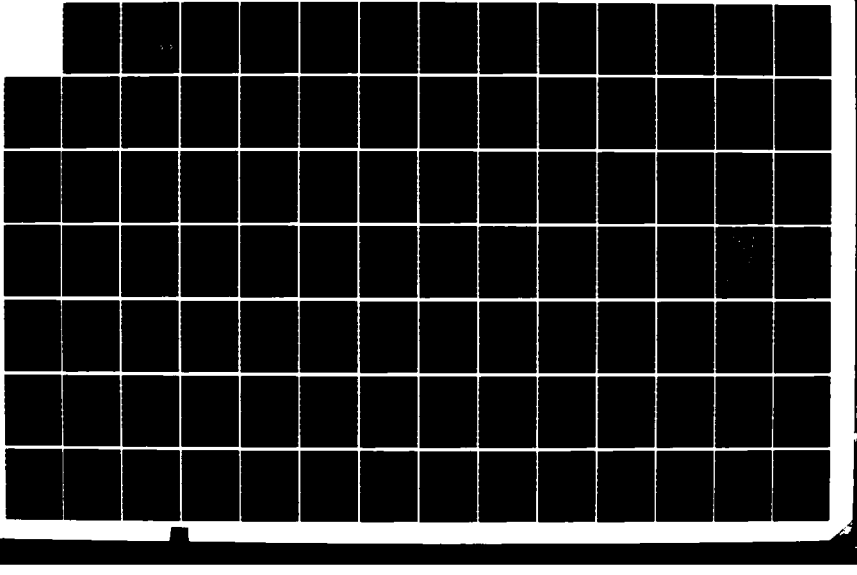
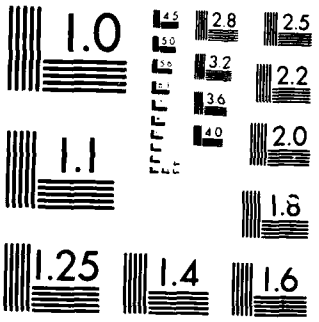
AD-A164 727 WHAT USAF AIRCRAFT SHOULD BE THE WILD WEASEL OF THE 1990'S?: AN ASSESSMEN..(U) ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS M J NEITZEL 07 JUN 85 1/2

UNCLASSIFIED F/G 1/3 NL





(2)

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

REPORT NUMBER	2. GOVT ACCESSION NO. ADA164727 / RECIPIENT'S CATALOG NUMBER
TITLE (and Subtitle) What USAF Aircraft Should Be the Wild Weasel of the 1990's?: An Assessment of the F-4G, the F-15WW, and F-16WW.	TYPE OF REPORT & PERIOD COVERED Master's Thesis
	6. PERFORMING ORG. REPORT NUMBER
AUTHOR(s) Major Michael J. Neitzel	8. CONTRACT OR GRANT NUMBER(s)
PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Command and General Staff College; ATTN: ATZL-SWD-GD, Ft Leavenworth, Kansas 66027-6900	12. REPORT DATE 7 June 1985
	13. NUMBER OF PAGES 121
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

"Approved for public release; distribution is unlimited."

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

"Approved for public release; distribution is unlimited."

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Wild Weasel, F-4G, F-15, F-16

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

See Reverse

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

BLOCK 20

ABSTRACT PAGE

WHAT USAF AIRCRAFT SHOULD BE THE WILD WEASEL OF THE 1990's?: AN ASSESSMENT OF THE F-4G, THE F-15WW, AND F-16WW. by Major Michael J. Neitzel, USAF, 121 pages.

The USAF Wild Weasel mission was born in 1965 during the Vietnam conflict. The purpose of the mission was to counter the serious radar-directed threats that were decimating the US fighter arsenal. While the current F-4G Wild Weasel aircraft has effectively met the threat into the 1980's, its capabilities reflect the aircraft's 1950's design. Meanwhile, the Soviet Union is fielding many technologically advanced radar-directed threats that bring the adequacy of the F-4G into question.

This study investigated what characteristics will be required to defeat the threat of the 1990's. Next, the F-4G, F-15WW, and F-16 Wild Weasel proposal were compared against the aircraft characteristics needed (as determined by a poll of experienced officers) to survive the threats in the 1990's.

This study concludes that the F-15WW possesses the most desirable characteristics to serve as the Wild Weasel aircraft for the 1990's.

(2)

WHAT USAF AIRCRAFT SHOULD BE THE WILD WEASEL OF THE 1990'S?: AN ASSESSMENT OF THE F-4G, THE F-15WW, AND F-16WW

A Thesis presented to the Faculty of the U.S. Army Command and General Staff college in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

MICHAEL J. NEITZEL, MAJ, USAF
B.A., San Diego State University, 1971

Fort Leavenworth, Kansas
1985

Approved for public release; distribution is unlimited.

WHAT USAF AIRCRAFT SHOULD BE THE WILD WEASEL OF THE 1990'S?: AN ASSESSMENT OF THE F-4G, THE F-15WW, AND F-16WW

A Thesis presented to the Faculty of the U.S. Army Command and General Staff college in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

MICHAEL J. NEITZEL, MAJ, USAF
B.A., San Diego State University, 1971

Fort Leavenworth, Kansas
1985

Approved for public release; distribution is unlimited.

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

Name of candidate: Major Michael J. Neitzel

Title of Thesis: What USAF Aircraft Should be the Wild Weasel of the 1990's?: An Assessment of the F-4G, F-15WW and F-16WW.

Approved by:

_____, Thesis Committee Chairman
Colonel Lawrence R. Brehm, B.A.

_____, Member, Graduate Faculty
Major Donald M. Krempel, M.A.

_____, Member, Consulting Faculty
Colonel John R. Breitlow, Ph.D.

Accepted this 7th day of June 1985 by:

_____, Director, Graduate Degree Programs
Philip J. Brookes, Ph.D.

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT PAGE

WHAT USAF AIRCRAFT SHOULD BE THE WILD WEASEL OF THE 1990'S?: AN ASSESSMENT OF THE F-4G, THE F-15WW, AND F-16WW.
by Major Michael J Neitzel, USAF, 121 pages.

The USAF Wild Weasel mission was born in 1965 during the Vietnam conflict. The purpose of the mission was to counter the serious radar-directed threats that were decimating the US fighter arsenal. While the current F-4G Wild Weasel aircraft has effectively met the threat into the 1980's, its capabilities reflect the aircraft's 1950's design. Meanwhile, the Soviet Union is fielding many technologically advanced radar-directed threats that bring the adequacy of the F-4G into question.

This study investigated what characteristics will be required to defeat the threat of the 1990's. Next, the F-4G, F-15WW, and F-16 Wild Weasel proposal were compared against the aircraft characteristics needed (as determined by a poll of experienced officers) to survive the threats in the 1990's.

This study concludes that the F-15WW possesses the most desirable characteristics to serve as the Wild Weasel aircraft for the 1990's.

