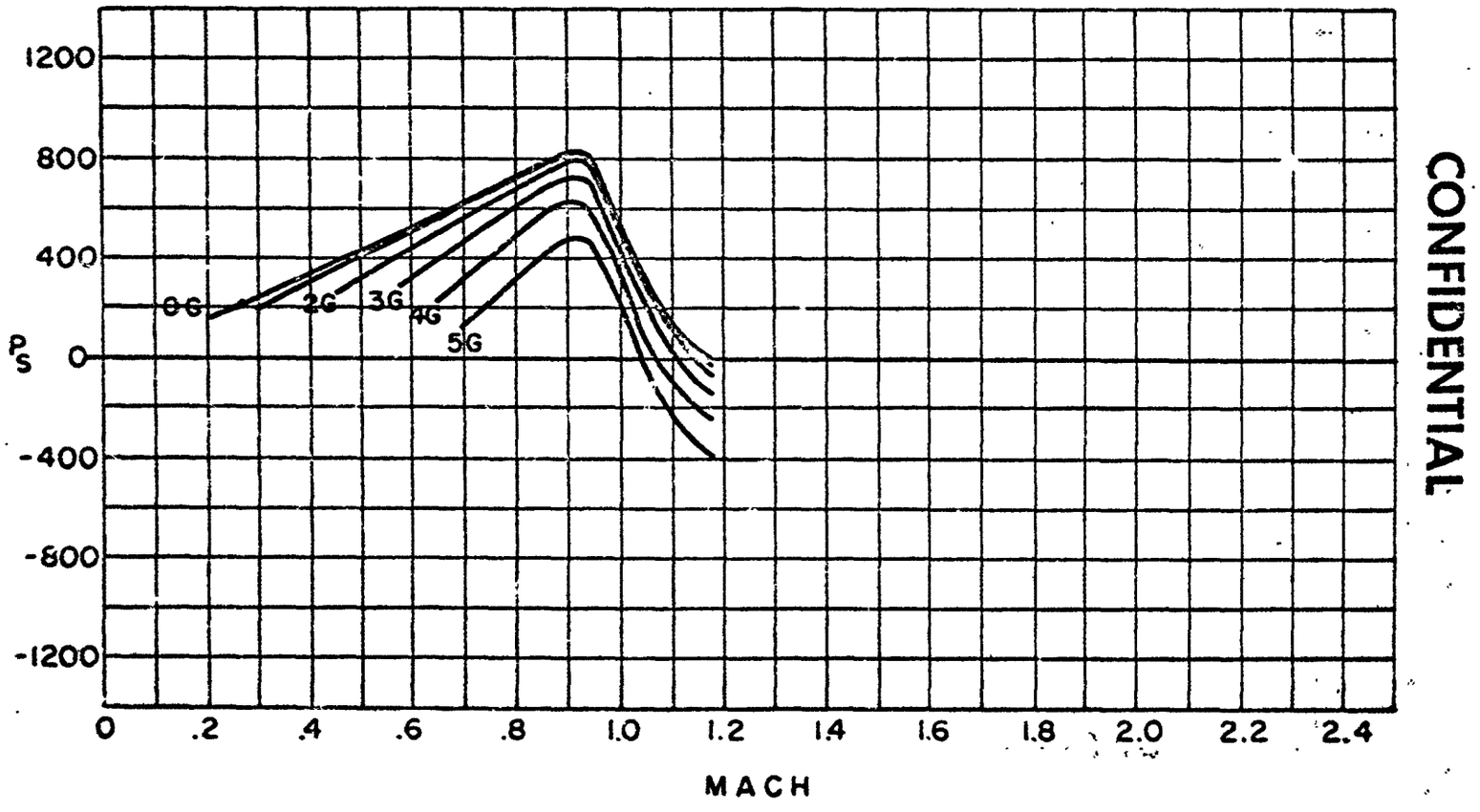


CONFIDENTIAL

88

MAXIMUM POWER · SEA LEVEL

F-104C

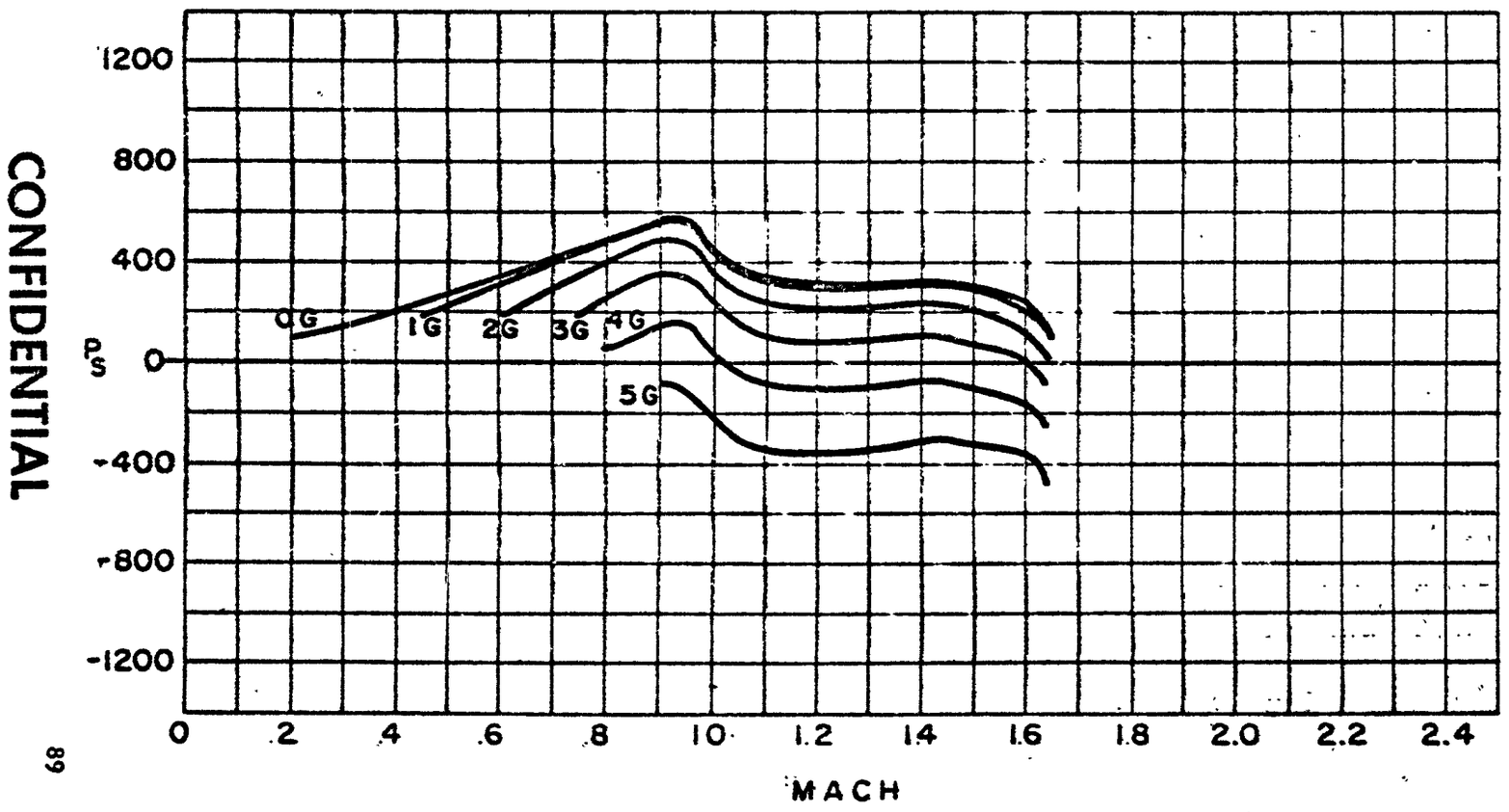


CONFIDENTIAL

CONFIDENTIAL

MAXIMUM POWER · 15,000'

F-104C



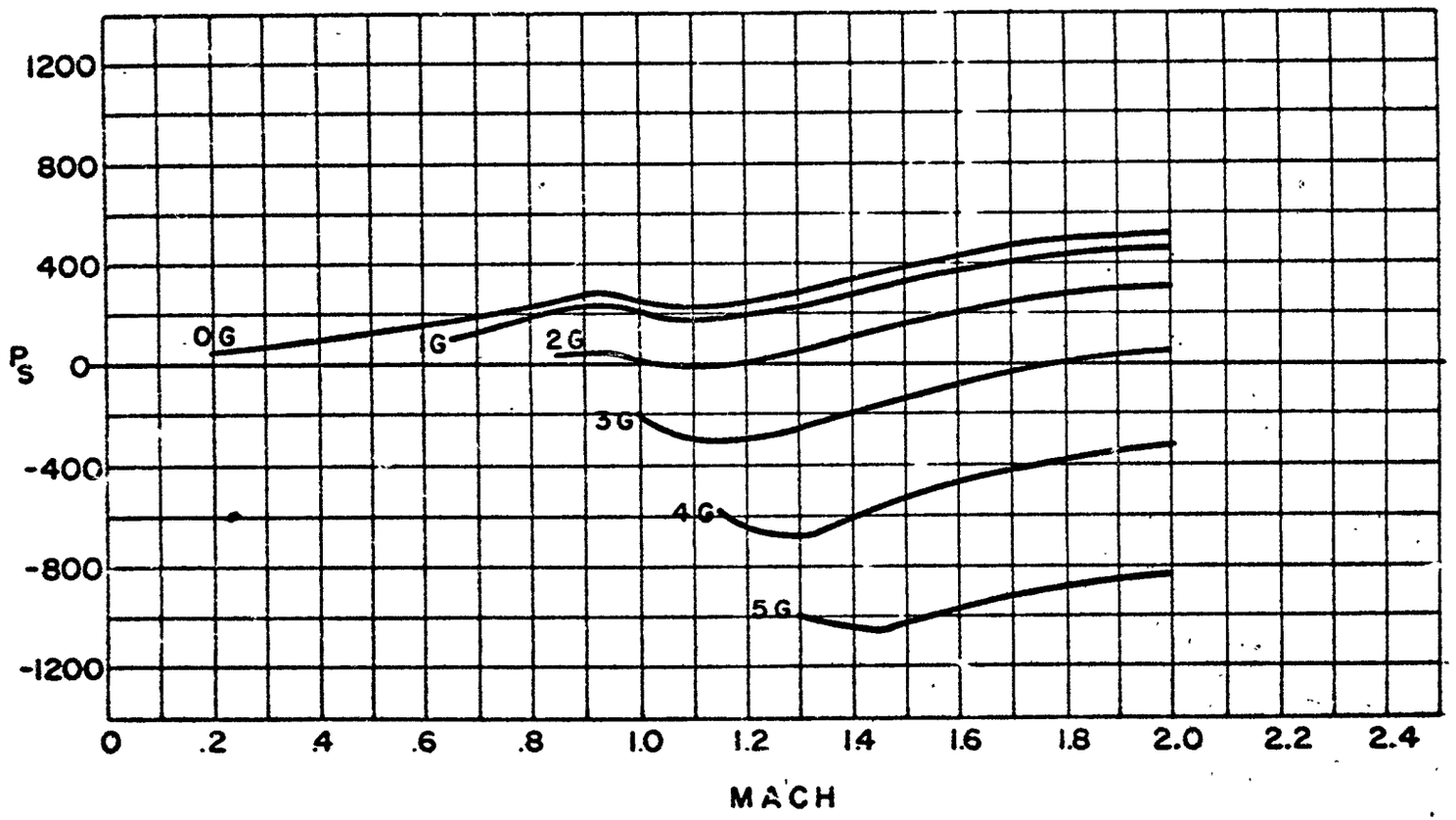
CONFIDENTIAL

CONFIDENTIAL

89

MAXIMUM POWER · 35,000'

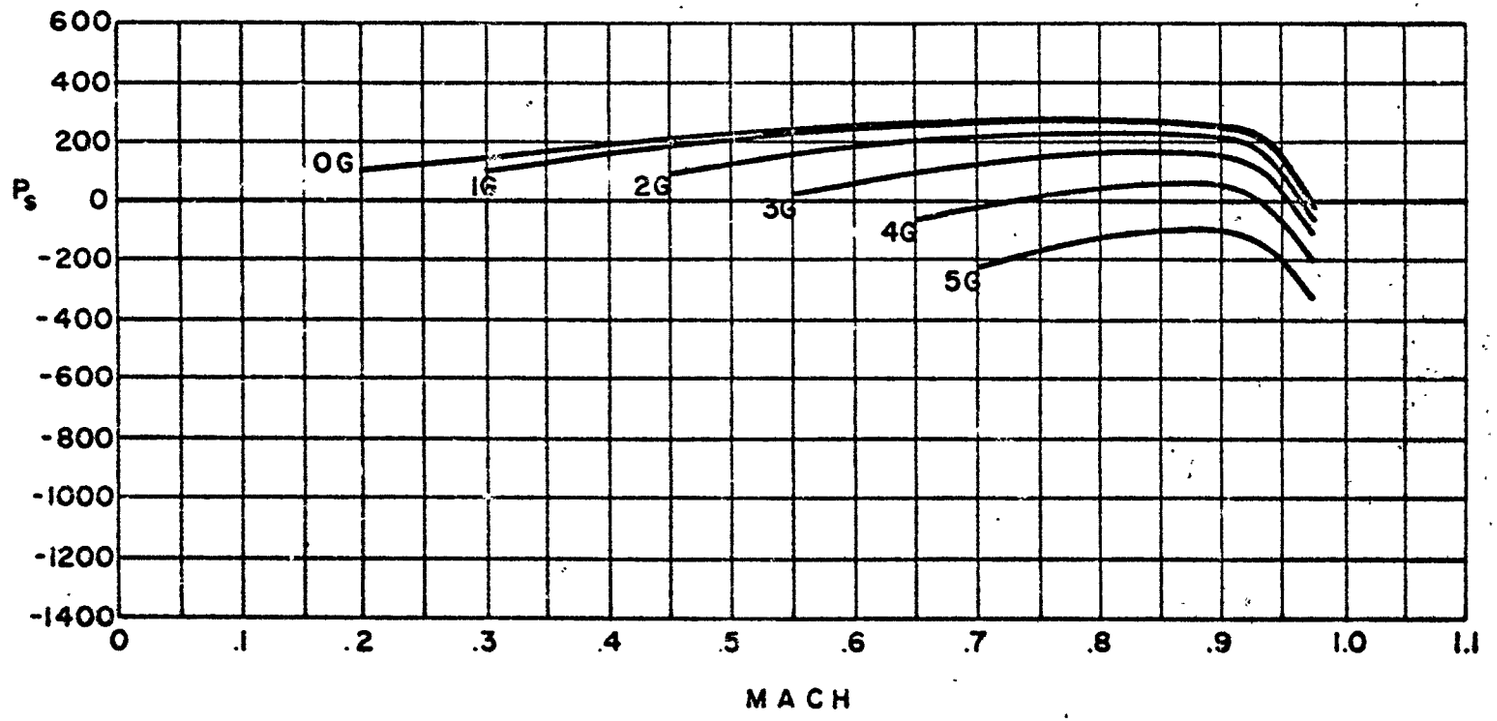
F-104C



CONFIDENTIAL

MILITARY POWER · SEA LEVEL

F-104C

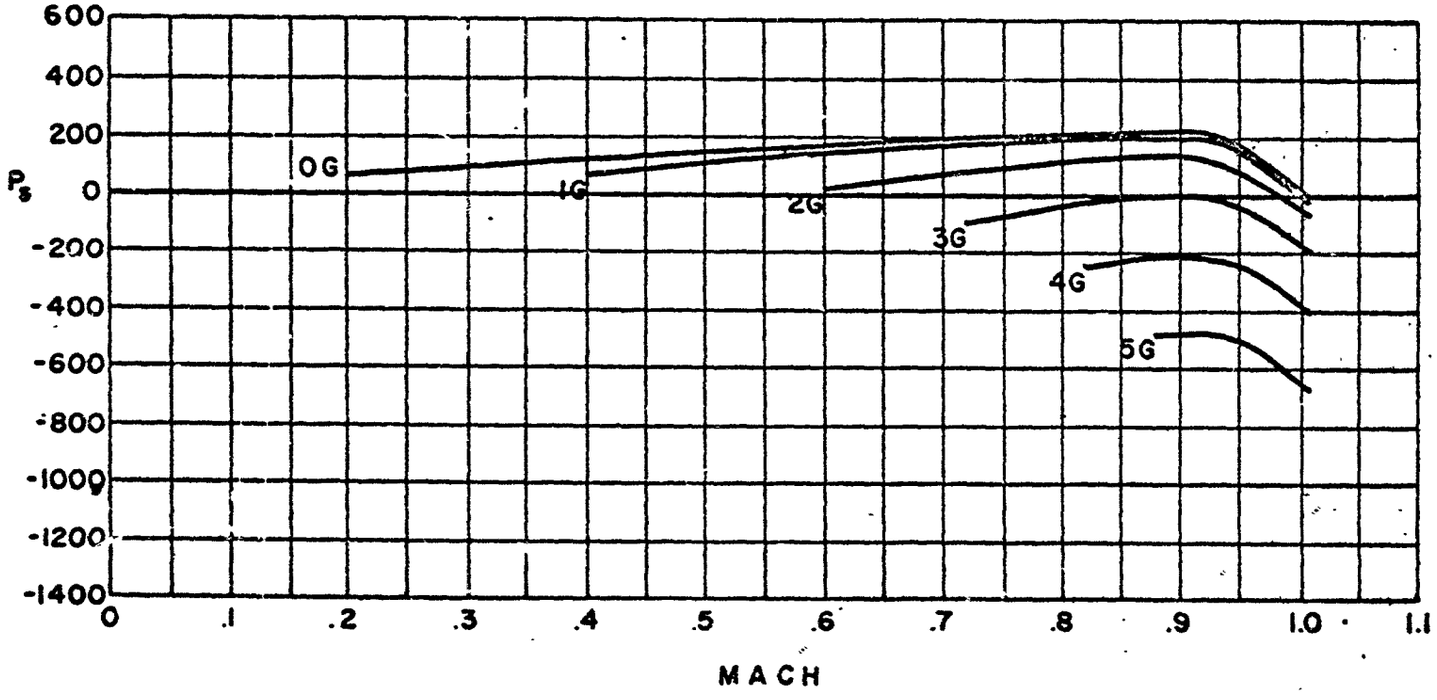


CONFIDENTIAL

CONFIDENTIAL

MILITARY POWER · 15,000'