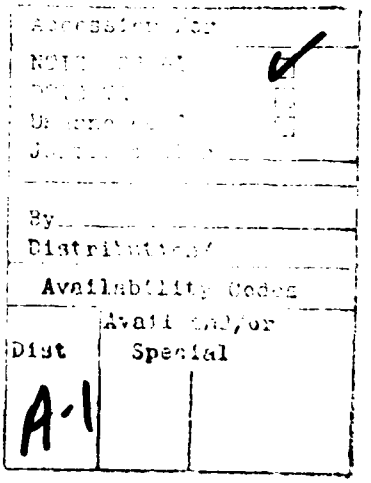


TABLE OF CONTENTS

APPROVAL PAGE	ii
ABSTRACT	iii
TABLES AND FIGURES	vi
GLOSSARY OF TERMS	vii
CHAPTER	
I. INTRODUCTION	1
Significance of Study	2
Purpose of Thesis	3
Background	3
Methodology	12
Assumptions	13
Limitations of the Study	15
Delimitations of the Study	16
Summary	16
II. REVIEW OF RESEARCH LITERATURE	20
Background Information	20
Electronic Warfare	21
The Threat	22
USAF Aircraft	23
Summary	25
III. DESIRED WILD WEASEL CHARACTERISTICS FOR THE 1990'S	26
The 1990 Threat	26
Surface-To-Air Missile (SAM) Threats	26

Anti-Aircraft Artillery (AAA) Threats 27

USSR Fighter Threats 27

Desired Wild Weasel Characteristics 32

Summary 44

IV. COMPARING THE F-4G, THE F-15WW, AND THE F-16WW 47

The F-4G 52

F-4G Aircraft Analysis 63

The F-15WW 64

F-15WW Aircraft Analysis 74

The F-16WW 76

F-16WW Aircraft Analysis 89

Aircraft Comparison 90

Aircraft Comparison Payoff Matrix Analysis 94

V. CONCLUSIONS, RECOMMENDATIONS FOR FUTURE STUDY, AND SUMMARY 99

Conclusions 99

Recommendations for Future Study 100

Summary 101

APPENDIX A 103

BIBLIOGRAPHY 109

TABLES AND FIGURES

TABLE OR FIGURE	SUBJECT	PAGE
TABLE 1	USSR SAM threats for 1990	29
TABLE 2	USSR AAA Threats for 1990	30
TABLE 3	USSR Airborne threats for 1990	30
TABLE 4	Desired Wild Weasel Characteristics	32
TABLE 5	Characteristics of the F-4G	54
TABLE 6	F-4G Aircraft Analysis	59
TABLE 7	Characteristics of the F-15WW	68
TABLE 8	F-15WW Aircraft Analysis	70
TABLE 9	Characteristics of the F-16WW	80
TABLE 10	F-16WW (2 Tank) Aircraft Analysis	82
TABLE 11	F-16WW (ASPJ) Aircraft Analysis	83
TABLE 12	Aircraft Comparison Payoff Matrix	92
TABLE 13	Aircraft Comparison Payoff Matrix	93
FIGURE 1	Evolution of Soviet SAM Systems	31
FIGURE 2	Integrated Electronic Warfare	42
FIGURE 3	Future Wild Weasel Needs	45
FIGURE 4	F-4G Wild Weasel Weapons Loading	55
FIGURE 5	F-15 Wild Weasel Weapons Loading	69
FIGURE 6	F-16 Wild Weasel Weapons Loading	81

GLOSSARY OF TERMS USED IN THIS THESIS

TERM	DEFINITION
AAA	-anti aircraft artillery. These are various calibers of guns specifically designed to shoot aircraft down.
Angle of Attack	-the angle between the relative wind flight path of the aircraft and the chord of the aircraft's wing. In more general terms, it is the amount of "bite" the wing is making into the air.
ASPJ	-Airborne Self Protection Jammer. A new jamming system destined for the F-16.
ECM Pod, or "suite"	-Electronic Countermeasures Pod. An electronic device that jams or deceives electromagnetic transmitters, thus denying the enemy information about your aircraft. Newer, internal systems are referred to as "suites".
HAWK	-A US produced surface-to-air missile system employed by the US Army.
Heart of the envelope	-a term used to describe the most favorable parameters (range, speed, etc.,) for employing a weapon.
Loft Bombing	-a technique of delivering bombs that doesn't require the delivery aircraft to overfly the target. The delivery aircraft flies toward his target and pulls up--releasing his bombs at a computed climb angle that literally "slings" the bombs to their target.
SAM	-Surface-to-air missile. High speed radar or infrared guided missiles designed to shoot aircraft down.
Strike Flight	-a term used to describe a group or "package" of aircraft, all headed to the same general area, that group together for security, tactical surprise and mass.

WW	-Wild Weasel aircraft
Military Power	-maximum throttle setting just short of afterburner. A throttle setting that usually approaches 100% RPM in jet engines.
Afterburner	-the throttle setting for maximum thrust available in an afterburning jet engine. This setting produces a lot more thrust than military power, and therefore utilizes fuel at a much higher rate.
HARM	-High Speed Anti-Radiation Missile. A new follow-on missile to the AGM-45 Shrike. The AGM-88 HARM is a sophisticated, state of the art anti-radiation weapon.

CHAPTER I

INTRODUCTION

"...I ROLLED TO THE RIGHT JUST IN TIME TO SEE THE NOSE OF THE AIRPLANE BLOWN OFF. ALL I SAW WAS A HUGE BALL OF FLAME.... EVERYTHING FORWARD OF THE FRONT COCKPIT WAS BLOWN OFF. THE HYDRAULIC LINES IN THE RADAR RUPTURED AND BLEW BACK INTO THE COCKPIT AND PROMPTLY SET ME ON FIRE..I WAS SITTING IN A BALL OF FLAMES!.....THE AIRCRAFT PITCHED DOWN TO 2 -2 1/2 NEGATIVE G'S...I SCREAMED TWICE FOR THE BACK SEATER TO EJECT WITH NO RESPONSE, SO I REACHED DOWN AND EJECTED US BOTH..."

LIEUTENANT COLONEL RICHARD A. RASH (1)

This was the reaction of Colonel Rash when he was hit by Soviet-built anti-aircraft artillery (AAA) over North Vietnam. As the numbers of American pilots that were shot down by Soviet equipment continued to rise, the United States realized that an effective countermeasure to this threat must be found.

Up to this point in time, the US had outfitted only our heavy bombers with adequate detection and jamming equipment for surface-to-air missiles (SAMs). The state of the art electronic black boxes in those days were still much too big to install in fighter aircraft, thus leaving our fighters vulnerable. (2)

The Vietnam conflict finally provided a much needed emphasis for a U.S. electronic warfare capability and the

"Wild Weasel" mission was created to satisfy our requirement. The Wild Weasel mission is to detect, identify, locate and suppress or destroy hostile radar-directed threats. (3) This Wild Weasel electronic counter-measures (ECM) mission was aptly named after an almost fearless, sleek animal with a ferocious temperment, that is unafraid to attack it's prey even in the most hard-to-get-at hiding places.

As electronic combat becomes more complex every day, the USAF has met the threat by continuing to update the current Wild Weasel aircraft, the F-4G Advanced Wild Weasel. This aircraft is composed of a new threat detection system with state of the art electronics, mated with a 25 year-old combat-proven airframe. (4) As the F-4G ages, the USAF will logically analyze whether it can still meet the threats being fielded in the 1980's, or whether the F-4G should be replaced by a newer airframe.