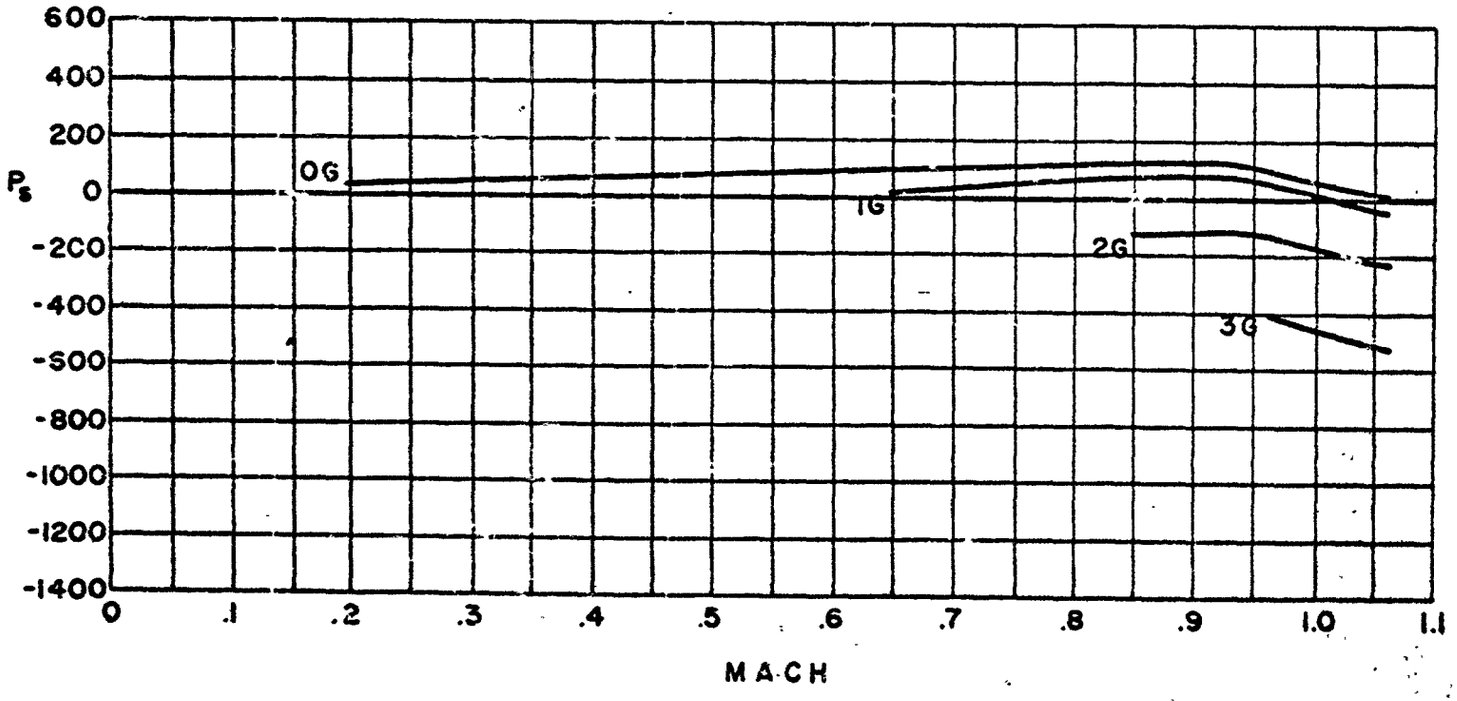
F-104C



CONFIDENTIAL

MILITARY POWER · 35,000'