SIGNIFICANCE OF STUDY

The other studies about the Wild Weasel mission that I found were detailed, but not very current. George Acree, William Baechle, Charles Bishop and Bobby Martin wrote a paper titled "Wild Weasel: Evolution of a Unique Weapons system" in 1973 while they were attending the Air War College at Maxwell Air Force Base, Alabama. Major Byron Huff investigated the plausability of a replacement Weasel aircraft in his thesis

"The F-16 Wild Weasel: A Feasibility Study" at Army Command and General Staff College in 1979. I found no further investigation of the Wild Weasel mission and of how well the F-4G performs it, and decided it was time for a fresh look at the subject.

PURPOSE OF THESIS

The purpose of this thesis is to recommend the aircraft to serve as the Wild Weasel for the 1990's. This will be accomplished by: 1) examining what capabilities are required of a Wild Weasel aircraft of the 1990's; and 2) comparing the F-4G and the fighters now in production with the desired Wild Weasel capabilities prior to recommending the aircraft to serve as the Weasel for the 1990's.

BACKGROUND

Since February, 1908, when the Army first contracted with the Wright brothers to purchase the first military aircraft, our enemies have been hard at work figuring out ways to shoot our airplanes down.

While surface-to-air threats were almost non-existant during WWI, the air-to-air threat was formidable. Superior training and tactics, however, resulted in American pilots claiming a 2.5 to 1 kill ratio over the enemy. (5)

During WWII, as anti-aircraft fire became more capable,

German flak guns made only the very highest altitudes safe from hostile ground fire. The air-to-air threat was dense at all altitudes, but American pilots could choose to face only one threat by remaining high and utilizing precision bombing. As a result of these tactics, air-to-air combat losses became higher than losses to flak and ground fire. By the close of WWII, the use of radar to detect and track aircraft had become commonplace, as had electronic jamming and deception to defeat the enemy's radar. (6)

By the time the Korean conflict was underway, jet engined fighters were on the scene. American pilots faced a very limited ground fire threat and eventually established total air superiority over the Korean peninsula.

Then on May 1, 1960, Francis Gary Powers became the first American pilot to be shot down by a Soviet surface-to-air missile. Two years later, Major Rudolf Anderson was killed in another U-2 spyplane on October 27, 1962, during an overflight of Cuba. (7) The SAM was here to stay, and aerial warfare would never be the same.

A few years later, as the Vietnam war became more intense, American pilots faced increasingly deadly ground fire from over 1000 AAA guns, located at over 400 sites. The AAA threat at the time consisted of 37, 57, 85, and 100mm anti-aircraft weapons. (8) In April 1965, another USAF U-2 photographed the first Russian SA-2 SAM battery in North

Vietnam. (9)

On 24 July, 1965, an F-4C became the first U.S. SAM victim of the Vietnam war. The USAF countered the SAM and radar-guided AAA threat by converting F-100F "Super Sabre" aircraft to a Wild Weasel role known as "Iron Hand". The F-100F, equipped with crude SA-2 and AAA radar detection equipment, would precede strike flights by several minutes and attempt to draw SAM and AAA fire away from the main strike package. One problem quickly emerged with the F-100F: It had trouble keeping up with the fighters it was supposed to escort.

Since the SA-2 was relatively ineffective at low altitudes, USAF pilots tried exclusive low altitude tactics to avoid the SAM fire. This proved fatal, as low altitude placed them in the "heart of the envelope" for small arms and light AAA fire. Losses quickly became unacceptable, and the pilots were directed to a minimum altitude of 4,500 feet above ground level to avoid the light AAA threats. (10)

In late 1965, the USAF introduced the AGM-45 Shrike anti-radiation missile to attack the SA-2. Now, for the first time, fighter aircraft had a "stand-off" weapon that could engage and destroy the SA-2 from the edge of the the SA-2's lethal range. Once an SA-2 radar beam was detected, the Shrike missile would follow the radar beam backwards to its source, and destroy the radar antennas. The North Vietnamese

radar operators soon developed defense tactics. They would shutdown their radar whenever they felt they were being fired upon. Once the radar was off the air, the Shrike went "blind", and would explode harmlessly away from its target. The Wild Weasel mission in the early stages would have to be judged as extremely effective though, when you consider that out of the first 180 SA-2 launches at USAF aircraft in 1965, only 11 kills were recorded for the SAM system. (11)

The effectiveness of the Wild Weasel mission against enemy SAMs can be directly measured by aircraft losses in relation to North Vietnamese SAM launches. Before the F-100F Wild Weasel began escorting missions, the USAF suffered one aircraft loss for every two SA-2 launches. After the F-100F began escort missions, the USAF loss rate dropped significantly to one aircraft loss for every 30 SA-2 launches. (12)

As the F-100F was slowly attrited by combat losses, it was replaced by the F-105G "Thud" in late 1966. The F-105G was less manueverable than the F-100F, but was exceptionally fast at low altitudes and carried more ordnance. Additionally, the F-105G was the first Wild Weasel to carry the more advanced AGM-78 "Standard Arm" anti-radiation missile. (13) The AGM-78 had the advantage of more frequency coverage, longer range, and could attack targets to either side of the launch aircraft, a feat the Shrike could not

accomplish.

By the end of 1965, in less than 12 months, the North Vietnamese had tripled the number of SA-2s to over 150. (14) Incredibly, by the summer of 1966, their AAA arsenal had grown to over 7000 guns of all calibers. (15) While the air-to-air threat had been negligible up to 1965, the North Vietnamese Air Force (NVAF) now acquired MIG-21s (NATO name Fishbed) that operated out of five bases near Hanoi. The 8th Tactical Fighter Wing (TFW) at Ubon, Thailand, was charged with negating the MIG threat under the direction of Colonel Robin Olds, a Korean War Ace (had five confirmed kills or more). Typical strike packages going into North Vietnam were designed to include F-105G Wild Weasels for ground threat suppression, F-4Cs for MIG protection, F-4s and F-105s as bombers, and EB-66s for jamming and deception. The largest attack in Vietnam to date was on January 2, 1967, when 80 aircraft attacked facilities near the Gulf of Tonkin. The bombers hit their targets, the Weasels suppressed and destroyed the SAMS and AAA, and Colonel Olds' 8th TFW downed seven MIGS in 10 minutes with no USAF losses. (16)

In 1969, the F-105G combat losses increased at an unacceptable rate, and the USAF supplemented the Wild Weasel force by converting F-4Cs to the specialized mission. The F-4C was much more maneuverable than the F-105G, but its threat detection system was designed exclusively for Southeast

Asia threats. By late 1972, the Linebacker II campaign saw B-52 pilots reporting "hundreds" of SAMS being shot at their formations. Despite massive electronic countermeasures and Wild Weasel support, eleven B-52s were lost by December 24, six in a single day! Clearly, the SAM threat was becoming increasingly sophisticated. (17)

THE 1973 ISRAELI WAR

The events leading to and during the 1973 Israeli "Yom Kippur" war deserve investigation. After the Egyptians suffered defeat in 1967, President Sadat was determined to re-arm his country with new equipment from the Soviet Union. Israel, on the other hand, felt "invincible" to Arab hostilities, and was convinced that the Arab re-armament would not be complete until 1975. Israel did, however, acquire F-4 and A-4 fighters, in addition to ECM pods, from the United States for defense against known Egyptian SA-2 and SA-3 SAMs. (18)

President Sadat was denied new MIG-23 Floggers to update his Air Force, so he relied exclusively upon heavy SA-6 SAM and ZSU-23-4 Gundish AAA coverage to provide air superiority for his armies.

On 13 September Syrian Mig 21s attacked an Israeli formation: 13 Syrian MIGs were shot down in exchange for 1 Israeli fighter loss. (19)

On Sunday, 6 October, the Egyptian Armies attacked. They formed a front 25 miles long and 5 miles deep, and conducted an aerial attack with over 450 aircraft that interdicted Israeli airfields, HAWK SAM sites, air defense radars, and command posts. The Israelis counter-attacked the Egyptians and flew head-on into the most formidable air defense net ever assembled in the world to that date. As a result, they lost 40 aircraft in the first three hours of the war (14% of their entire Air Force)- and risked total annihilation of their Air Force in 3 days if no changes in tactics were made. (20) The Israelis were unable to close Egyptian airfields due to SAM/AAA coverage. When they attempted to find "safe" corridors to cross into Egypt, they were surprised by the mobility of the SA-6 and its ability to quickly move into these new corridors and close them. The mobility of the SA-6 cost the Israelis 12 aircraft losses in 10 minutes in the North Sinai because of the unexpected presence of the SAMs. (21)

To counter their new threat, new tactics were devised against the SAMs. To increase survivability, loft bombing techniques were utilized to minimize exposure to the threats. Additionally, ECM pods were carried on Israeli fighters to jam the enemy radars. Instead of flying missions totally in support of Army movements, the Israeli Air Force concentrated on Suppression of Enemy Air Defenses (SEAD), and asked for

Israeli Army assistance with artillery to assist in their SEAD effort.

As a result of the Israelis shifting their main effort to SEAD at the critical point of battle, the SAMs and AAA were steadily decimated. This resulted in vulnerable Egyptian armies and airfields, which the Israelis summarily destroyed in short order. Once again, they emerged victorious, and on 22 October the Egyptian 3rd Army surrendered.

The Israelis had faced an awesome threat: The Egyptians had fired more SAMs in three days than all of NATO owns; they fired 1,800 SAMs total, with 768 of those being SA-6s; Syria fired a total of 892 SAMs, with 512 of those being SA-6s. This compared to 50 HAWK firings by the Israelis against Egyptian and Syrian fighters. (22)

The AAA threat had been serious. The Egyptians had employed over 1,300 guns, the Syrians employed 736 guns, and the Israelis had utilized 982 AAA guns.

The face of air-to-air combat had changed dramatically also. Two out of three air-to-air kills by the Israelis had been obtained by missiles. In the 1967 air-to-air war, not even one kill was obtained by missiles; they were all obtained with a gun. Superior training and skillfull Israeli piloting had resulted in a 66 to 1 kill ratio in air-to-air engagements over the enemy in 1973. (23)

LESSONS LEARNED

Surface-to-air radar-directed threat technology had changed the face of electronic warfare tremendously. The fighter pilot could no longer survive with the belief that he could somehow out-manuever SAMs and AAA just with skillful aircraft handling; he now needed electronic help in the form of an ECM pod to defeat this tremendous threat.

With the significant SAM/AAA threat facing the Israeli Air Force, they had no choice but to shift their focus to SEAD before they could procede with missions in support of the Army. Their timely decision to shift the focus of their battle undoubtedly had a significant impact on the outcome of the war.

PRESENT SITUATION

In the years following Vietnam and the 1973 Israeli conflict, the Soviets fielded many new SAM and AAA systems. The USAF countered by introducing the F-4G Advanced Wild Weasel in 1978. The F-4G is a converted 1969 model F-4E with the 20mm internal nose gun removed. In place of the gun, an equivalant weight of programmable digital computer processors and associated electronic equipment was installed and was designated the APR-38 threat detection system.

The APR-38 is the heart of the F-4G, and can detect an

impressive list of surface-to-air threats as well as air-to-air threats. The most significant advantage to a computer driven threat detection system is that the computer can be reprogrammed very quickly as new threats appear, or as older threats change their electronic signature. The F-4G is only slightly more manueverable than the F-4C, but uses fuel at a much higher rate due to increased aerodynamic drag. (24)

METHODOLOGY

Chapter II reviews the literature that was useful in completing my research. Only unclassified sources were researched, and are grouped by topic or subject category, instead of by type of document. Types of publications include: civilian periodicals, government documents, research studies, and books.

Chapter III establishes exactly what the desired Weasel characteristics must be to meet the threat in the 1990's. This will essentially be a "wish list" of capabilities that will optimize both Wild Weasel survival in a high threat environment, and insure sufficient combat offensive potential to complete the Wild Weasel mission. Some of the capabilities defined are range, speed, self-protection abilities against both ground and air threats, maneuverability, and the potential to effectively reduce/eliminate the enemy's air defense capability.

The desired Weasel characteristics were established based on a consensus opinion of Wild Weasel aircrews, 37th Tactical Fighter Wing senior leadership, and electronic warfare experts at the USAF Air Staff and Tactical Air Command. Telephone surveys of 40 questions were conducted with 25 Wild Weasel crewmembers, 5 37th TFW Wing level personnel, 5 electronic warfare experts at the Air Staff, and 5 personnel associated with electronic warfare at Headquarters Tactical Air Command (all with previous Weasel experience).

In Chapter IV the known capabilities of the F-4G, F-15 and F-16 are be compared to the required capabilities outlined in Chapter III. The fighters will be compared in terms of aircraft configuration, ordnance load, fuel efficiency, and survivability.

The final chapter summarizes the analysis of comparisons of the new USAF fighters. It states the conclusions to the research in this thesis and offers recommendations for further studies.

ASSUMPTIONS

One assumption of this thesis is that the current F-4G aircraft may possess unacceptable shortcomings when facing modern Soviet SAM, AAA, and fighter threats of the 1990's. Based on a poll of Weasel crewmembers, the following characteristic assumptions are made about the F-4G:

1) Limited fuel capacity.

2) High fuel consumption rates at all altitudes.

3) Limited "G" availability when configured with any ordnance on wing stations.

4) Limited radar capability to detect non-emitting low altitude enemy fighters.

5) Excessive radar cross-section (the size of the radar "blip" on an operator's radar scope).

6) Limited self protection capability.

7) Limited growth potential for future Wild Weasel equipment.

8) Excessive energy loss during heavy maneuvering.

9) Low thrust to weight ratio (engine thrust available in proportion to total aircraft weight).

10) High wing loading (total aircraft weight in proportion to wing area supporting that weight in flight).

Other assumptions that have direct bearing to this thesis are:

1) The Wild Weasel mission will continue to be a primary asset to all Air Force conventional wartime oplans.