F-104C

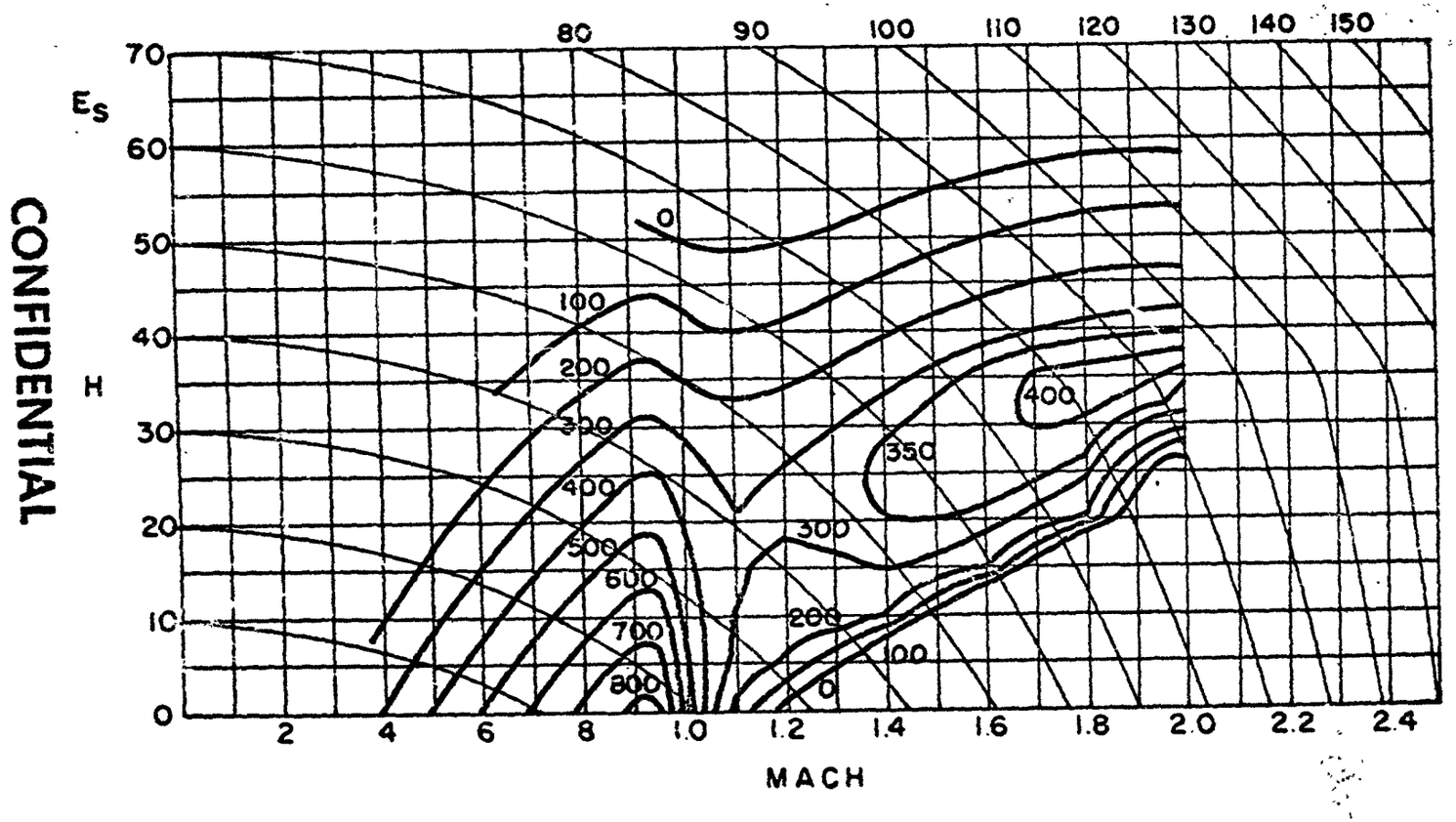


CONFIDENTIAL

CONFIDENTIAL

MAXIMUM POWER · 1G

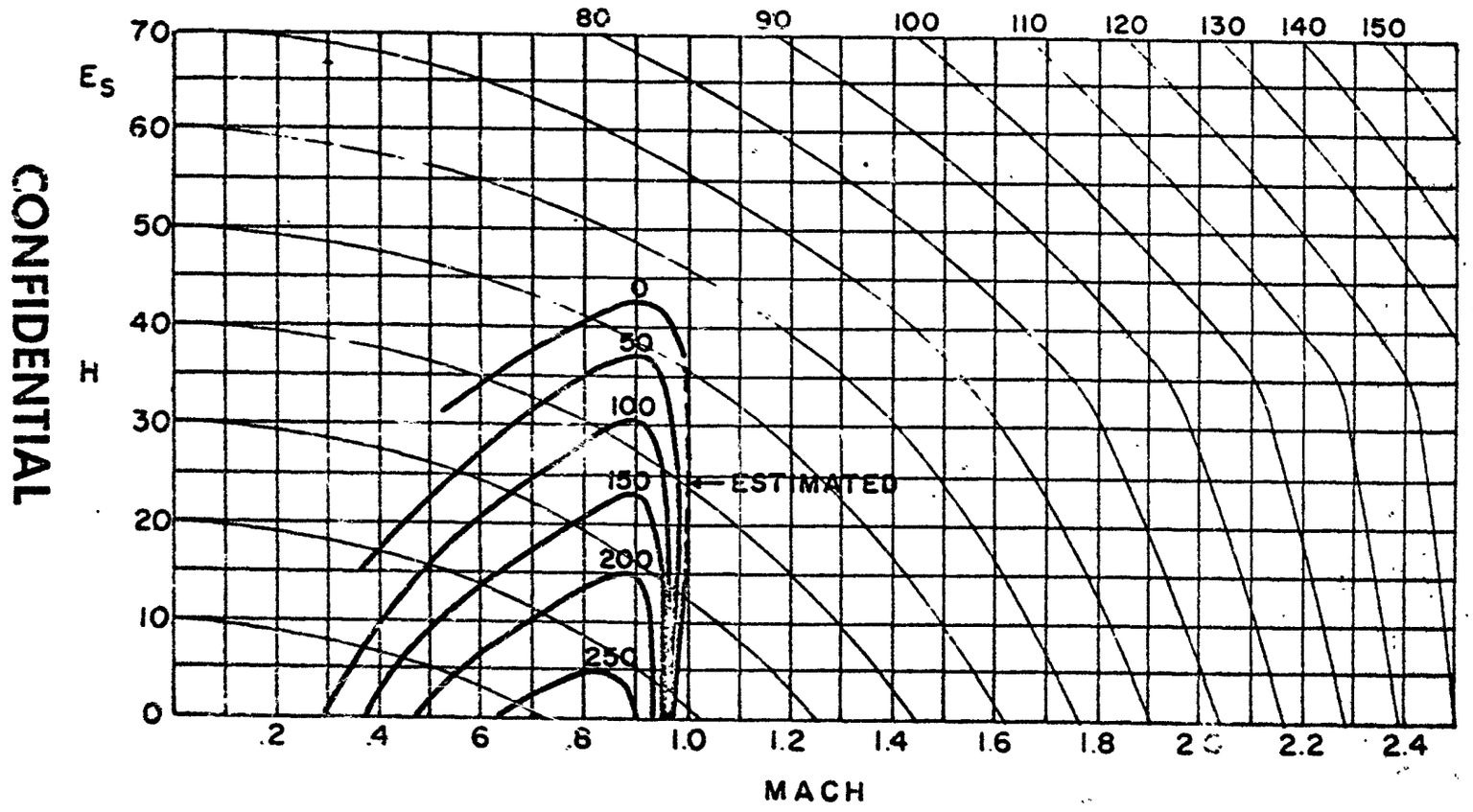
F-104C



CONFIDENTIAL

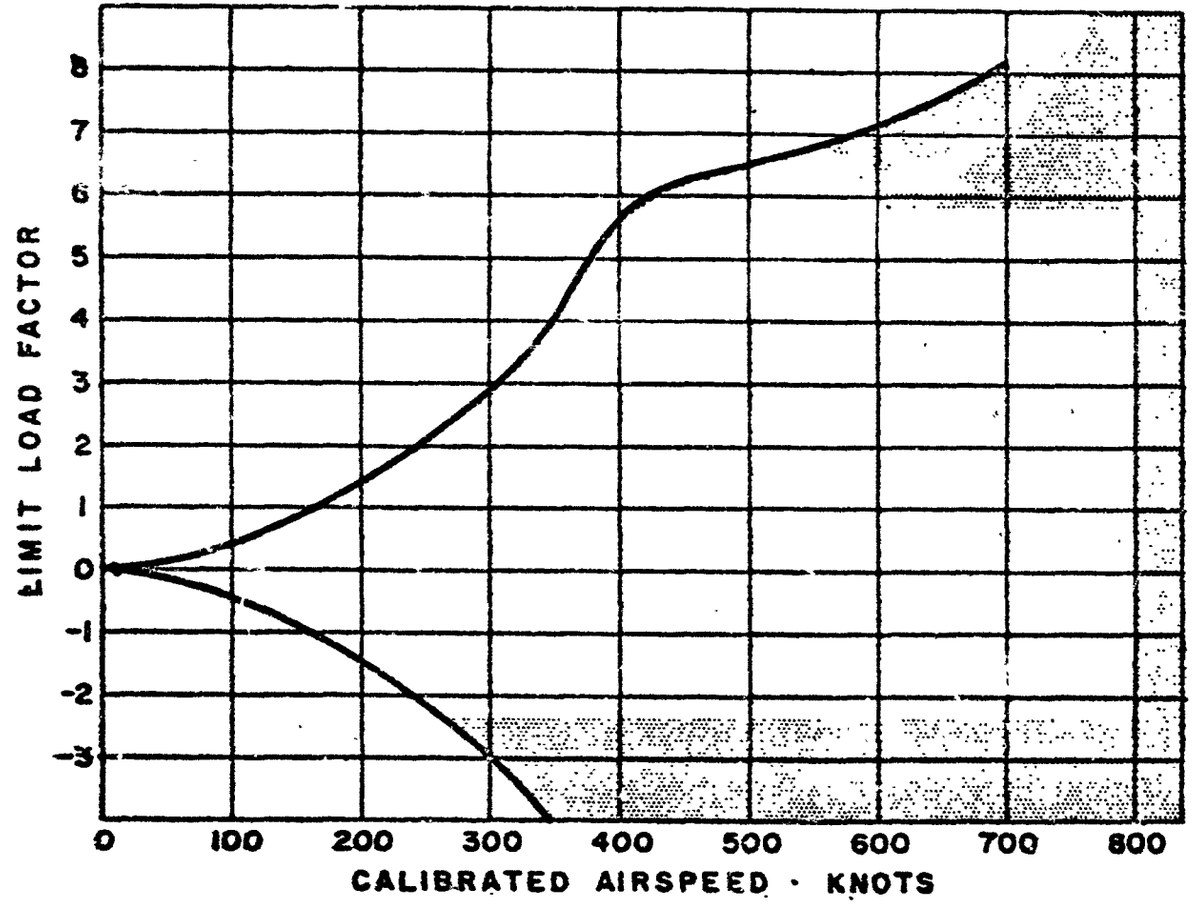
% MILITARY POWER · 1G

F-104C



CONFIDENTIAL

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

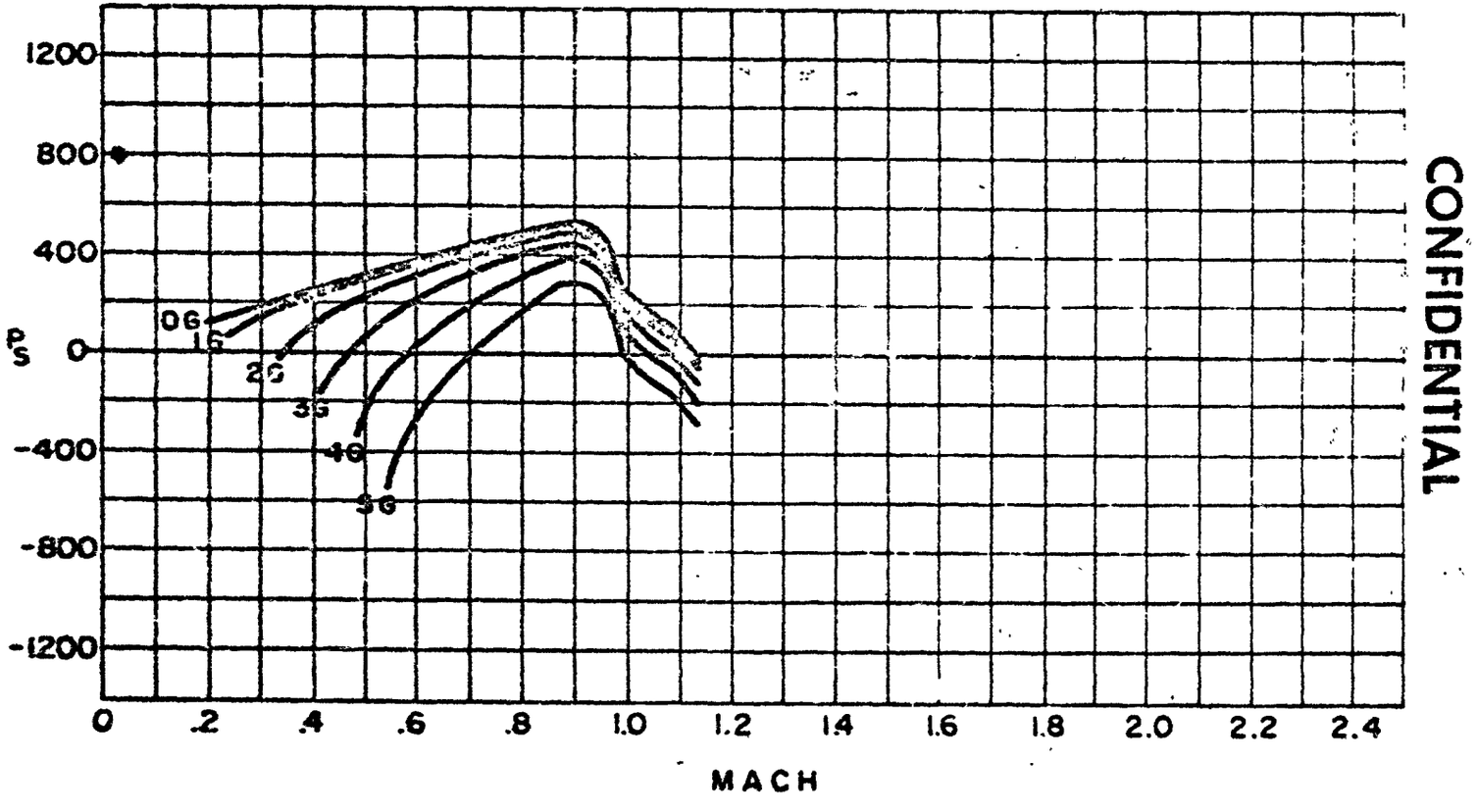


CONFIDENTIAL

100

MAXIMUM POWER · SEA LEVEL

F-105D

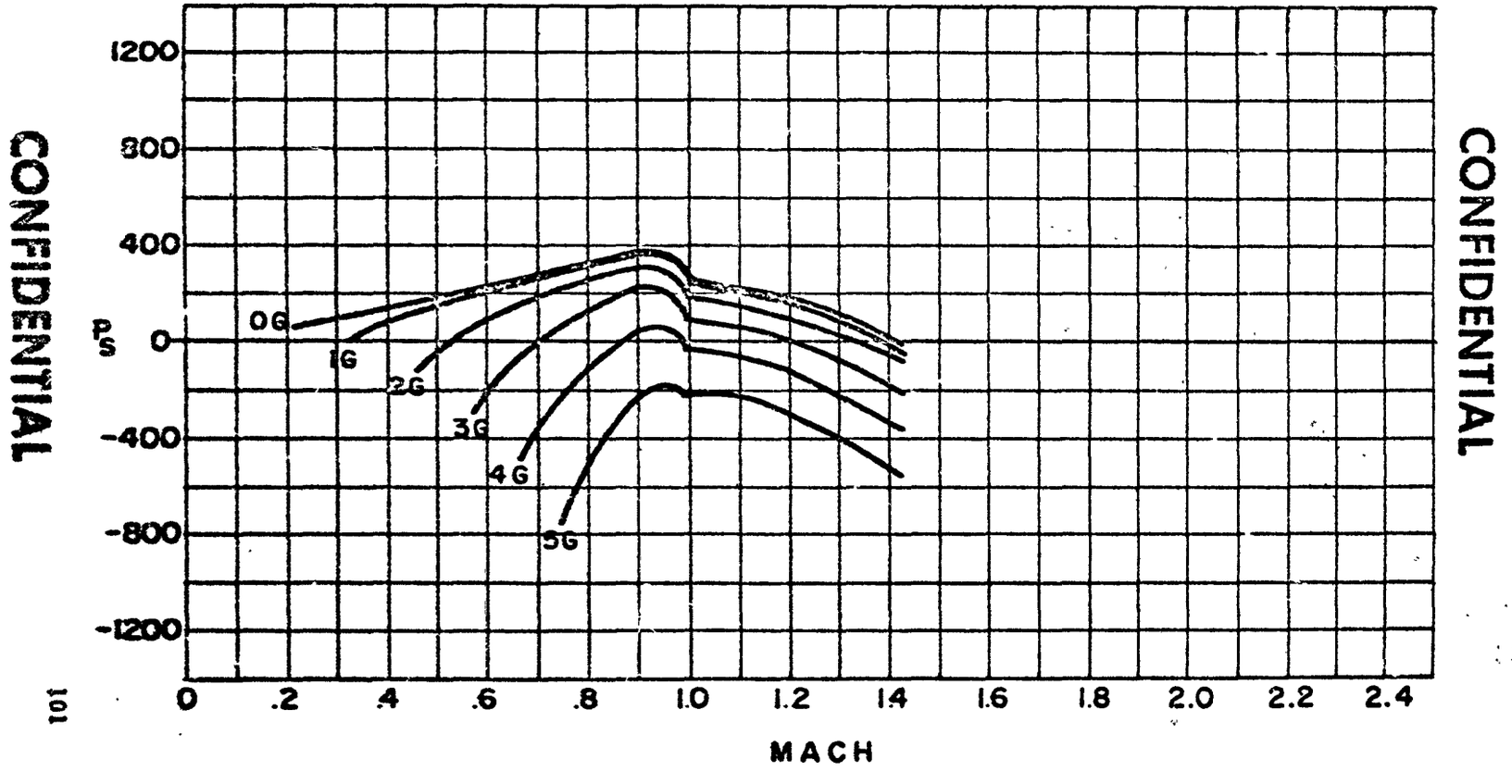


CONFIDENTIAL

CONFIDENTIAL

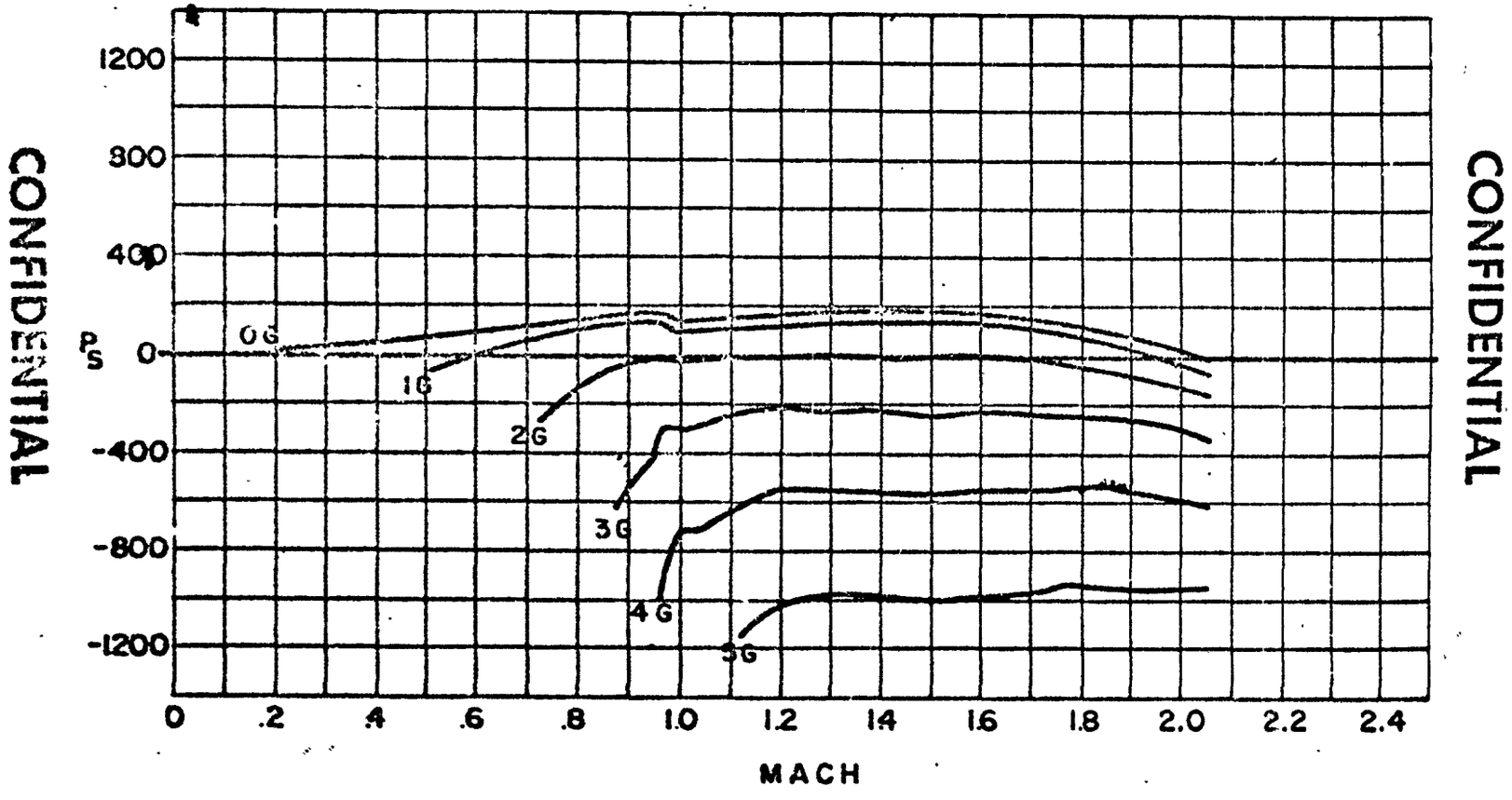
MAXIMUM POWER · 15,000'

F-105D



MAXIMUM POWER · 35,000'

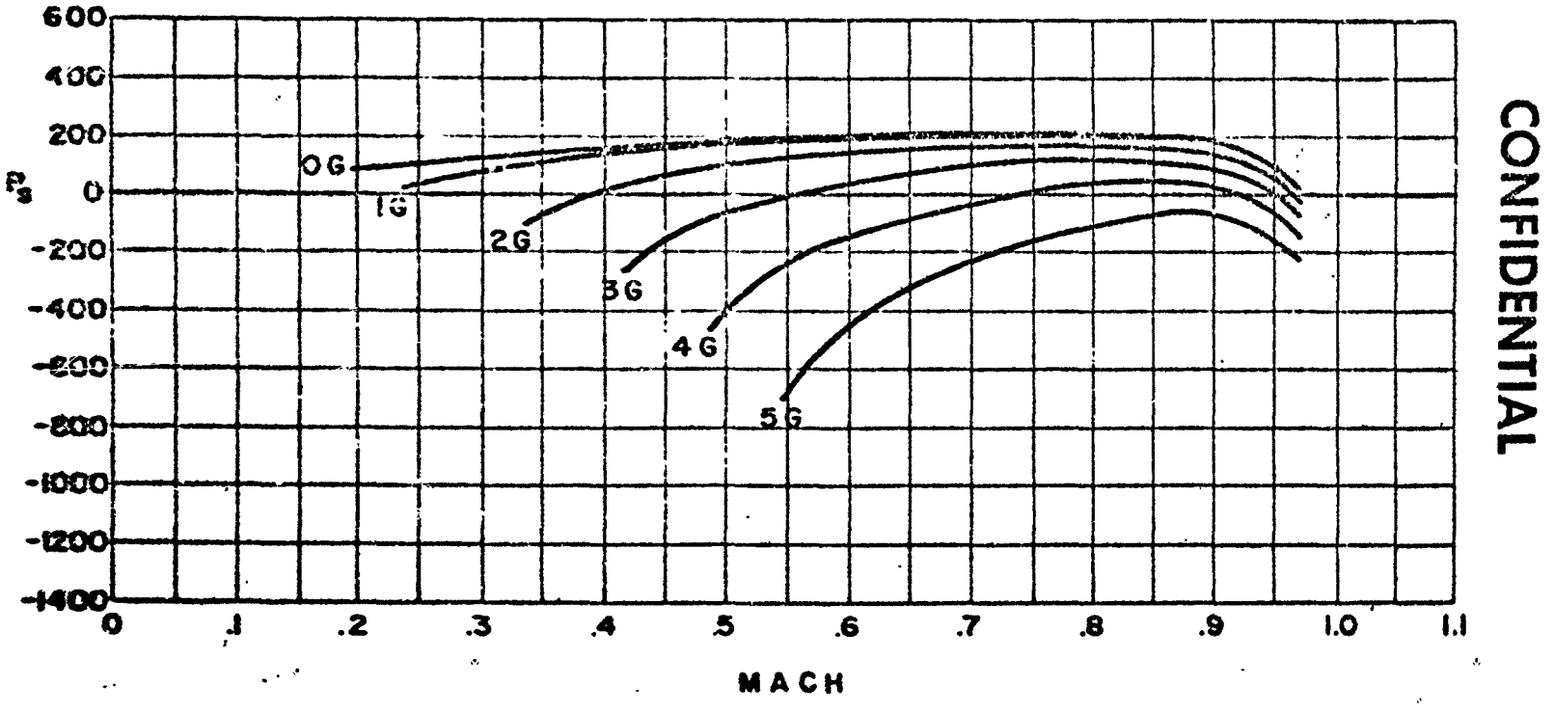
F-105D



CONFIDENTIAL

MILITARY POWER · SEA LEVEL

F-105D



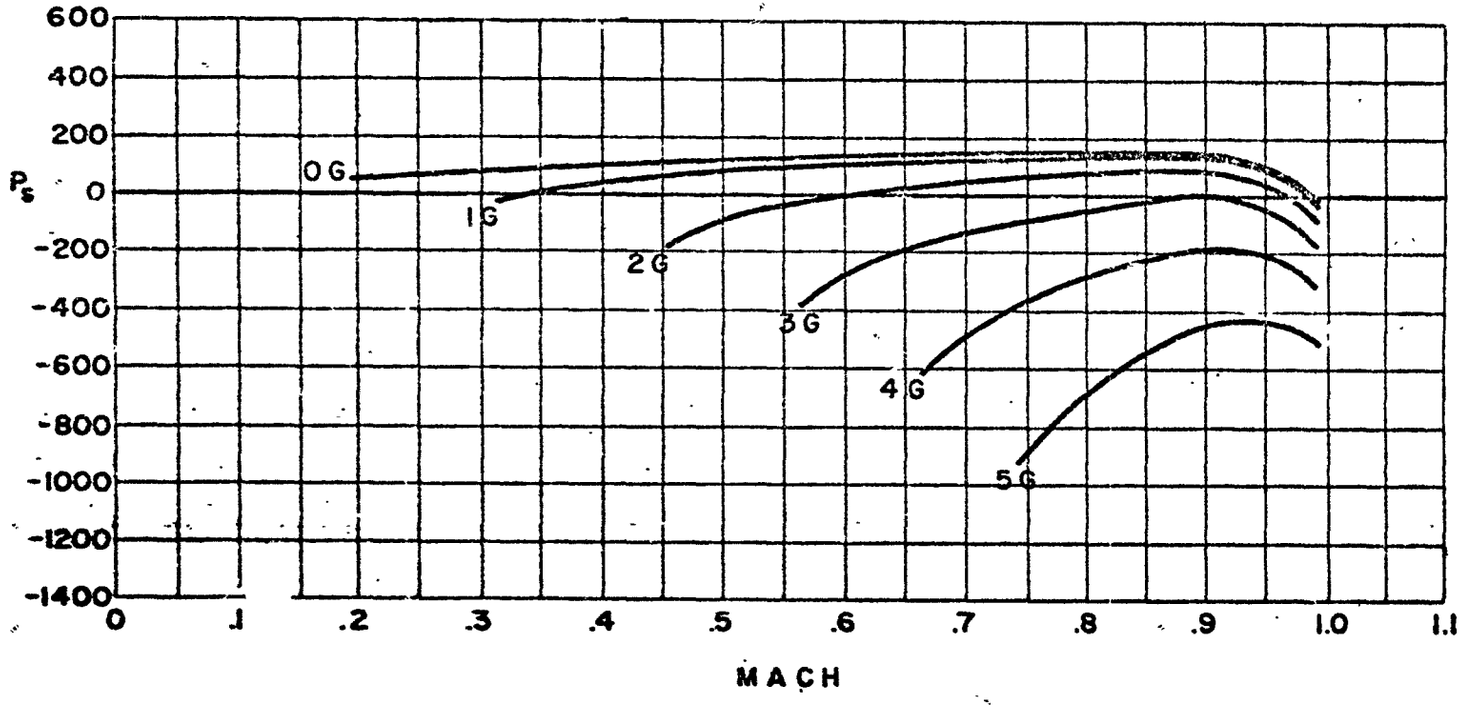
CONFIDENTIAL

CONFIDENTIAL

103

MILITARY POWER · 15,000'

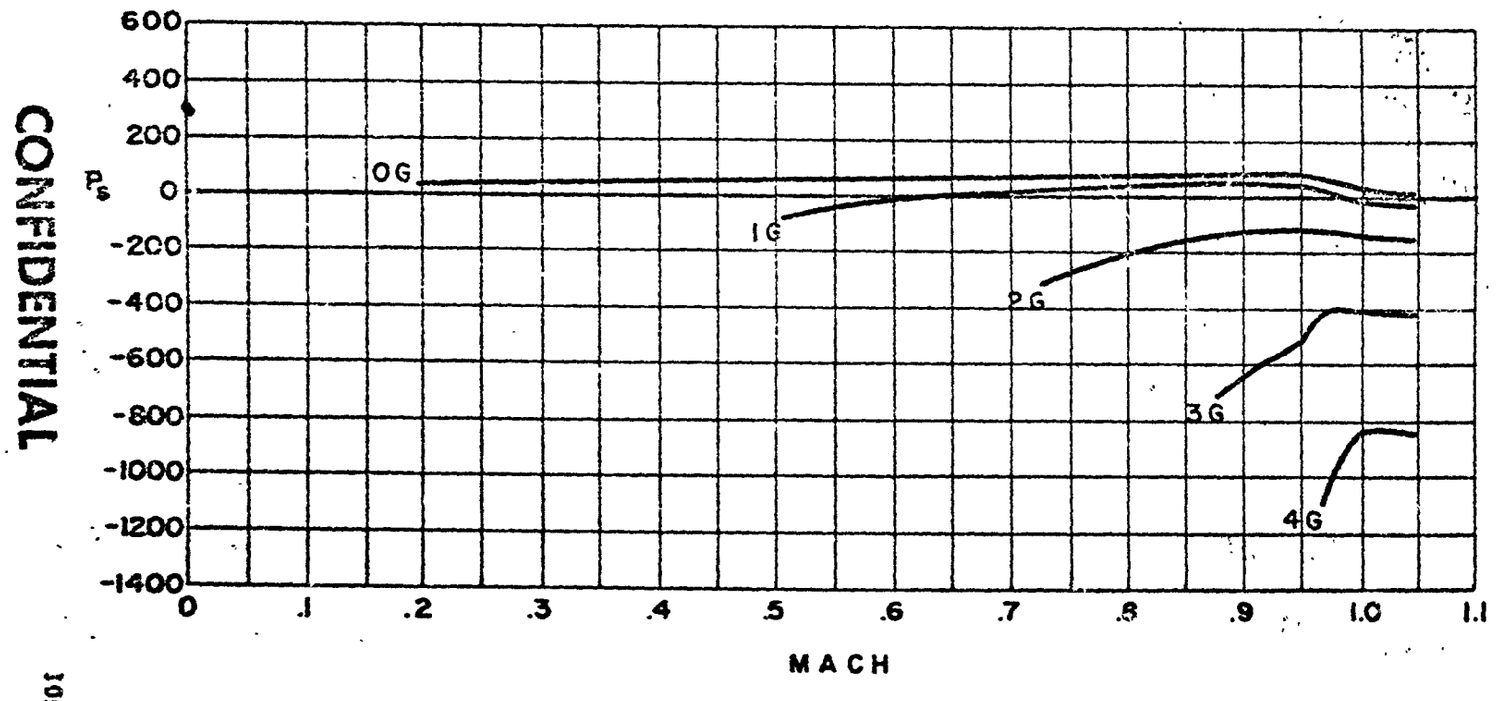
F-105D



CONFIDENTIAL

MILITARY POWER · 35,000'

F-105D



CONFIDENTIAL

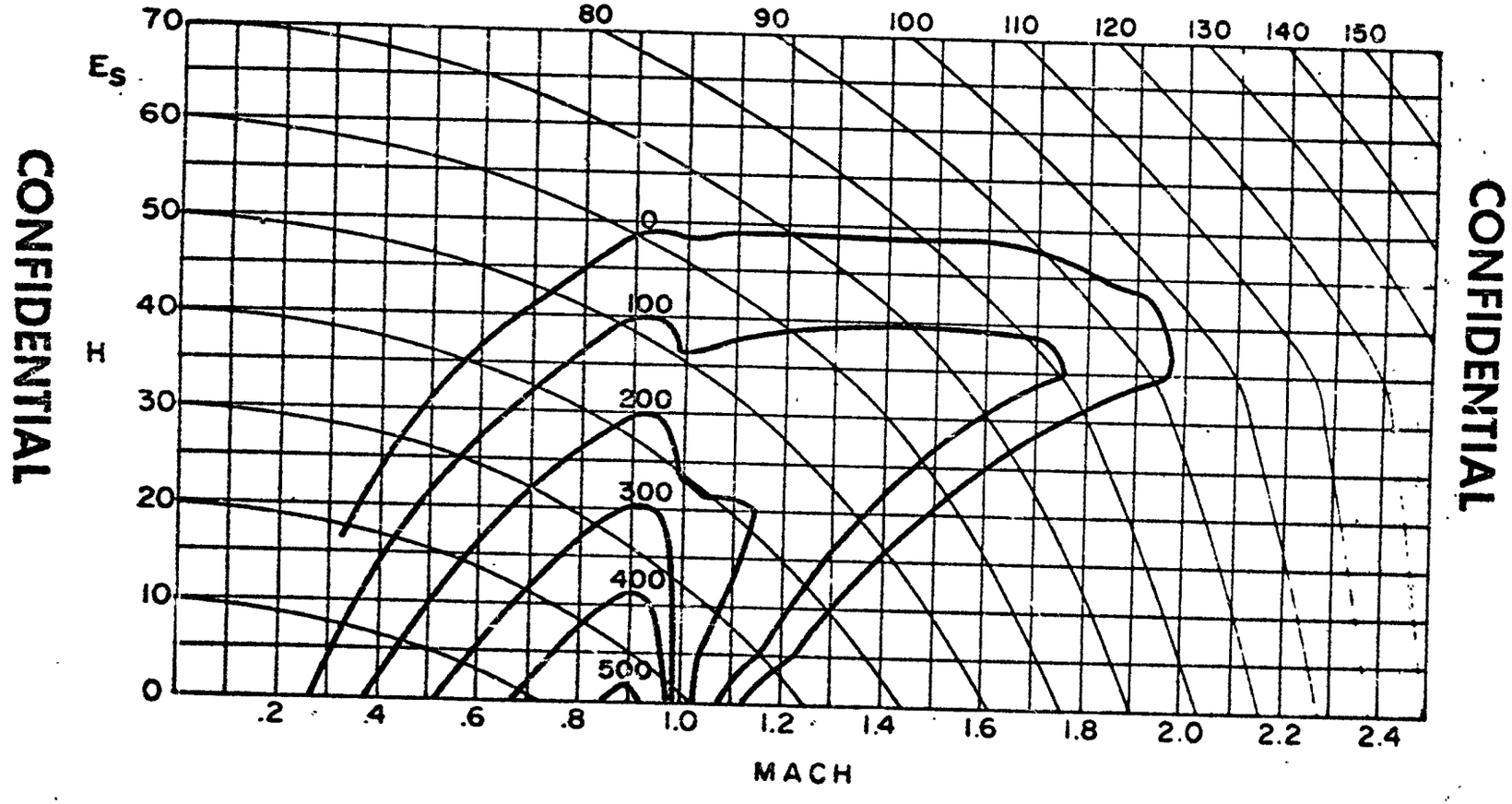
CONFIDENTIAL

105

106

MAXIMUM POWER · 1G

F-105D

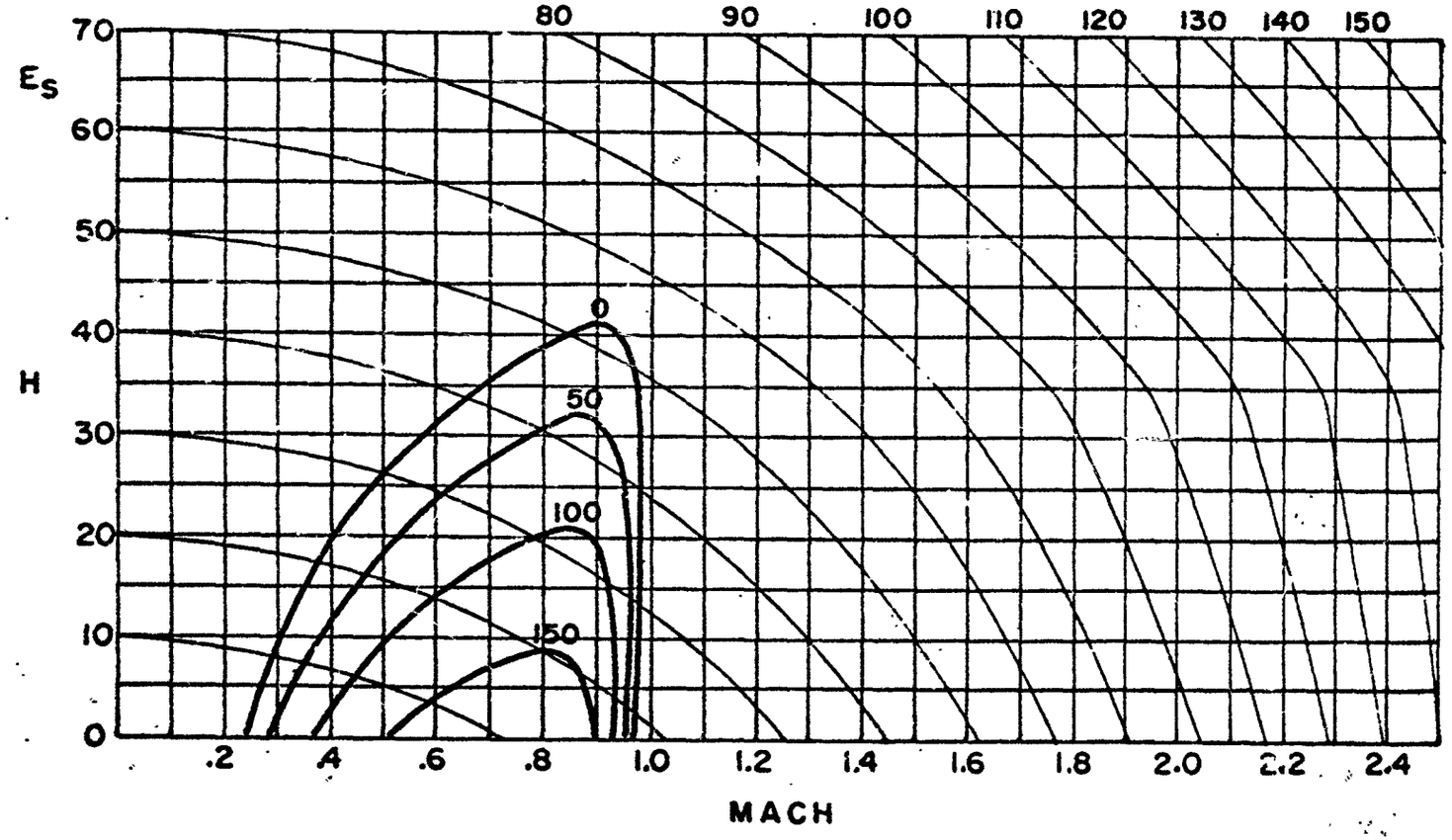


CONFIDENTIAL

CONFIDENTIAL

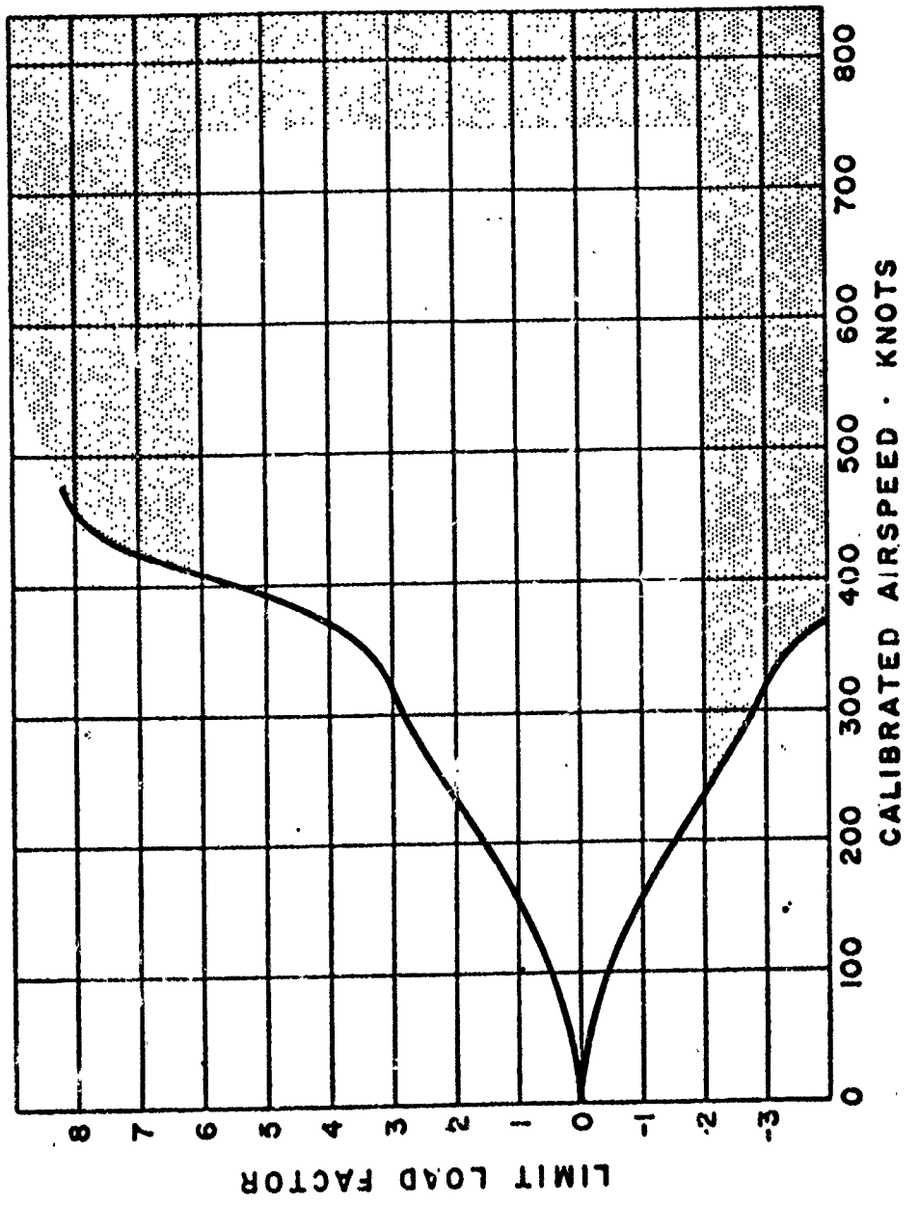
MILITARY POWER · IG

F-105D



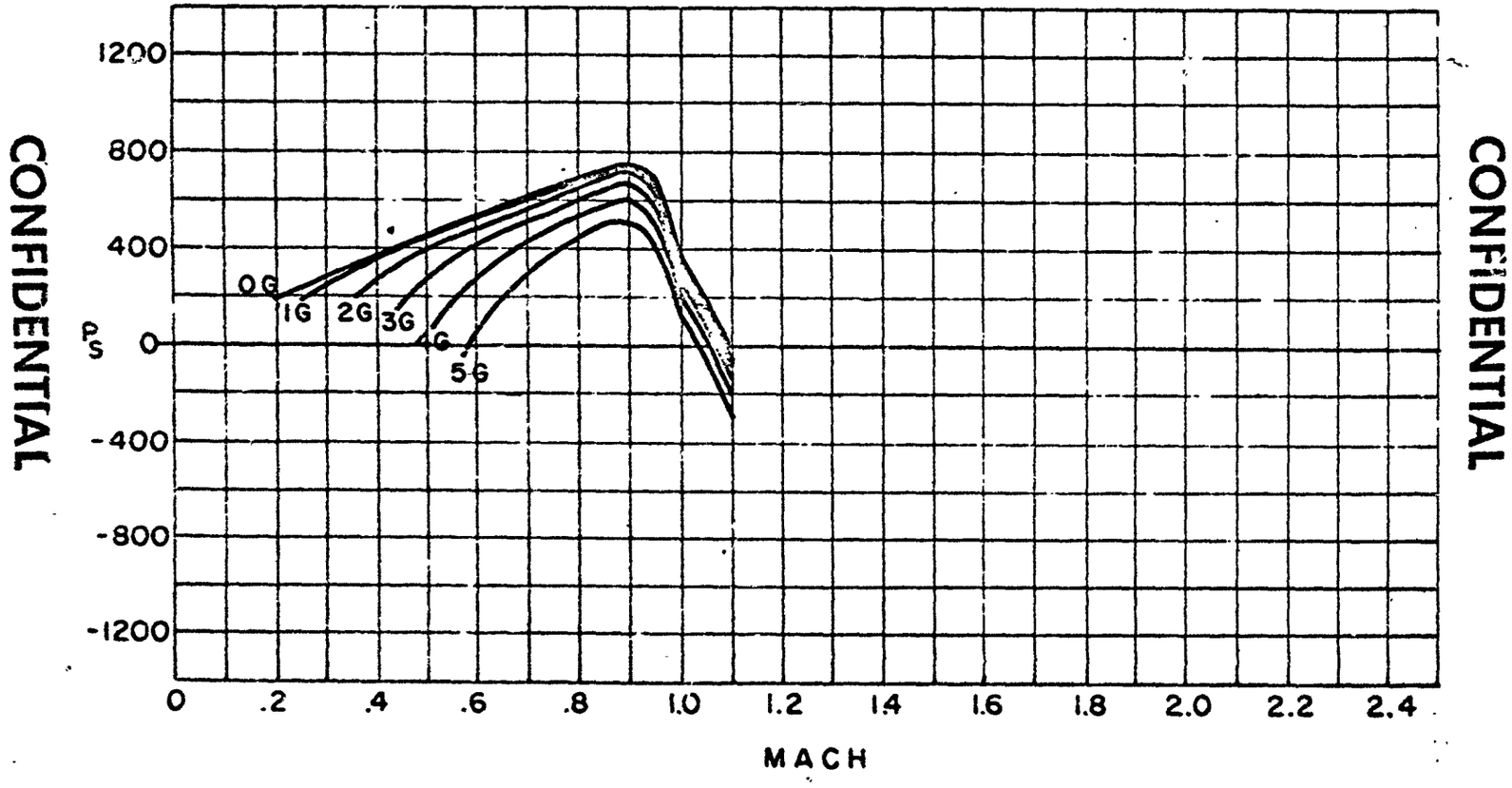
CONFIDENTIAL

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



MAXIMUM POWER · SEA LEVEL

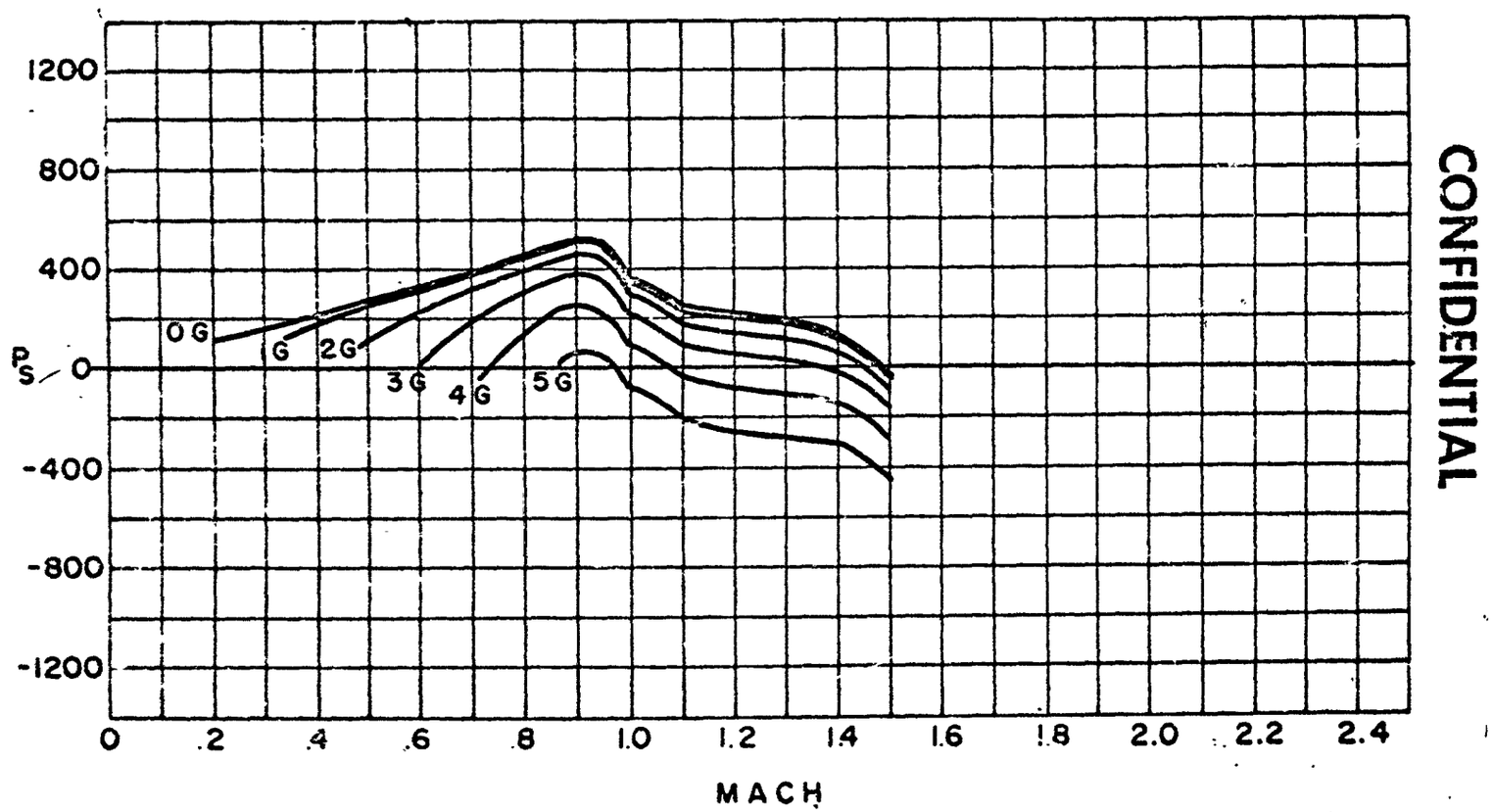
F-4C



CONFIDENTIAL

MAXIMUM POWER · 15,000'

F-4C



CONFIDENTIAL

CONFIDENTIAL

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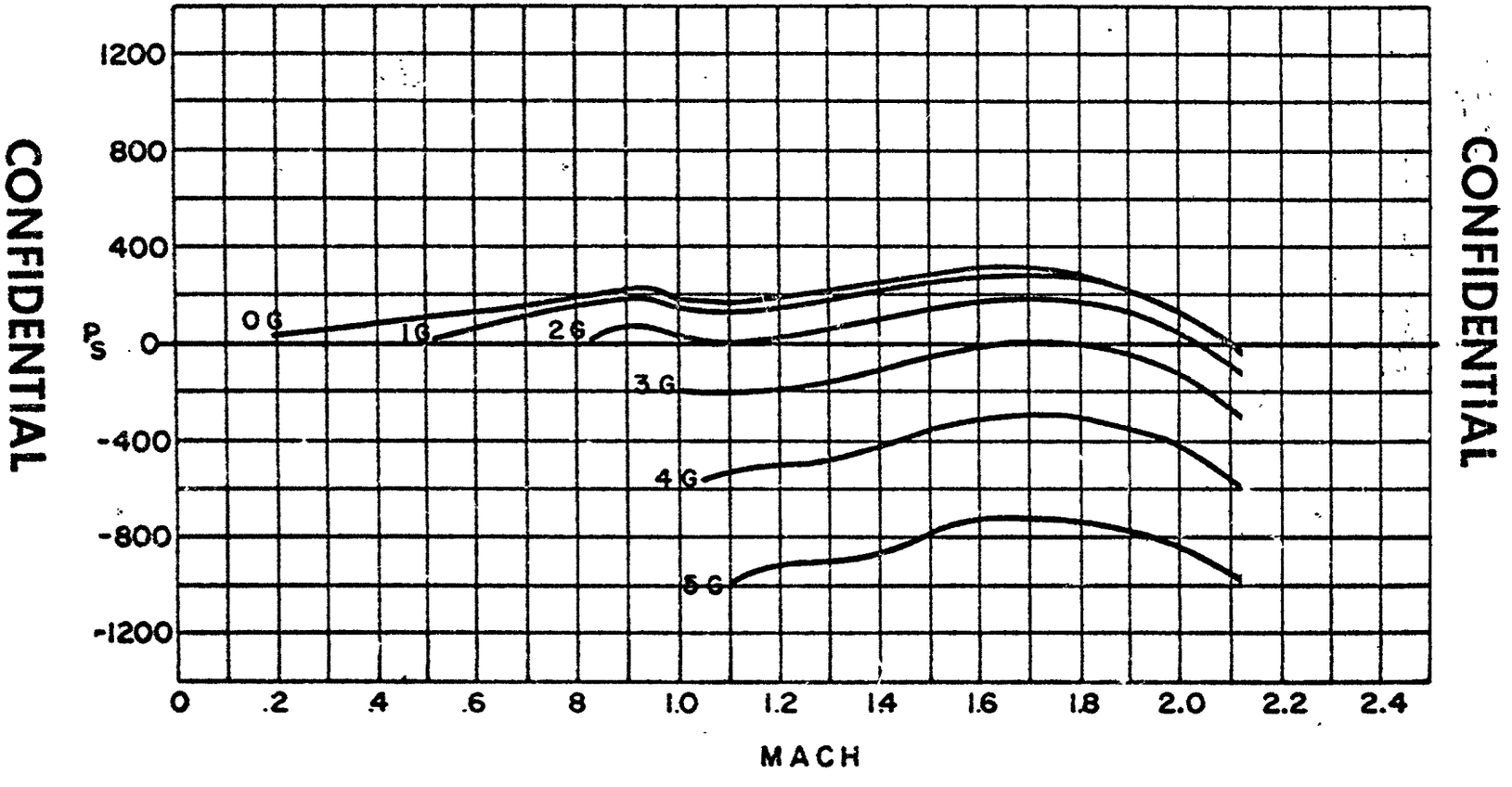
MAXIMUM POWER · 35,000'