2) The Soviet Union will continue to build more capable SAMS, AAA, and fighter aircraft for use in any hostilities against the United States.

3) Congress will continue to fund and the USAF will purchase the planned buy of F-15E and F-16 aircraft.

4) The F-4G is approaching the end of its life cycle, and

a follow on Wild Weasel aircraft will be considered to meet the threat of the 1990's.

5) The USAF will continue to modify existing operational aircraft for conversion to the Wild Weasel mission.

6) The APR-38 or derivitive threat detection system for the F-4G, F-15WW, and F-16WW will all have the same capabilities to detect radar directed threats.

LIMITATIONS

This thesis will be constrained as follows:

1) The specific capabilities of Soviet SAMs, AAA, and new fighter aircraft are classified. The threat capabilites used in this thesis will be gained from unclassified sources exclusively, and published capabilities may vary slightly from classified sources.

2) Not all Soviet fighters are considered to be expected threats to Wild Weasel aircraft. This thesis, therefore, will address only Soviet fighters with known air-to-air capabilities, or with lookdown-shootdown capabilities.

3) Although other US produced fighters still in production might be capable of performing the Wild Weasel mission, only USAF aircraft will be investigated (Excludes the F-14 Tomcat and F-18 Hornet).

4) Cost criteria for converting existing airframes goes beyond the scope of this thesis, and will not be addressed as

a favorable or unfavorable factor in selecting the Weasel for the 1990's.

5) If the F-4G is considered for replacement, the USAF will only investigate existing USAF aircraft still in production due to prohibitive costs of re-tooling old aircraft production lines.

6) The F-111 and EF-111 will not be considered as a future Weasel aircraft due to a total lack of self protection capabilities (has no air-to-air missiles or a gun).

DELIMITATIONS

This study will not include specific employment considerations for different geographical areas. The demands made on the Wild Weasel mission differ significantly in Korean, European, and Southwest Asia war scenarios and go beyond the scope of this study. Additionally, the study will only include radar-directed AAA, SAM, and fighter threats, since the Wild Weasel threat detection system is specifically designed to detect only radar-guided threats, not infrared-guided systems.

SUMMARY

As the modern battlefield continues to become more dense and increasingly lethal to aircraft, the importance of the Wild Weasel mission must be recognized. If we are to keep SAM and radar AAA losses to an acceptable level, Wild Weasels must

accompany all possible attack packages to the SAM/AAA concentrations. At exercises such as RED FLAG, at Nellis AFB, Nevada, that is exactly the way the tactical fighter force is training. (25)

ENDNOTES

1 Telephone interview with Lt Col Richard A Rash, USAF, 37th Tactical Fighter Wing Assistant Deputy Commander for Operations, George Air Force Base, California, 18 January, 1985.

2 Lt Col Richard A. Rash, USAF. "Electronic Combat: Making the Other Guy Die For His Country!," Research Report, Air War College, 1983, p. 7.

3.Telephone interview with Colonel Doyle Baker, USAF, 37th Tactical Fighter Wing Deputy Commander for Operations, George Air Force Base, California, 21 January, 1985.

4 Martin Streetly. World Electronic Warfare Aircraft, pp.91-94.

5 D.A. Anderton. The History of the US Air Force, p. 30.

6 Rash, "Electronic Combat", p. 6.

7 Anderton, History, p. 152.

8 Ibid., p. 174.

9 Ibid.

10 Walter Hanak, Editor. Aces & Aerical Victories (The United States Air Force in Southeast Asia 1965-1973), p. 7.

11 Anderton, History, p. 175.

12 Gowri S. Sunderam. "Modern Airborne Electronic Warfare." International Defense Review, Vol 18 No. 2/1985, p. 167.

13 Rash, "Electronic Combat", p. 10.

14 Anderton, History, p. 176.

15 William W. Momyer, General, USAF. Air Power In Three Wars: (WWII, Korea, Vietnam), p. 119.

16 Anderton, History, p. 182.

17 Ibid., p. 208.

18 Unclassified briefing given to US Army Command and General Staff College course Officers, by Randall K. Bigum, Major, USAF, on 1 March, 1985, Subject: Arab-Israeli War (Yom Kippur), 1973.

19 Ibid.

20 Ibid.

21 Ibid.

22 Ibid.

23 Ibid.

24 Streetly, Electronic Warfare Aircraft, p. 91-94.

25 Michael Skinner. Red Flag: Air Combat for the 80's, pp. 1-150.

CHAPTER II

REVIEW OF RESEARCH LITERATURE

The purpose of this chapter is to review the sources of information used throughout this study. Since the Wild Weasel mission is only 20 years old, only limited volumes of material on this ECM mission are in print.

The vast majority of information collected for this study was derived from periodicals and government publications. In order to keep this thesis unclassified, only public sources or unclassified portions of classified documents were utilized to gain specific weapons systems capabilities of both US and Soviet systems. Several high-quality, well-respected military oriented publishers have yielded information which should be accurate enough to facilitate correct analysis of the different weapons systems addressed in this paper.

This chapter reviews the literature by topic or subject category of matter, and discusses the value of source material in relation to the research that was necessary to complete this thesis.

BACKGROUND INFORMATION

The most lucrative source of information in this category was D.A. Anderton's The History of the U.S. Air force. This

book conducts a comprehensive review of Air Force activities from the Wright Brothers through the Vietnam conflict. Another historical work, Air Power in Three Wars: (WWII, Korea, and Vietnam), by General William Momyer, also contains an excellent description of Air Force operations, but concentrates primarily on the Vietnam conflict. This book was invaluable for its discussion of the very beginnings of the Wild Weasel mission, and how it evolved throughout the war.

Another excellent source of background information about the Vietnam conflict is Aces & Aerial Victories (The United States Air Force in Southeast Asia 1965-1973), by Walter Hanak, Editor. This book discusses aerial warfare, provides a good source of aerial combat statistics, and contains a summary of each aerial engagement that resulted in a MIG kill during the conflict.

ELECTRONIC WARFARE

This category of research material was the richest in information to help me in my research and analysis of all the other categories. Colonel Rash's Electronic Combat: Making the Other Guy Die For His Country! contained the most comprehensive study of electronic warfare I could find. It provided excellent background for the progression of ECM from WWII to the recent Israeli and Falkland Islands conflicts, and proves to the reader that electronic combat is the wave of the

future.

For sources that contained updated information about more recent electronic warfare advancements, I consulted two highly respected periodicals, International Defense Review, and Aviation Week and Space Technology. An excellent discussion of ECM warfare is found in "Modern Airborne Electronic Warfare", by Gowri Sundaram in International Defense Review.

THE THREAT

The first category of the threat that I investigated was the SAM threat. The most valuable source I found for this topic was the Defense Intelligence Agency's publication Warsaw Pact Ground Forces Equipment, *Identification Guide:* Artillery, Rockets, and Missiles. Other good sources of information about SAMs were the US Army FM 100-2-3 Soviet Army Troops Organization and Equipment, along with Jane's Armour and Artillery, with Christopher Foss, editor, and The World's Missile Systems, by W.C. Ruckert.