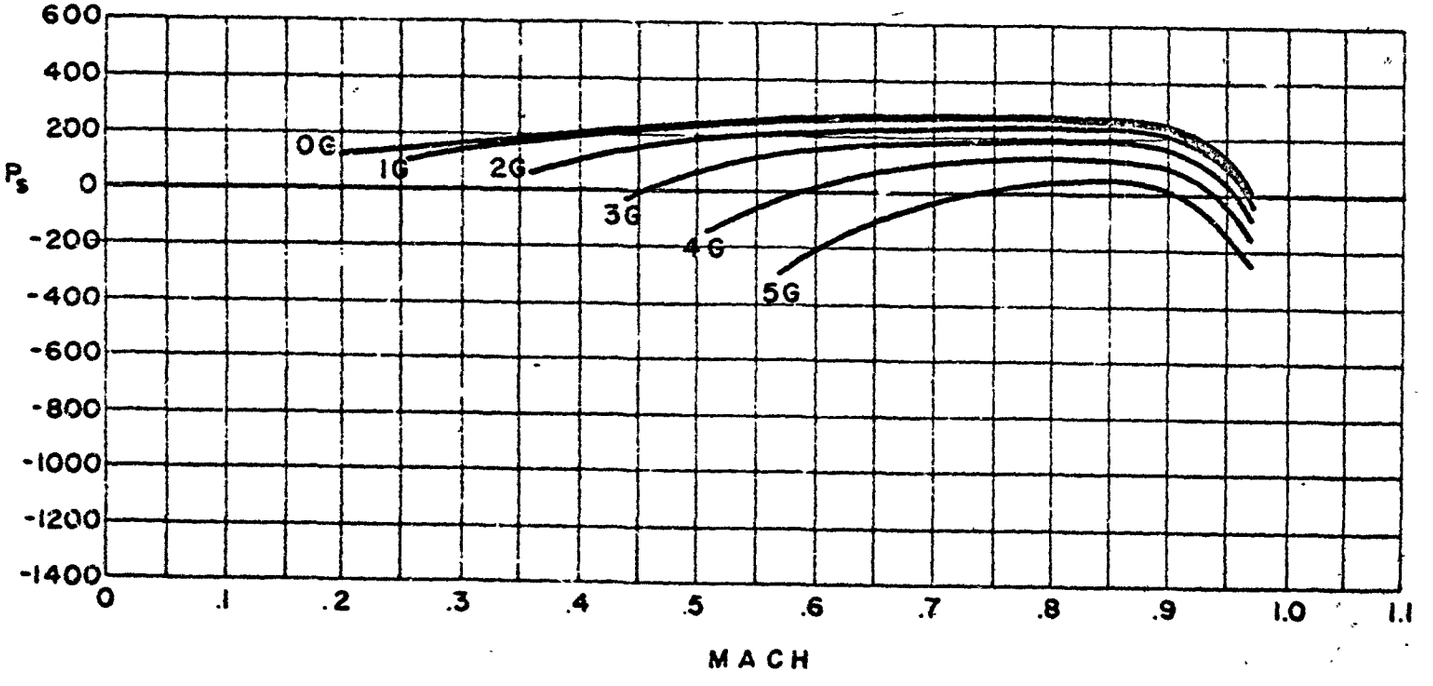
F-4C



CONFIDENTIAL

MILITARY POWER · SEA-LEVEL

F-4C

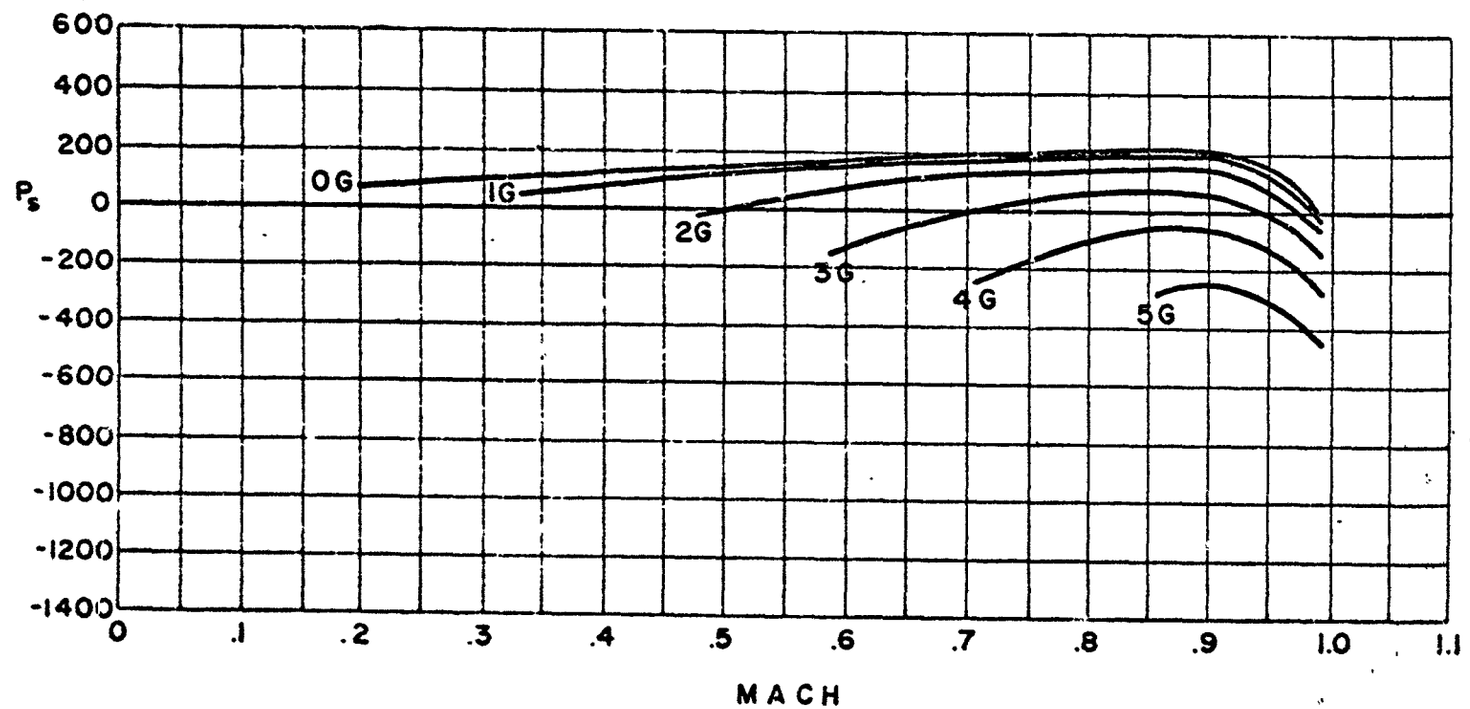


CONFIDENTIAL

CONFIDENTIAL

MILITARY POWER · 15,000'

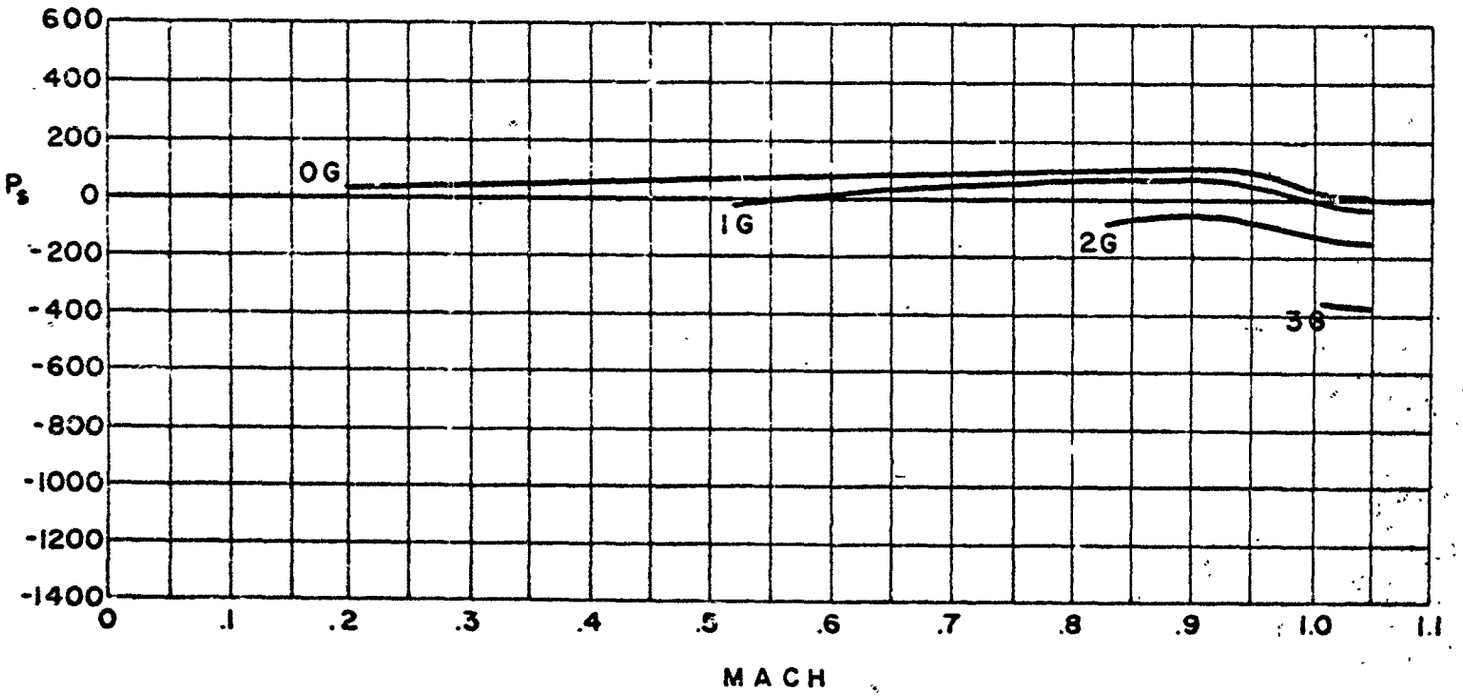
F-4C



CONFIDENTIAL

MILITARY POWER · 35,000'

F-4C



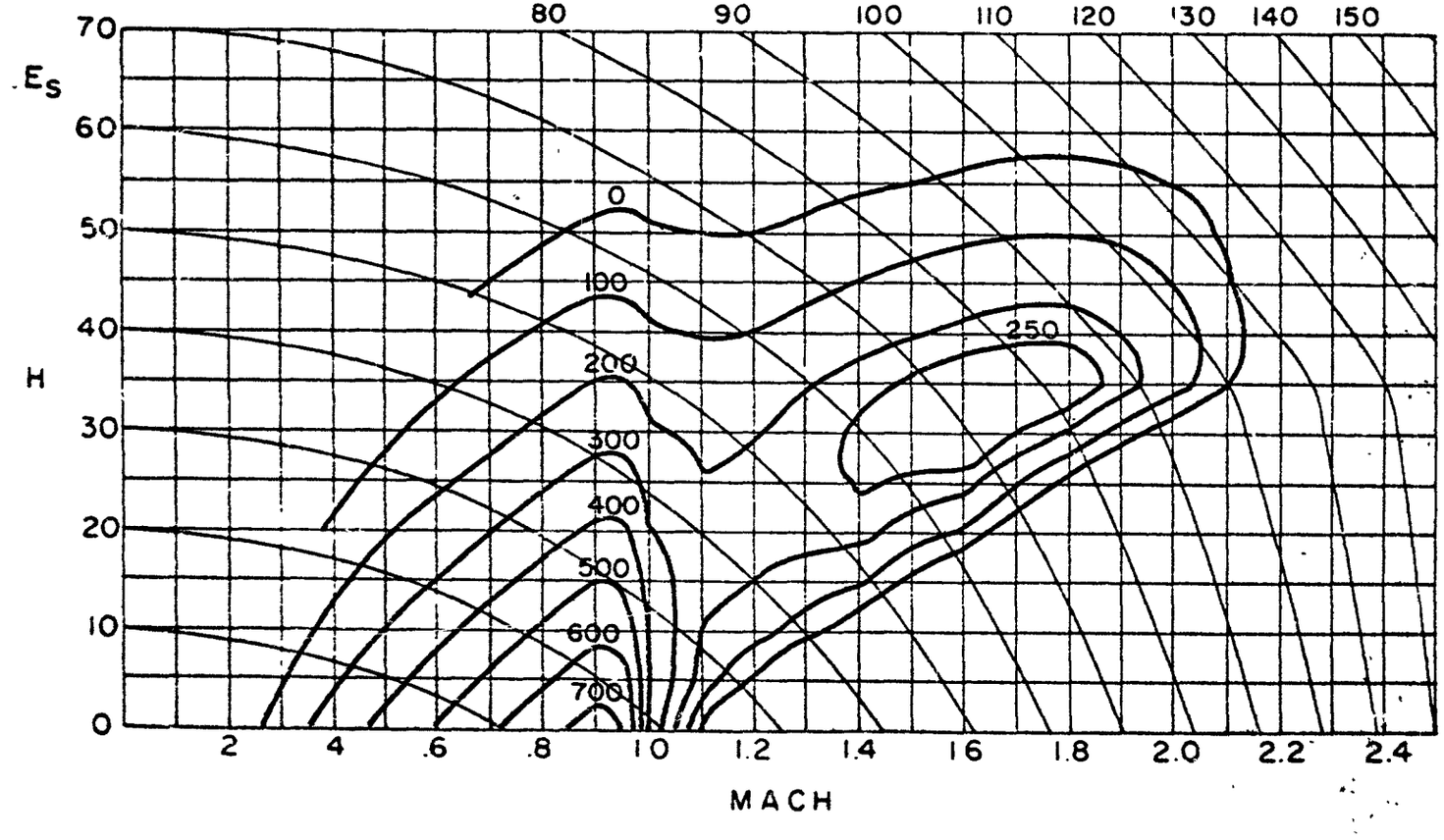
CONFIDENTIAL

CONFIDENTIAL

126

MAXIMUM POWER · 1G

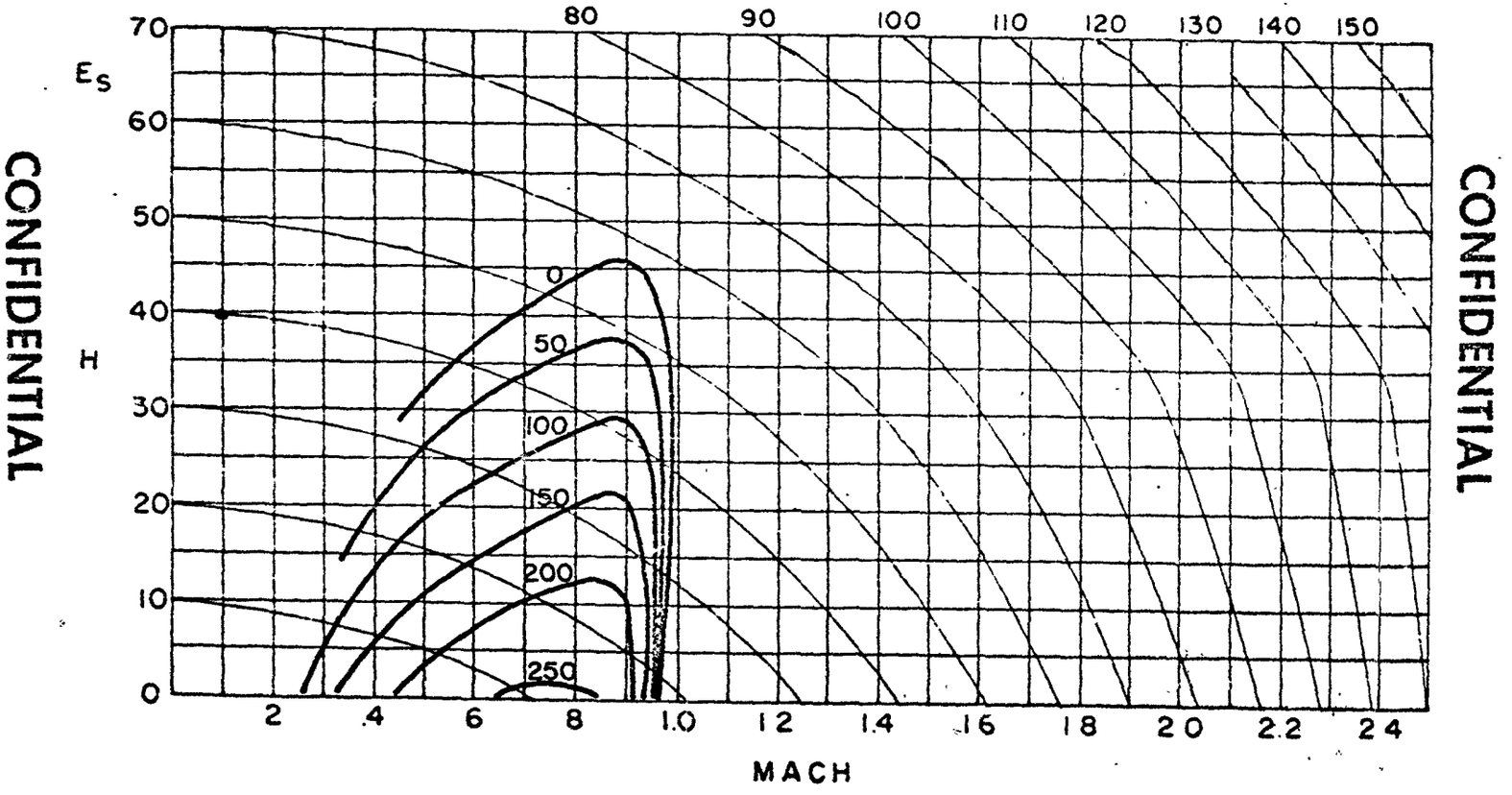
F-4C



CONFIDENTIAL

MILITARY POWER · 1G

F-4C

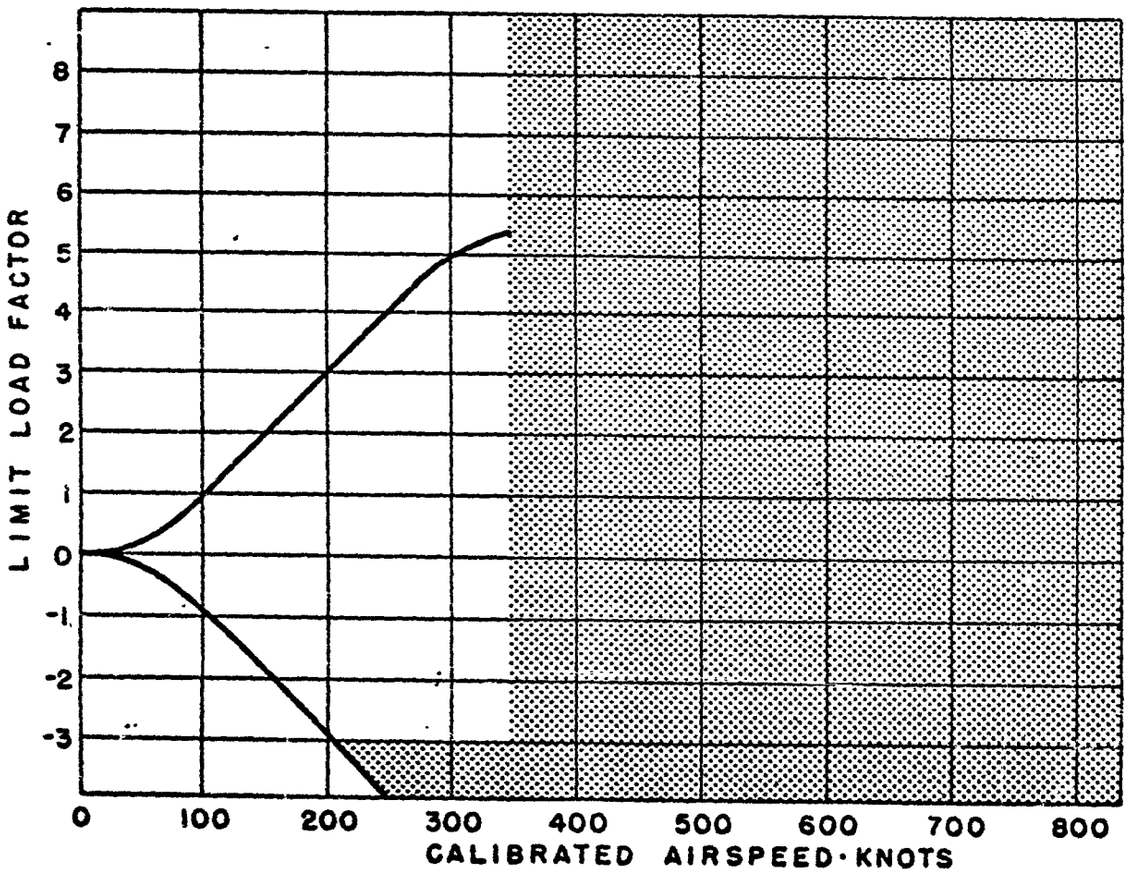


SECRET

FLIGHT OPERATING LIMITS

30,000'

MIG-15



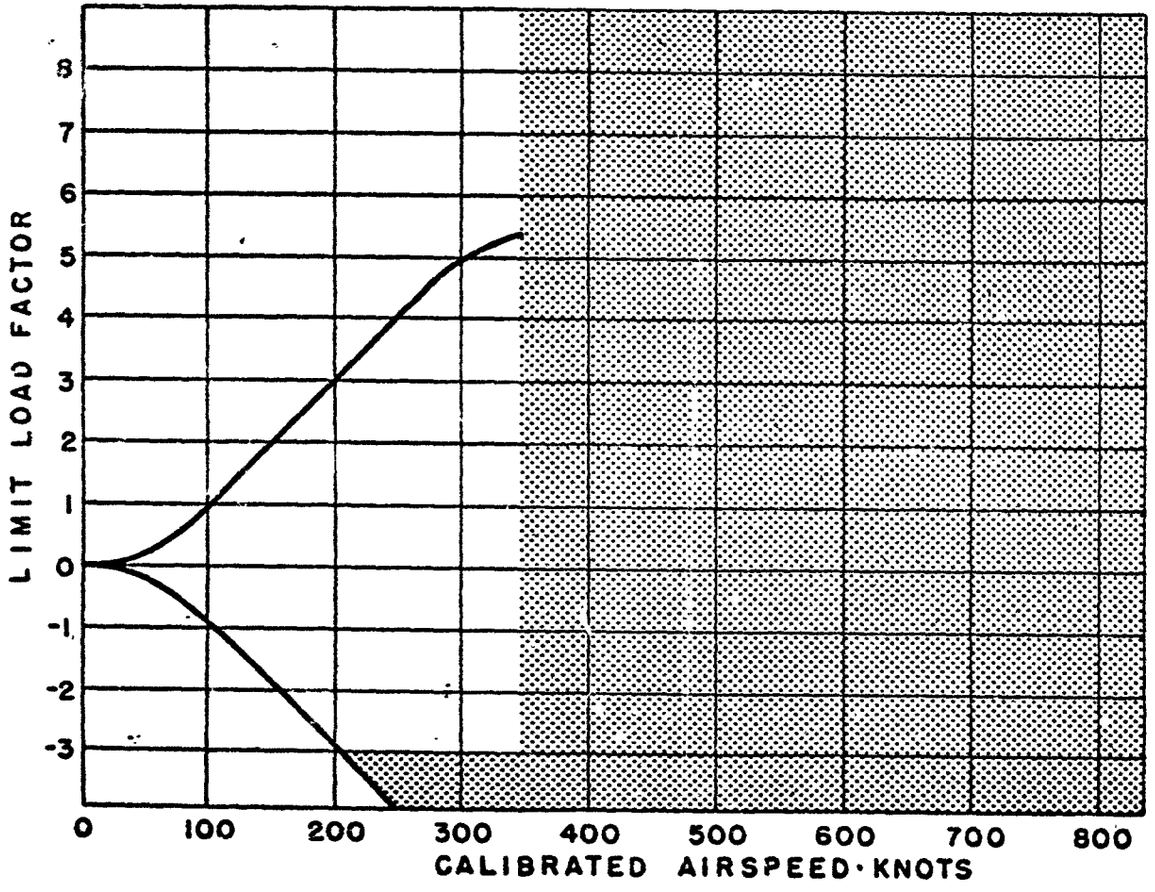
SECRET

SECRET

FLIGHT OPERATING LIMITS

30,000'

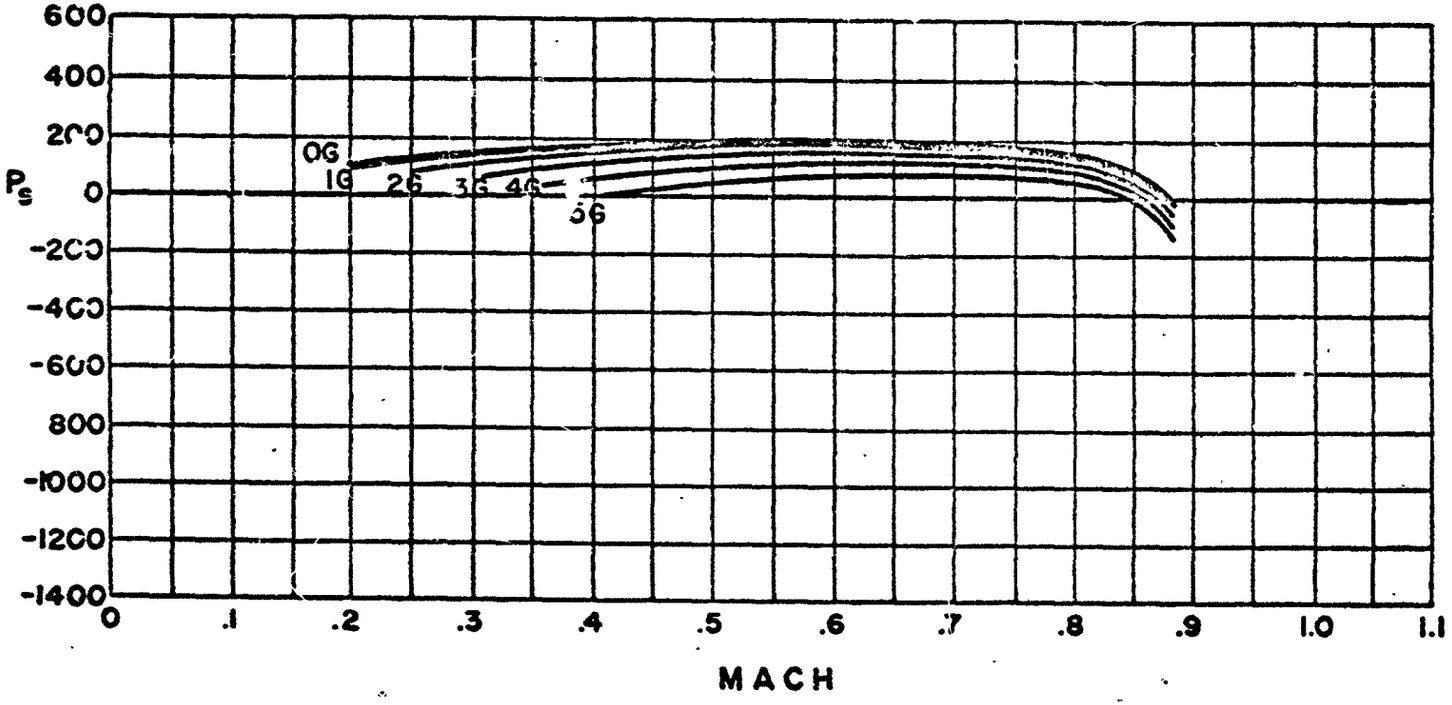
MIG-15



SECRET

MILITARY POWER · SEA LEVEL

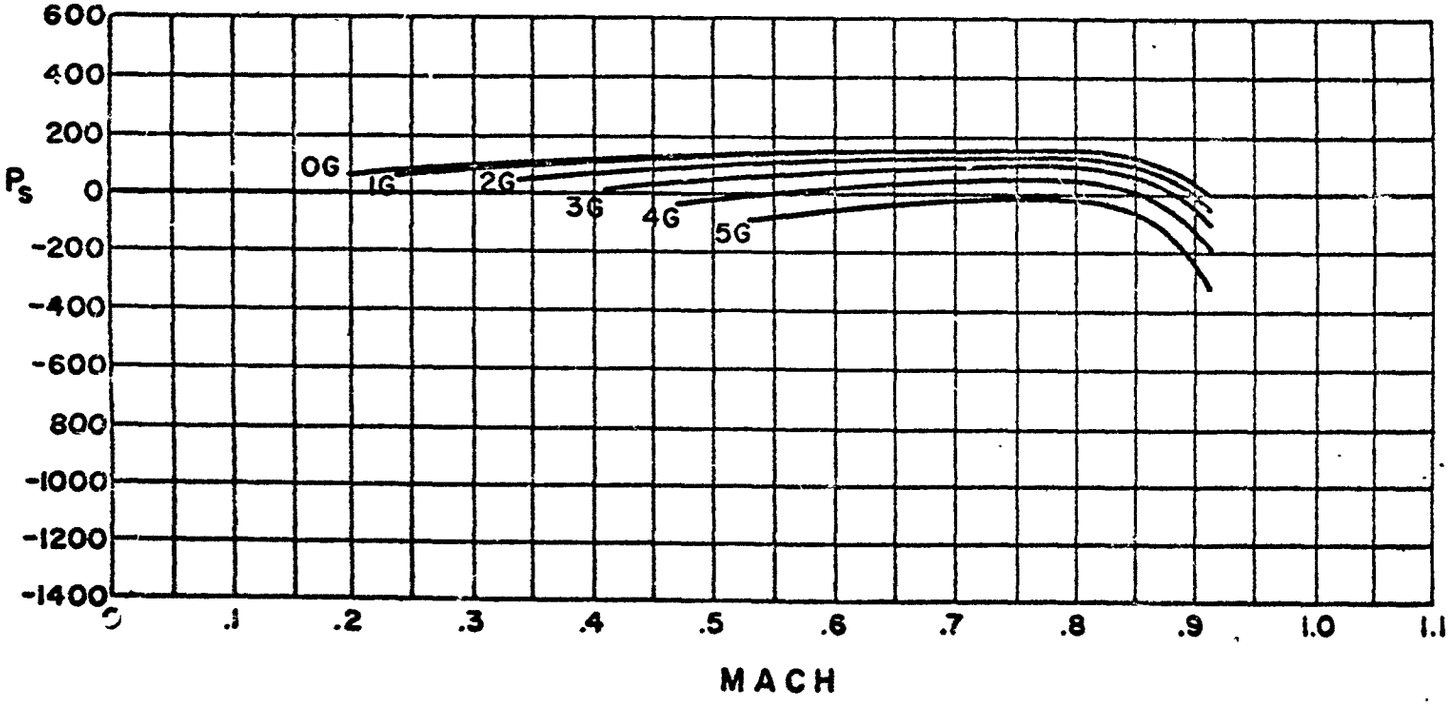
MIG-15



SECRET

MILITARY POWER · 15,000'

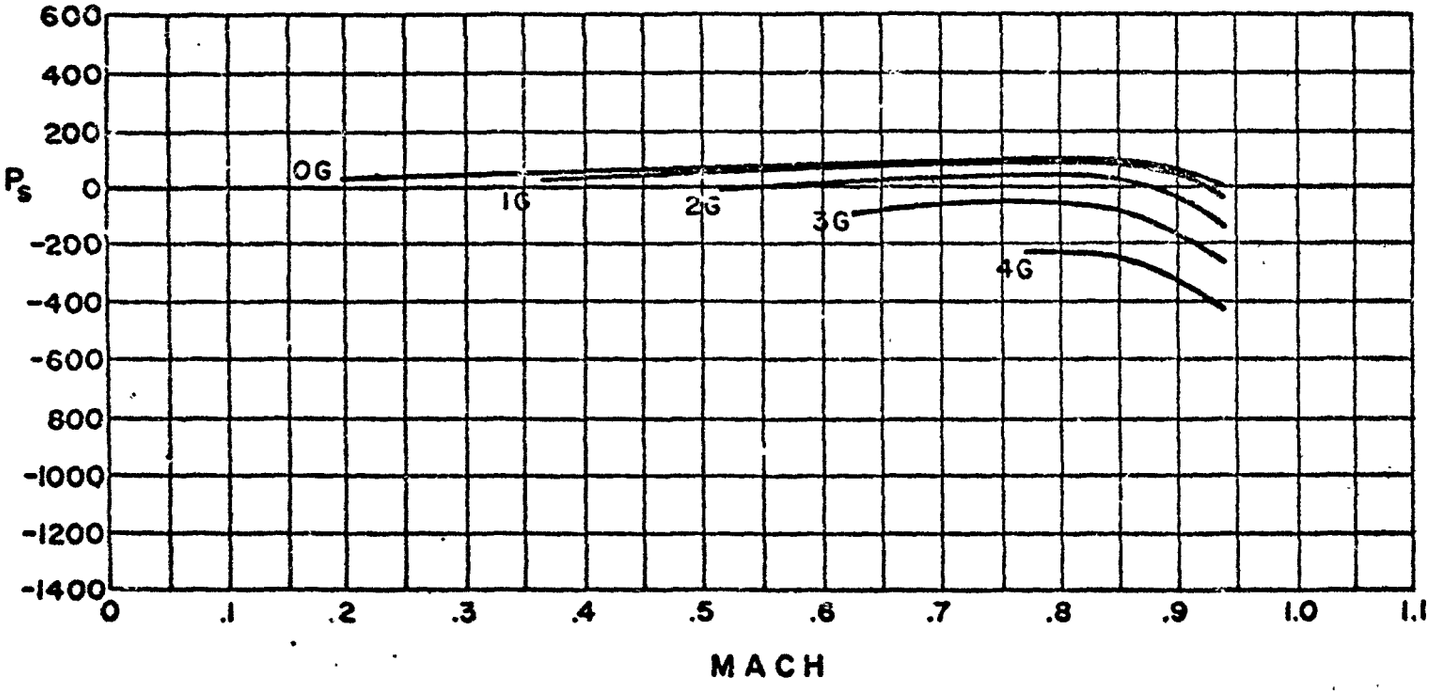
MIG-15



SECRET

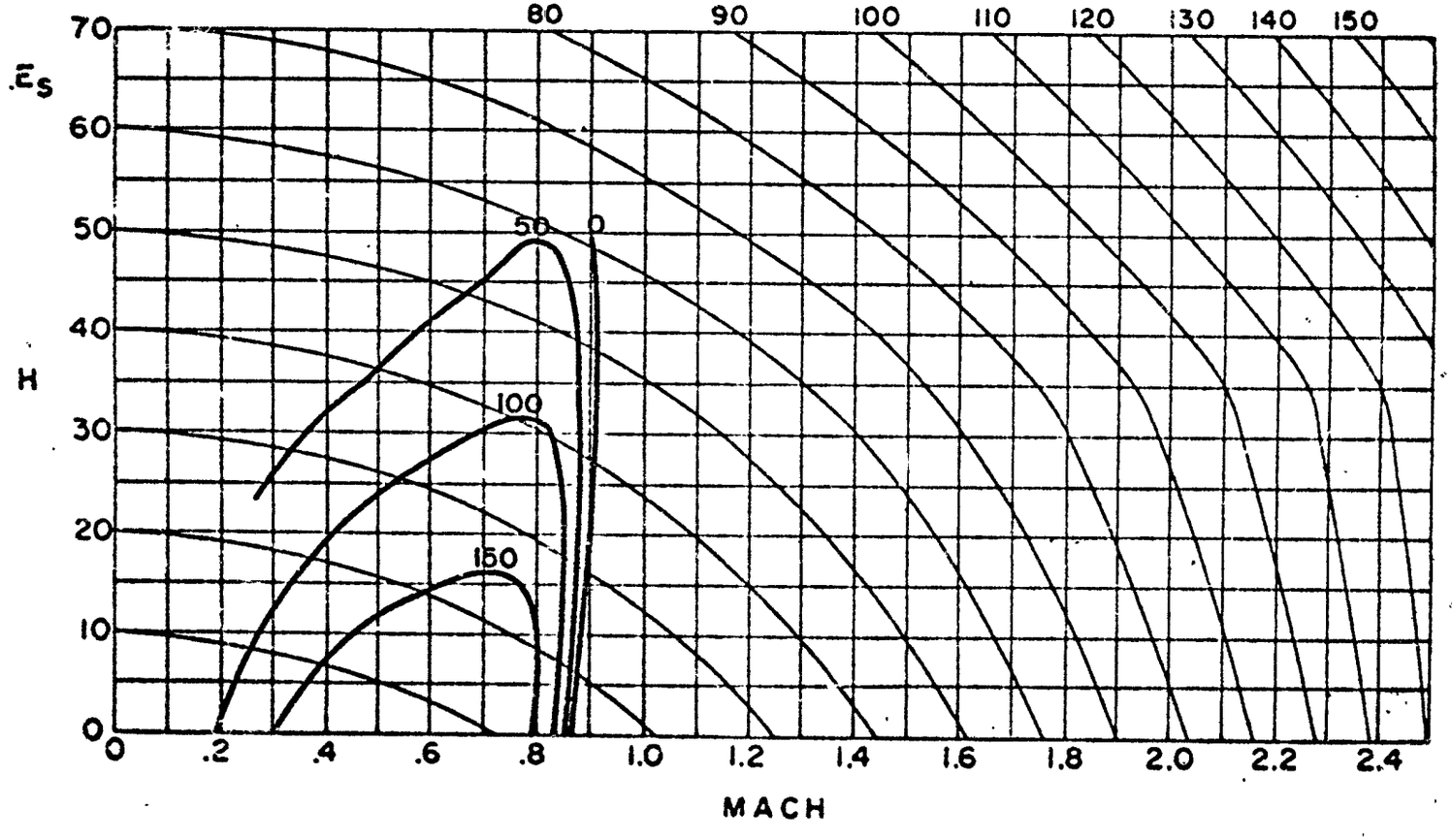
MILITARY POWER · 35,000'