The best source for researching AAA capabilities was the DIA publication Warsaw Pact Ground Forces Equipment Identification Guide: Artillery, Rockets, and Missiles. Another valuable research tool was Jane's Armour and Artillery, with Christopher Foss, editor. Together these publications provide the reader with a superb research source of information about AAA.

Jane's All the World's Aircraft is probably the most revered single world-wide authority on aviation, and was utilized heavily in conjunction with other works to investigate the Soviet air defense aircraft, both old and new.

Major Krempel's Can the Aggressor Continue to be Effective in the F-5E? contains the most thorough analysis of the Soviet fighters that I am addressing in this paper. His analysis of these threats was invaluable to establishing what the threat capabilities of the 1990s will be, and therefore, what airborne threat the Wild Weasel of the 1990s must be capable of defeating.

Other informative sources about Soviet fighters were "Soviets Reshape Structure for Air Attack, Defense," and C. A. Robinson's article "Soviets Deploying New Fighters,", both from Aviation Week and Space Technology.

USAF AIRCRAFT

For a broad overview of what aircraft the USAF has, and what their missions are, J. W. Taylor's "Gallery of USAF Weapons" from Air Force Magazine is the single best source I could find. For a descriptive summary of how those aircraft are actually being utilized in 1985, Michael Skinner's book RED FLAG: Air Combat for the 80's is an outstanding source that describes a large Air Force exercise that simulates

combat.

For background information about the F-4 in general, the best book I found was Gunston's F-4 Phantom. For information about the F-4G, the most lucrative source for technical data was the F-4G flight manual. For other less technical information, "Wild Weasels Prepare to fly the F-4G" from Defense Electronics provided an astounding amount of material about the design and integration of the aircraft's threat detection system. Another article by B. Sweetman, titled "F-4G Wild Weasel", from International Defense Review contains an excellent discussion of the Wild Weasel suppression mission. Both articles should be read together for a more thorough understanding of the Weasel's mission.

The single best research source concerning the F-15 was Michael Gething's book Modern Fighting Aircraft: F-15. This book contains a wealth of information starting with the history and design of the aircraft, and continues with a discussion of recent improvements to the aircraft's avionics and stucture. Additionally, E. Kozicharow's article "USAF Selects F-15 as Dual Role Fighter", from Aviation Week and Space Technology was the best source of information about the F-15E, and therefore, the derivative F-15 Wild Weasel proposal. For updated capabilities, R. Ropelewski's "F-15 Fighter Abilities Evaluated," also in Aviation Week and Space Technology contains a very specific analysis of the F-15's acceleration, turning,

and range capabilities.

In order to research the F-16, I first consulted Major Byron Huff's MMAS thesis The F-16 Wild Weasel: A Feasibility Study. This paper, which is my major source of information about the F-16, conducts a thorough analysis of the F-16WW proposal and analyzes the aircraft's capabilities in relation to the F-4G in detail. The second best source about the F-16 that I found was Doug Richardson's book Modern Fighting Aircraft: F-16. This book contains a comprehensive history of the aircraft, discusses the improvements that have been incorporated throughout its production history, and outlines the enhancements and proposals that lie in the future. Another helpful document for analyzing the F-16's capabilites was the F-16 flight manual.

SUMMARY

This review of literature discussed my major sources of information in conducting the research for this thesis. My absolute determination to keep this paper unclassified has really not been the problem I expected it to be, largely due to the outstanding civilian publications that are didicated to the study of the aerospace industry. Additionally, previous studies done by other Air Force officers have been a superb source of research material for my thesis.

CHAPTER III

DESIRED WILD WEASEL CHARACTERISTICS FOR 1990

THE 1990 THREAT

The purpose of this chapter is to establish what capabilities are required of a Wild Weasel aircraft in the 1990's. The required capabilities must insure that the aircraft can survive in a high threat environment while continuing to suppress or destroy the enemy's air defenses.

The wartime high threat environment of the 1990's will be lethal, sophisticated, and intense. The known threats that the Wild Weasel will face include sophisticated SAM, AAA, and airborne interceptor threats.

SAMS

As the Soviets continue to update their surface-to-air missile systems, they become increasingly difficult to subdue. The USSR's newer SA-10 became operational in 1981, and the SAX-12 development is continuing. (1) Both systems will subject USAF fighters to missile attacks employing unprecedented speed, accuracy and agility. The surface-to-air threats are listed in Table 1: Note that many of the SAMs are effective to very low altitudes, and that others are effective at very long ranges. This gives the Soviets very comprehensive defensive coverage of their airspace.

AAA

The USSR's AAA capabilities are also very significant. They continue to field more ZSU-23-4 systems and are reported to be developing another more lethal system called the ZSU-30-6 to supplement the ZSU-23-4.(2) Of all the threats facing fighters, AAA historically has been the most dangerous, due to pilot's short reaction time to defeat the threat at low altitudes. It was for this reason that 68% of our losses in Vietnam were to AAA fire. (3) At higher altitudes, the enemy can barrage the sky with flak and obtain kills because the aircraft has no safe piece of sky to escape to. When a radar direction system is added to this already serious threat, fighters have no choice but to resort to electronic protection if they are to survive the radar-directed AAA fire. Table 2 shows the radar-directed USSR AAA threats for 1990. Note that the ZSU-23-4 gun is effective all the way down to ground level, and therefore cannot be underflown.

FIGHTERS

The air defense fleet of the USSR is equally impressive. The new MIG 29 (NATO name Fulcrum), MIG 31 (NATO name Foxhound), and SU-27 (NATO name Flanker) will pose an onerous air-to-air threat. Recent tests with the Mig 31 aircraft have shown that it can intercept targets with radar signatures less than one square meter at altitudes below 200 feet, with the

Mig 31 above 20,000 feet. (4) Since the Soviets have traditionally kept their fighters operational for long periods of time, it is logical for the USAF to plan on encountering the older MIG-21, MIG-23, and MIG-25 aircraft that will probably supplement all the older SAM systems in defense of Soviet armies. The air-to-air threats are found in Table 3. Note that the maximum speed of the USSR's newest airborne threats are equal to our own fighter's capabilities.

SUMMARY

The Soviet Union has demonstrated steady progress in upgrading their air defense arsenal. They continue to refine mobility and capability in their SAM and AAA systems, and have designed those systems to compliment one another on the future battlefield. A pictorial summary of the evolution of the Soviet systems is shown in Figure 1, and shows their increased emphasis on firepower and mobility.