MIG-15



ENERGY RATE
MILITARY POWER · IG

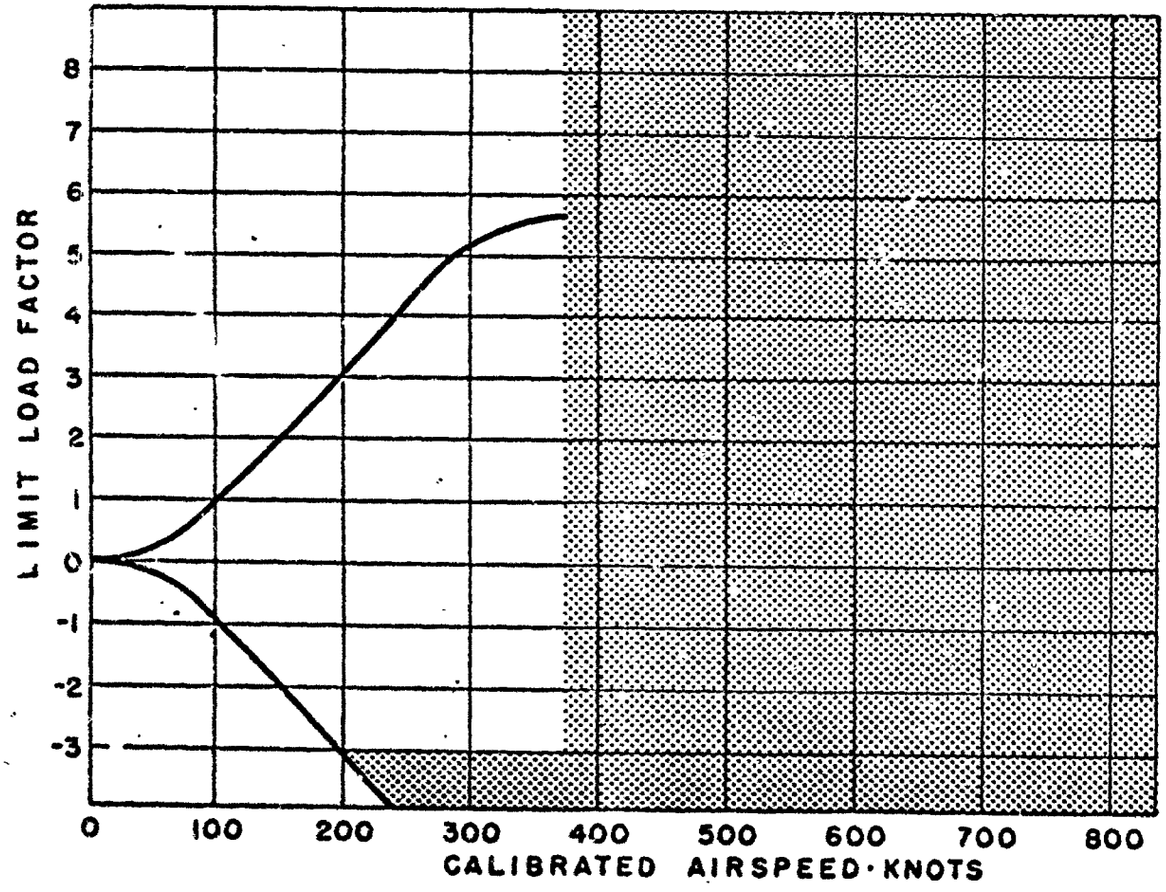
MIG-15



FLIGHT OPERATING LIMITS

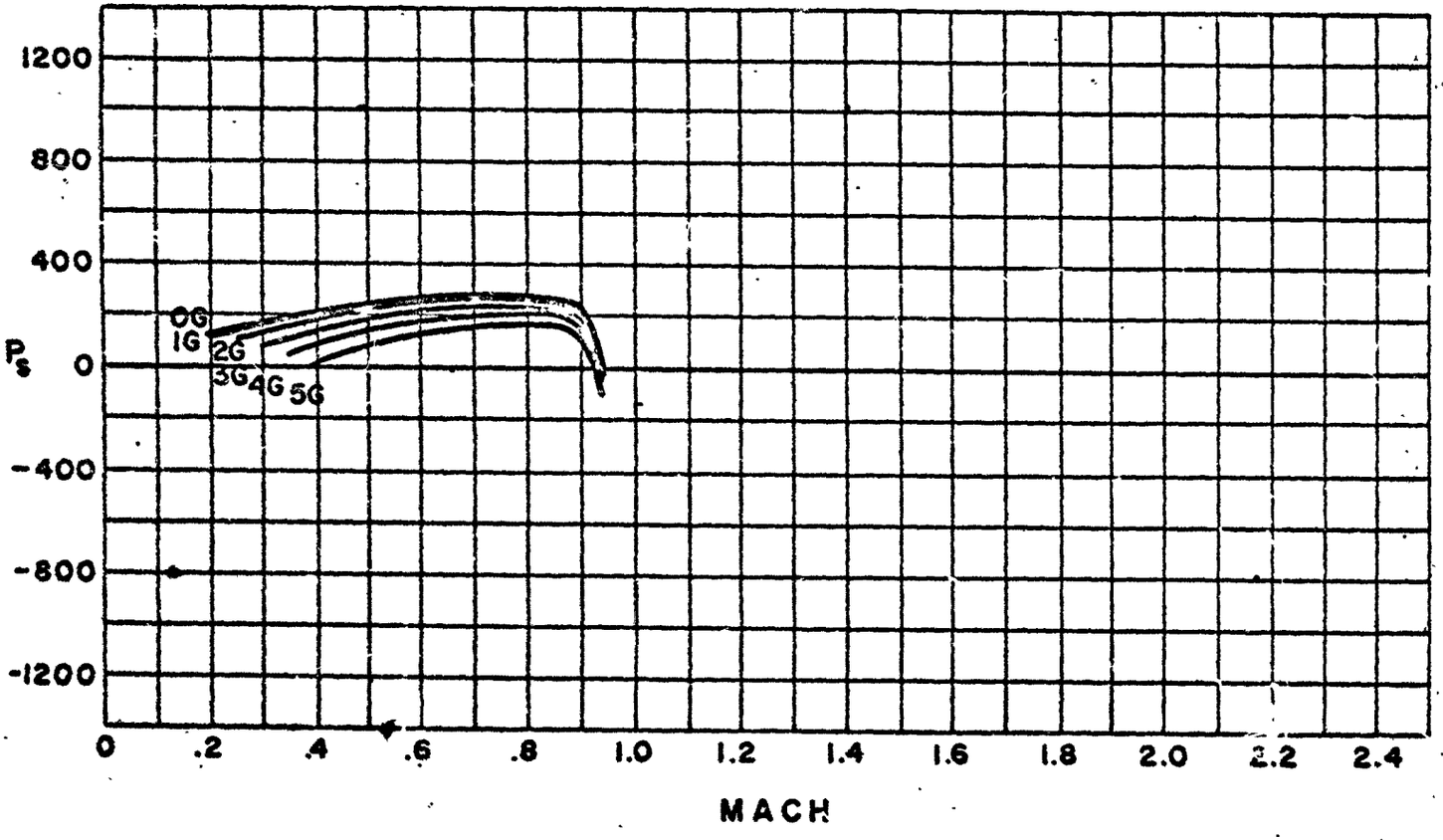
30,000'

MIG-17



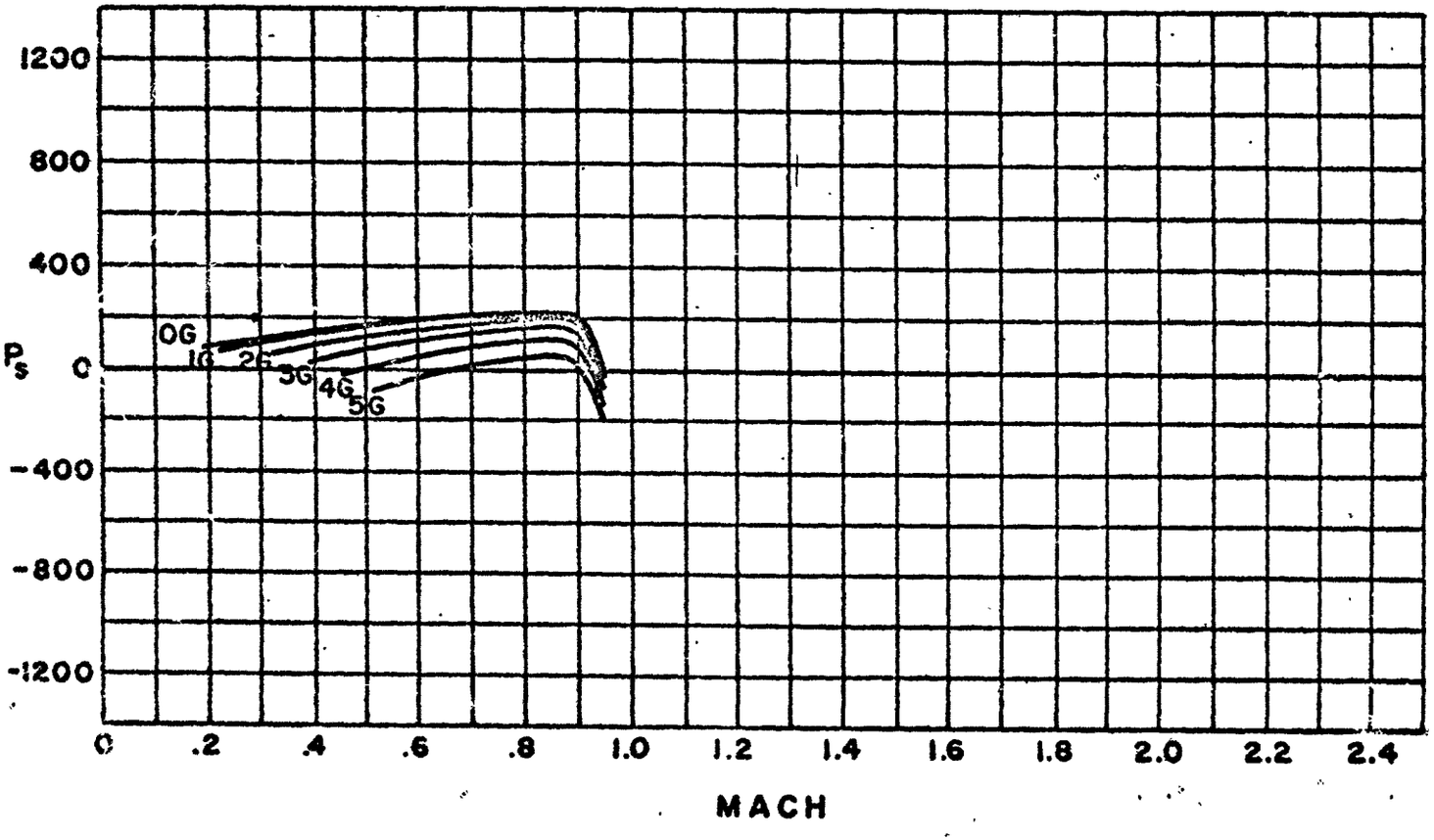
MAXIMUM POWER · SEA LEVEL

MIG-17



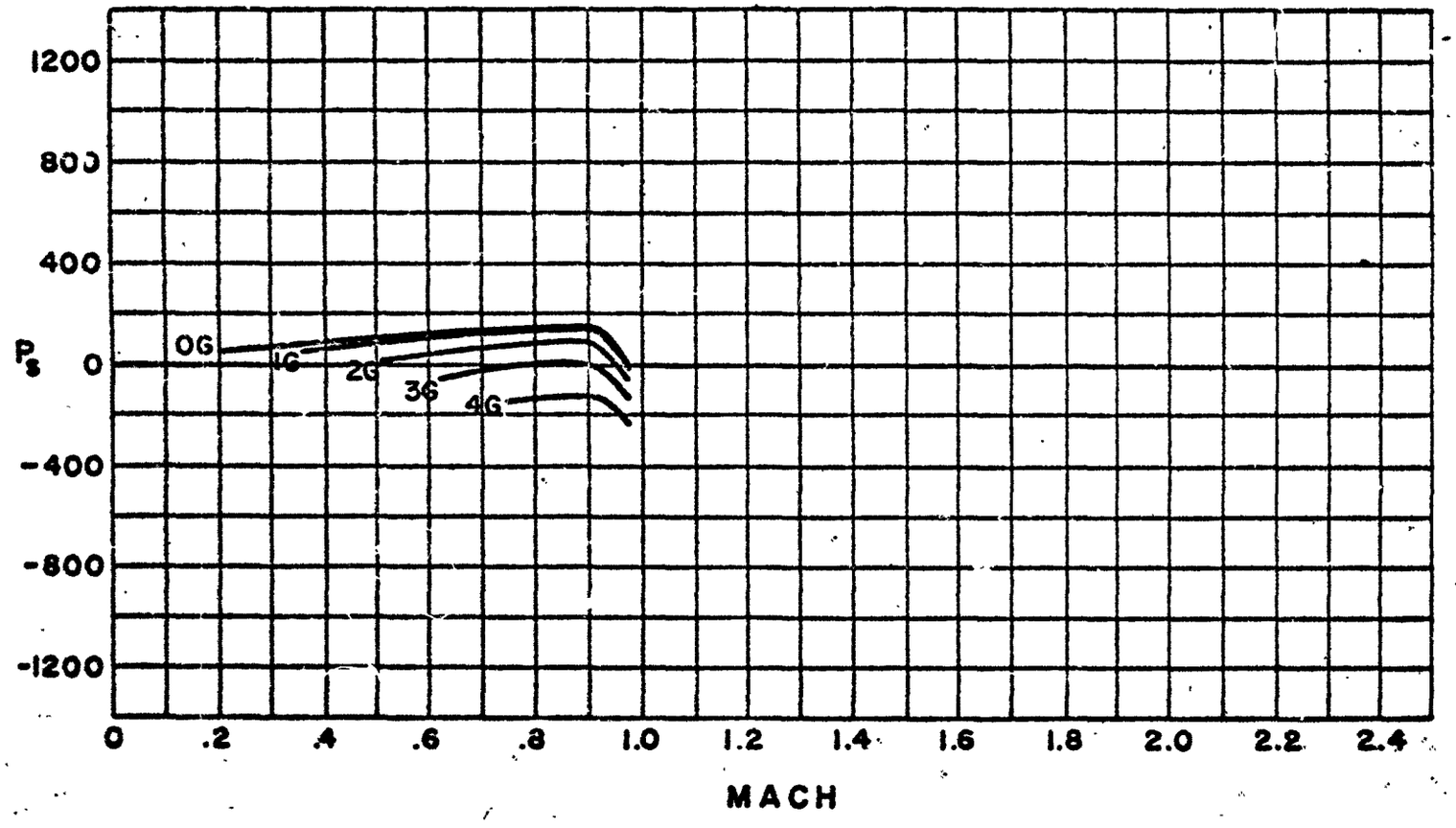
MAXIMUM POWER · 15,000'

MIG-17



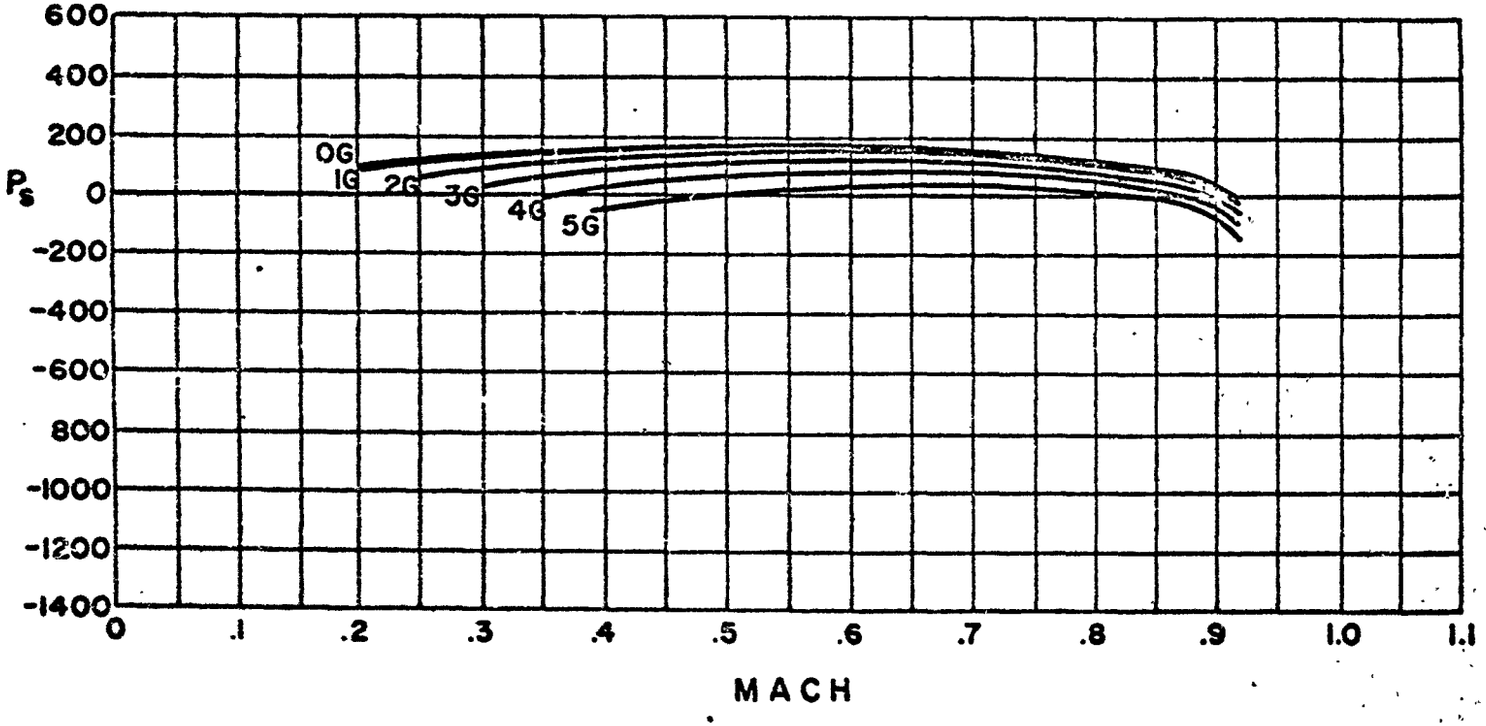
MAXIMUM POWER · 35,000'

MIG-17



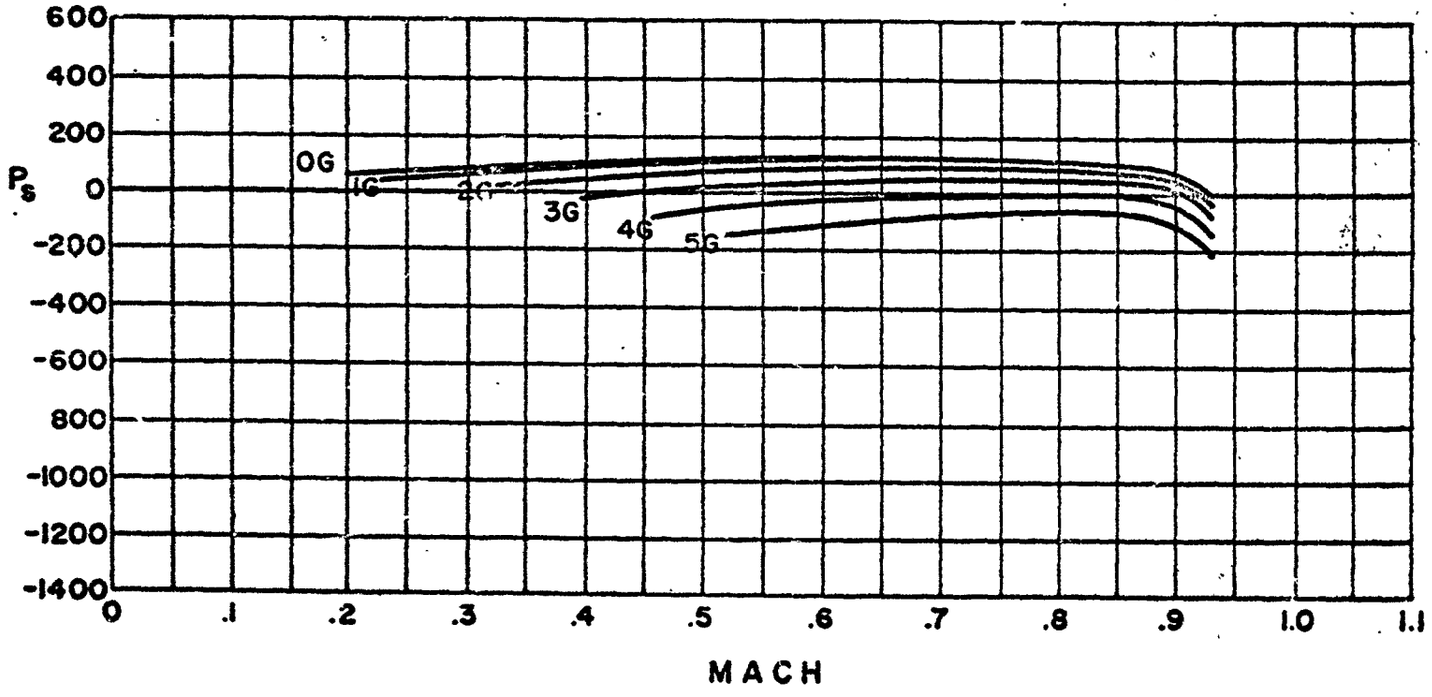
MILITARY POWER · SEA LEVEL

MIG-17



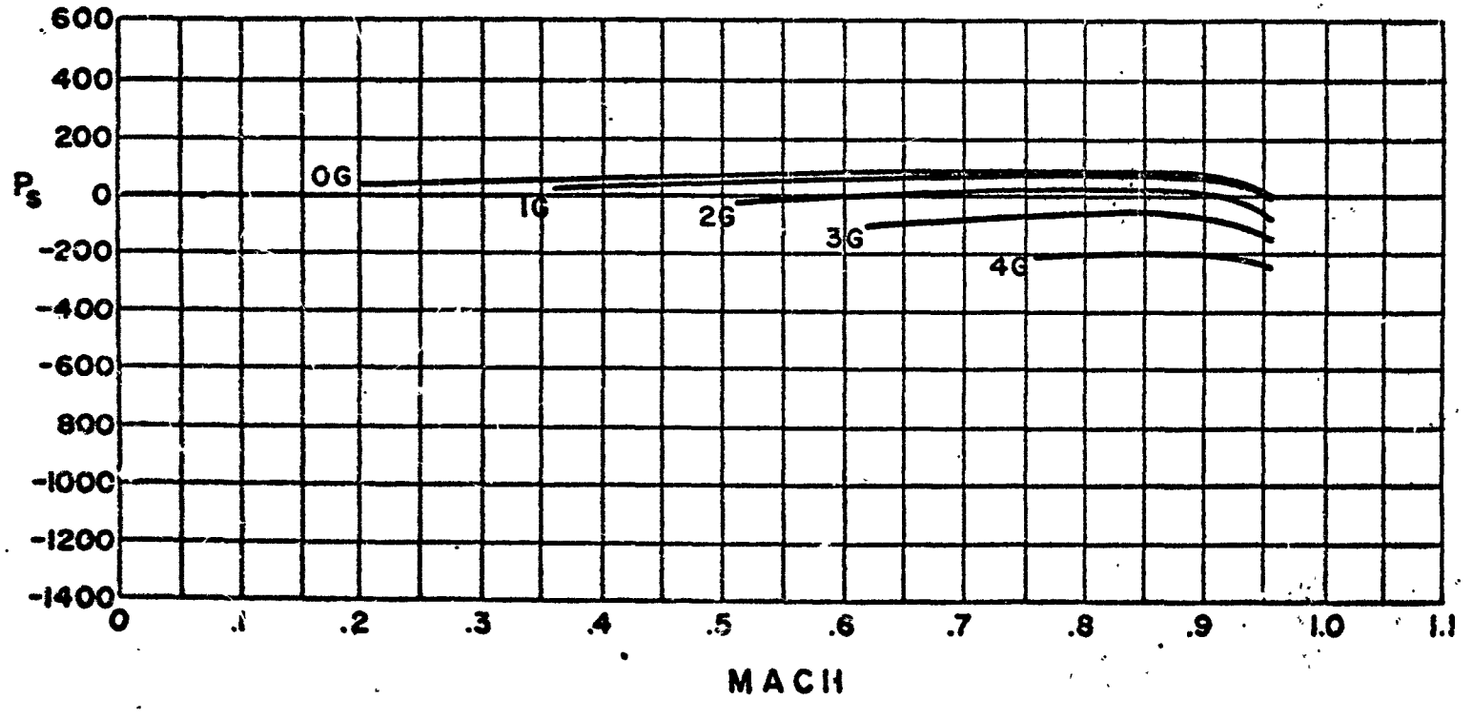
MILITARY POWER - 15,000'

MIG-17



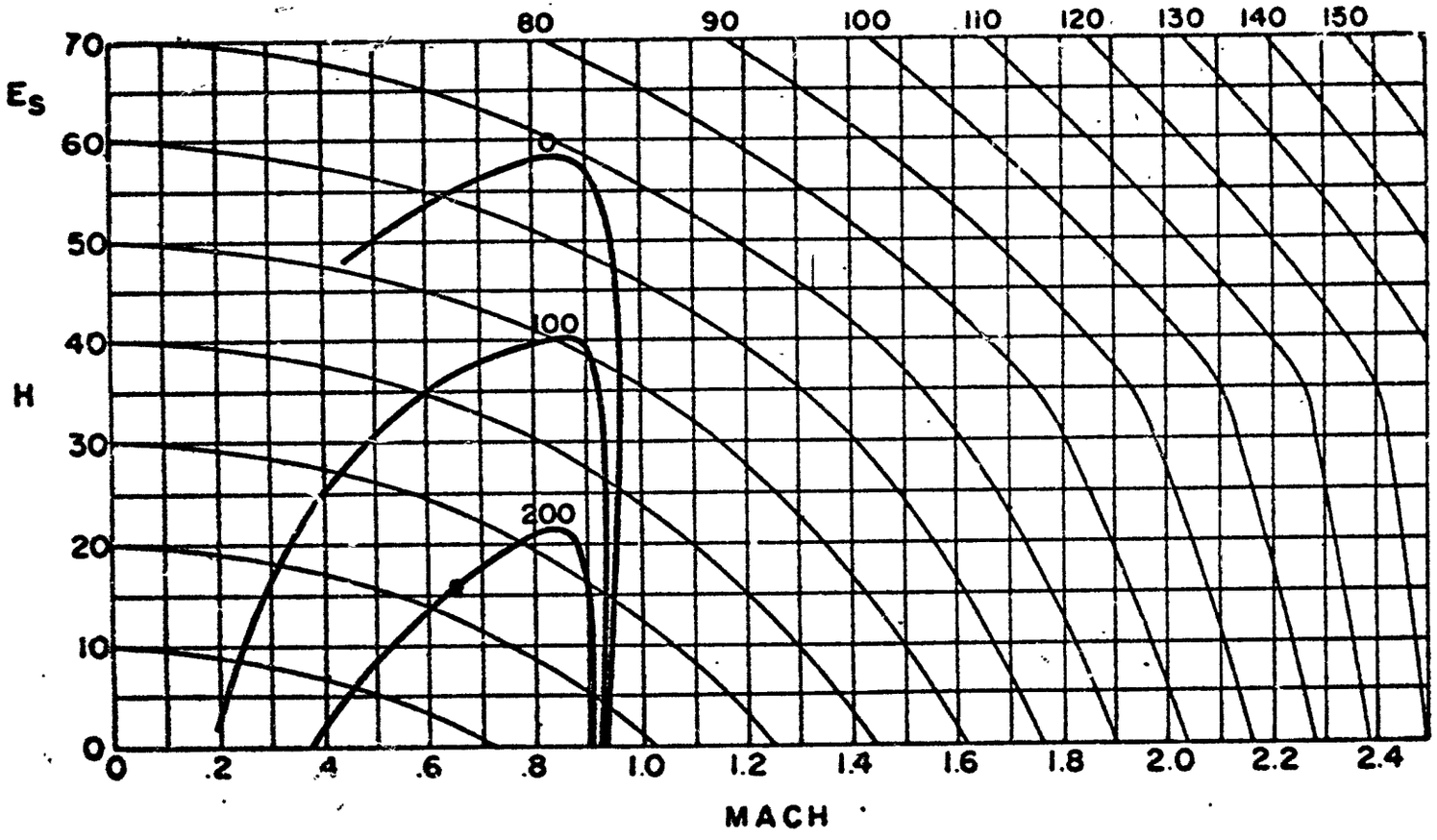
MILITARY POWER · 35,000'

MIG-17



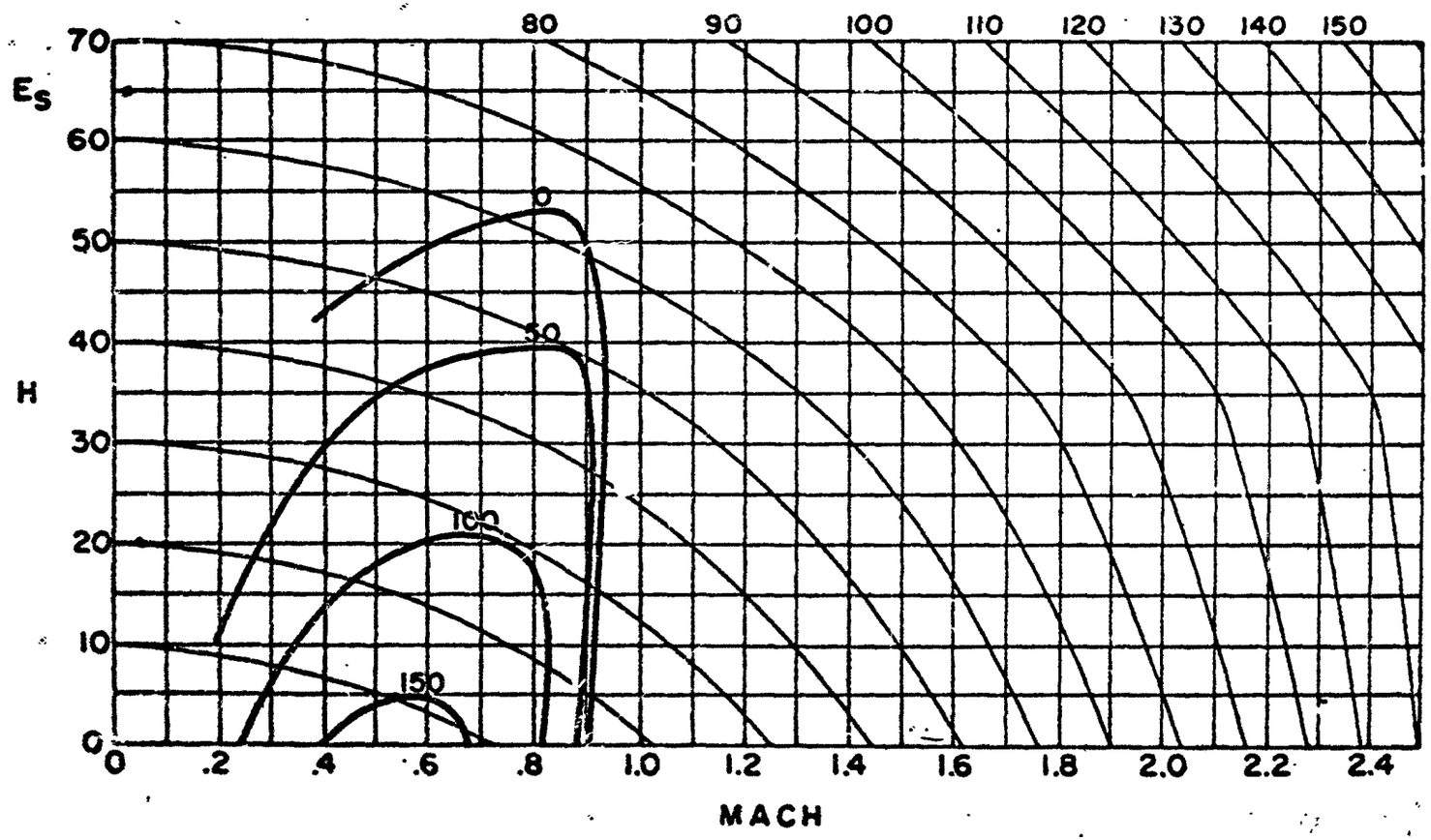
ENERGY RATE
MAXIMUM POWER 1G

MIG-17



ENERGY RATE
MILITARY POWER · IG

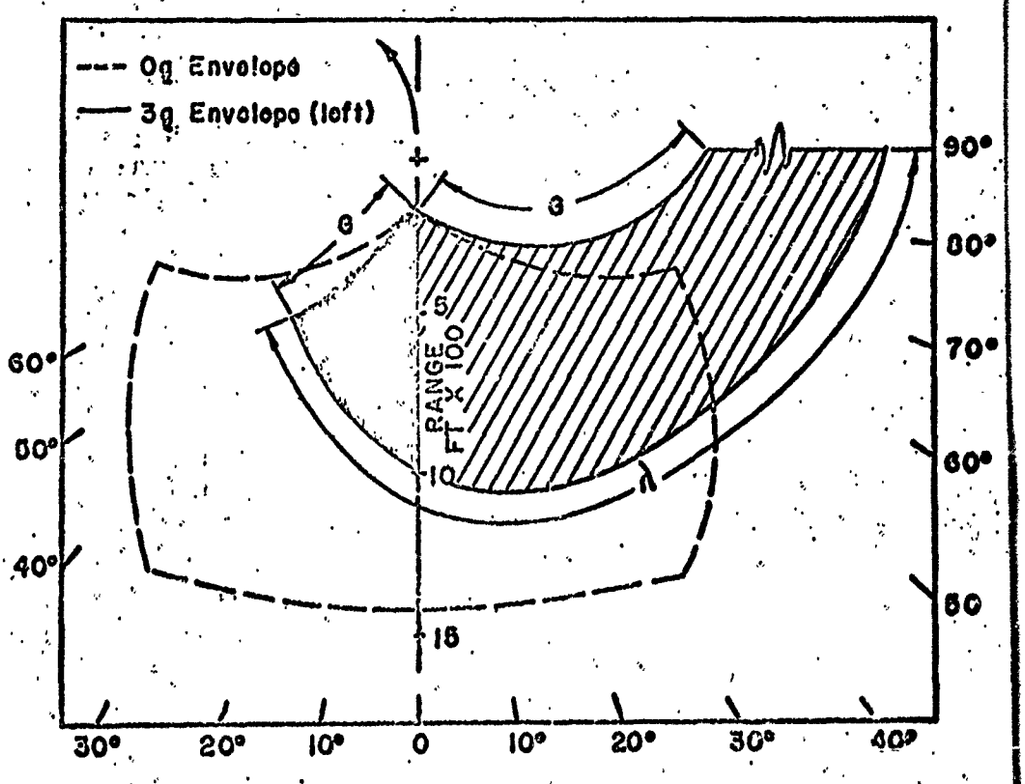
MIG-17



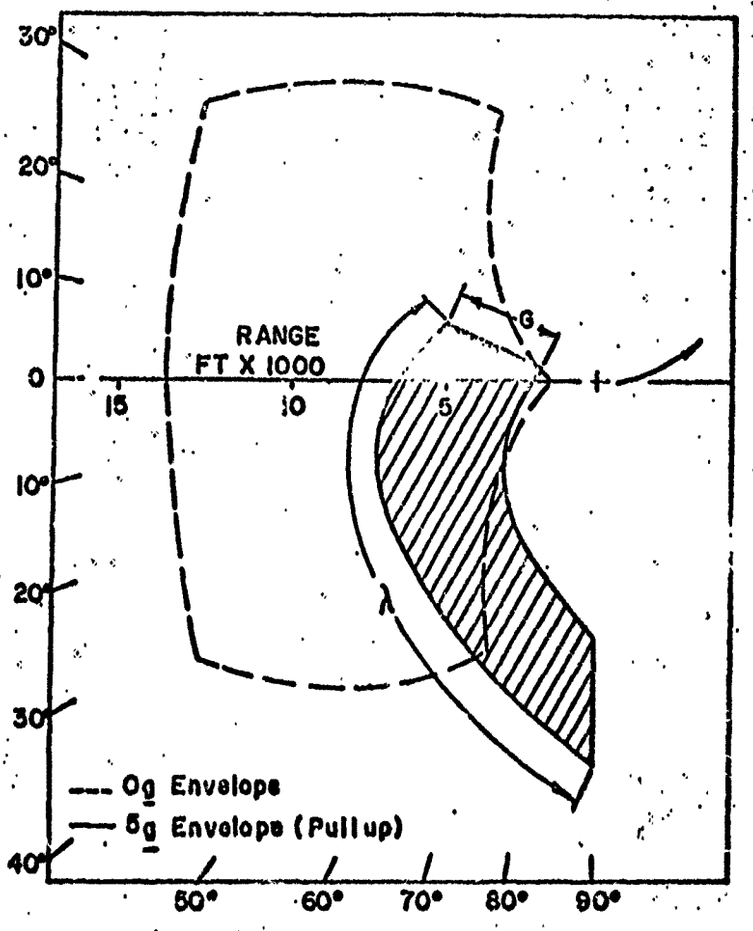
ANNEX H

AIM-9/B MANEUVERING ENVELOPES

SECRET



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

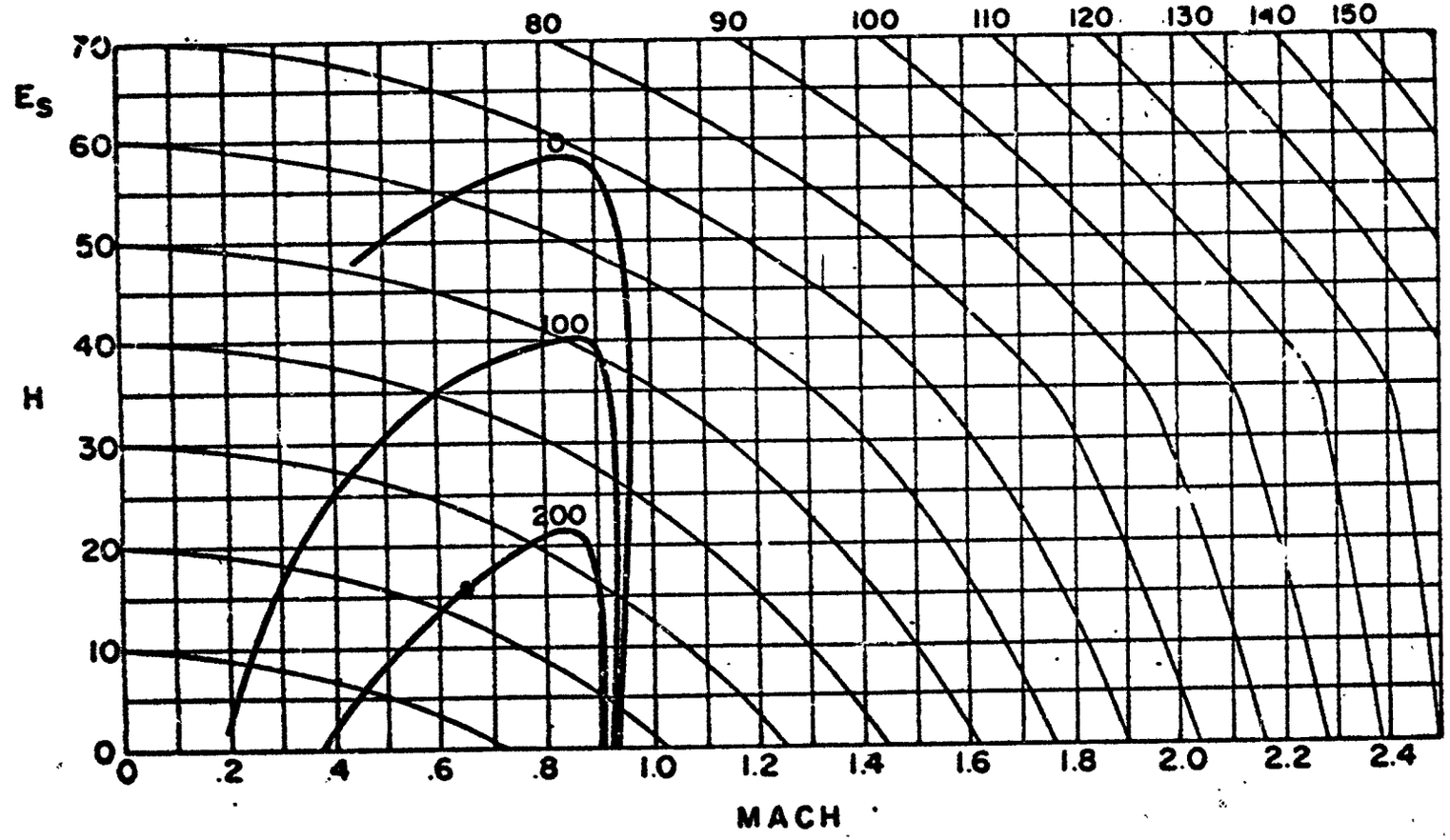


TGT - .9 MACH
ATTACK - .9 MACH
ALTITUDE-35000
TGT MANEUVER - 5g PULL UP

Figure 20

ENERGY RATE
MAXIMUM POWER 1G

MIG-17



(13)

Distribution: 1 cy ea Fr Wg (except 679th which got sep)
1 cy CEAG.
1 cy Lt Mersch, Maryland ANG.

SUPPLEMENTAL

INFORMATION

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

14 November 1995

ERRATA
AD-372,500

MEMORANDUM FOR DTIC

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

SUBJECT: Release of USAF Weapons School Publication

Publication titled, Final Report: TAC Mission FF 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