TABLE 1

USSR SURFACE-TO-AIR MISSILE THREATS FOR 1990 (5)

MISSILE	NATO NAME	ASSOCIATED RADAR	MAX RANGE	MIN ALT
SA-2	Guideline	Fan Song	30NM	300'
SA-3	Goa	Flat Face/Low Blow	13NM	300'
SA-4	Ganef	Pat Hand	60NM	300'
SA-5	Gammon	Square Pair	100NM	Unknown
SA-6	Gainful	Straight Flush	16 NM	150'
SA-7	Grail	N/A (Infrared)	2.6NM	50'
SA-8	Gecko	Land Roll	8.1NM	30'
SA-9	Gaskin	N/A (Infrared)	3.2NM	30'
SA-10	Unknown	Clamshell/Flaplid	Unknown	Unknown
SA-11	Gadfly	Straight Flush	18NM	150'
SA-X-12	Gladiator	Unknown	100NM	300'
SA-13	Gopher	N/A (Infrared)	3.2NM	30'
SA-14	Unknown	N/A (Infrared)	2.6NM	50'

TABLE 2

USSR AAA THREATS FOR 1990 (6)

AAA GUN	NATO NAME	ASSOCIATED RADAR	MAX RANGE	MIN ALT
ZSU-23-4	Gundish	Gundish	8,200'	0'
S-60	AAA	Flap Wheel	19,500'	Unknown
ZSU-57-2	AAA	Flap Wheel	13,000'	Unknown

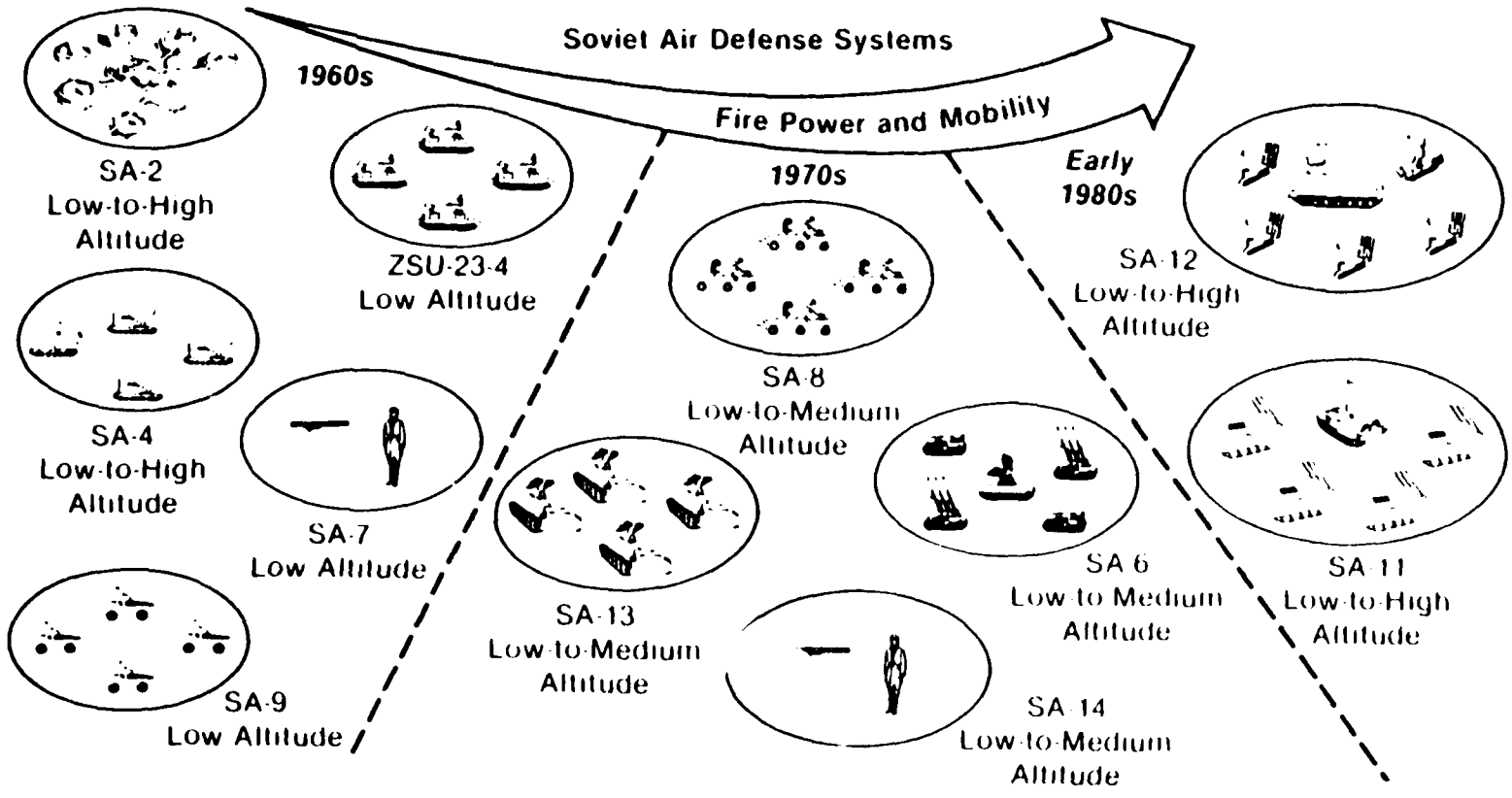
TABLE 3

USSR AIRBORNE THREATS FOR 1990 (7)

AIRCRAFT	NATO NAME	MAX SPEED (Mach)	INSTANTANEOUS TURN RATE	LOOK-DOWN SHOOT-DOWN?
Mig 21	Fishbed	2.1	16 DEG/SEC	NO
Mig 23	Flogger	2.3	12 DEG/SEC	Yes(limited)
Mig 25	Foxbat	2.8	Unknown	Yes(limited)
Mig 29	Fulcrum	2.3	16 DEG/SEC	Yes
Mig 31	Foxhound	2.4	Unknown	Yes
Su-27	Flanker	2.3	23 DEG/SEC	Yes

FIGURE 1

Mobile Threat Detection Required



Threat Uses

- EMCON - Emission Controls (Shutdown)
- Decoys; Multiple Antennas
- Radar Frequency Agility
- Optical Trackers
- Launch Without Guidance

WILD WEASEL CAPABILITIES FOR 1990

In assessing what required fighter characteristics the 1990's Weasel must possess, the following criteria were established by the Wild Weasel community: (NOTE- see appendix A for the specific questions asked of Wild Weasel Officers, and for the range of the poll's answers).

TABLE 4

DESIRED WILD WEASEL CHARACTERISTICS

Speed	cruise - 540 Knots airspeed, using military power dash - supersonic
Range/station time	500 Nautical Miles/20 minute loiter
Self Protection	four all aspect air-to-air missiles plus an internal gun
Weasel ordnance weapon stations	minimum of four
Crewmembers	one Pilot, one Electronic Warfare Officer
Manueverability	must sustain 7 G's with ordnance must sustain 9 G's without ordnance
Size and stealth	aircraft may be larger, do not desire stealth characteristics
Growth Potential	must have room to accomodate future technology as it becomes available

Detailed Criteria

1) Speed

a. Cruise-must be capable of 540 knots sustained cruise throughout ingress or egress, using military power

b. Dash- must be capable of supersonic dash

2. Range/station time

a. Range- On a typical Weasel mission profile of high altitude cruise, low altitude 50 NM ingress to the target, low altitude 50 NM egress from the target, and high altitude cruise to the recovery base (Hi-Lo-Lo-Hi profile) , the Wild Weasel of 1990 should have a 500 nautical mile combat radius.

b. Station time- (fuel limited time available to remain in the target area). For a Hi-Lo-Lo-Hi mission profile over a distance of 500NM, the Weasel should have a minimum of twenty minutes station time, subsequent to a 50NM low ingress.

3. Self-Protection (surface-to-air and air-to-air defensive systems).

a. The Weasel should have a minimum of four air-to-air missiles of the following mix:

1) two all-aspect launch and leave radar missiles supplemented with two all-aspect heat seeking missiles,

or

2) four all-aspect launch and leave radar missiles, or

3) four all-aspect heat seeking missiles.

b. The Weasel should have a 20mm internally mounted gun (ammunition amount unspecified).

c. The Weasel should have an internally mounted, totally automatic jamming system that is capable of reacting to threat radars with previously programmed human inputs.

d. The Weasel should have an automatic chaff and flares dispensing system that works in conjunction with the automatic jamming system.

4. Ordnance stations

The Weasel should have a minimum of four weapons stations capable of carrying any mix of Wild Weasel ordnance desired.

5. Crewmembers

The Weasel aircraft should have two cockpits, one for the Pilot and the other for an Electronic Warfare Officer.

6. Maneuverability

The Weasel aircraft must be capable of sustaining a seven G turn at low altitude without requiring ordnance jettison to prevent overstressing the aircraft structure (Over-G).

Once the Weasel aircraft has delivered its ordnance, it should be capable of sustaining a nine G turn at low altitude without overstressing the aircraft.

7. Size and stealth

The radar cross section of the F-4G is large. In some scenarios, the Weasel actually desires to be seen by SAM or AAA radar operators, in the hopes that they will be

intimidated by the presence of Weasels in the area. (8) On the other hand, the Weasel never desires to be seen by enemy aircraft radars. As a compromise, the poll indicated that size was not very critical. (9) Most personnel indicated that while a smaller size would give the enemy a more difficult visual acquisition problem, they would not trade reduced size if they had to sacrifice any ordnance stations or fuel capacity. (10)

If size is not critical, then neither are stealth characteristics. 100% of the poll indicated that a stealth Weasel for the 1990's would degrade the Weasel's ability to suppress or intimidate enemy radar operators. As one Pilot put it, "you can't fight what you can't see."

DISCUSSION

Of all fighter characteristics, speed continues to be the most important underlying characteristic to the fighter pilot. Supersonic cruise will be a necessity to escort the Advanced Technology Fighter (ATF), and very high sustained subsonic speeds are required to escort F-111 and EF-111 aircraft today. (11)

Limited range/endurance is probably the most mission limiting factor for the F-4G today. It provides little comfort if your Wild Weasel escort ingresses X number of miles at high speed right along with the package if he has to egress

immediately due to a low fuel state and before he has a chance to suppress/destroy the enemy's air defenses. A 500NM Hi-Lo-Lo-Hi mission range/endurance capability would tremendously help the Weasel to successfully complete the suppression mission.

The twenty minute station time is based on low to medium altitude, using minimum afterburner, maintaining 450 knots airspeed, which the poll designated as the minimum acceptable airspeed in a hostile environment. Twenty minutes will allow completion of most forseeable Wild Weasel missions of the future.

Self -protection measures are an absolute must for survival in the 1990's. Most Weasel crews advocate that it is impossible to Weasel in a high threat air-to-air environment. Today, if air defense MIGs are found in the area where the Weasel had planned to conduct his suppression operations, he has two choices: 1) he can go somewhere else to conduct his mission; or, 2) he can risk being engaged by the MIGs at a severe disadvantage, fighting outnumbered in aircraft and outnumbered in air-to-air munitions, and without a gun.

While air-to-air combat is not the Weasel's role, a powerful air-to-air capability would help immensely by giving the Weasel the capability to negate or defeat an attack quickly and reliably. Additionally, if the Weasel is forced to suppress in the MIG's area, he has the ability to

neutralize the threat so he can get on with his mission of suppressing enemy air defenses. If nothing else, a long range air-to-air radar would allow the Weasel to detect where the MIGs are electronically, so he can avoid them before they gain visual or radar acquisition.

The question of whether the Weasel needs a gun has been a controversial USAF issue for quite some time. In 1982, Captains Frank Brewer and Ken Pullen conducted the test of an externally mounted 30mm (GAU-8) cannon on the F-4G with very impressive results. (12) Yet it made no sense to download the F-15 centerline tank from the F-4G to upload the GAU-8 because fuel limitations then forced the loading of two external wing tanks to regain endurance. When the external wing tanks were loaded, two weapons stations were lost, thus reducing the Weasel's stand-off offensive missile and/or bomb load capability by 50%. Since the GAU-8 only has an effective range of slightly under two miles, it would force the Weasel back into the AAA "heart of the envelope" discussed in Chapter I. The 37th TFW leadership wisely decided to exclude the GAU-8 from the Weasel arsenal.

The obvious answer to the Weasel pilot's wanting a gun is to install one internally. Most of the personnel interviewed admitted that they probably wouldn't try to strafe AAA or SAM sites, but the gun would be invaluable if the Weasel somehow found himself into a close-in fight with a MIG. A logical

counter-argument can also be made that the Weasel pilot should just manuever his aircraft to insure that he doesn't find himself in a close-in fight with a MIG, thus eliminating the need for a gun.

One very potent argument for including a gun in the next Wild Weasel aircraft is the potential for its use as a combat power multiplier. The use of combined arms, for example, is a combat power multiplier. The synergistic effect of using several weapons all at once is more devastating than their use individually. If the Weasel has a gun, the use of 20mm forward firing chaff, 20mm decoy drones, and other exotic futuristic technology will act as a combat power multiplier in the suppression mission. The lack of a gun will reduce the aircrew's flexibility in completing the Wild Weasel mission.

An internally mounted, totally automatic jamming and chaff dispensing system that work together as a single defensive unit would increase the Weasel's survivability immeasurably. (13) The Weasel EWO currently has to analyze the threat, while either he or the pilot dispenses the chaff and/or flares to defeat a missile attack. An automatic system would greatly reduce the EWO's workload and would free both members to turn their attention to other important matters.

More importantly, an automatic system could change the dispensing schedule almost instanteously and tailor it to the most favorable settings to defeat whatever threat is engaging

the aircraft at that moment. Because of slow human reaction time, an unwillingness to look inside the cockpit while under attack, and human inability to accurately move some switches under heavy G manuevering all make settings changes while under attack in the F-4G not practical today.

Ordnance stations are used to carry Shrike, Standard Arm (being phased out), or HARM missiles in addition to all the free-fall ordnance (bombs). Very simply, the more stations the aircraft has, the more offensive capability it has. The four station minimum from the poll is based on the twenty minute station time established by the poll. This twenty minute time is actually the time the respondents expect to have to employ whatever ordnance they are carrying in the target area.

One question that was answered unanimously was whether a single pilot, with the help of electronic wizardry, could perform the Weasel mission alone. The answer was an emphatic "No!". The responsibilities inherent in the Wild Weasel mission require a minimum of a Pilot and an EWO to successfully complete the mission.

Maneuverability will undoubtedly be the key to survival in the 1990's. Currently, if the F-4G is attacked, it cannot exceed 4.8 G's with ordnance loaded on the wing stations without overstressing the aircraft. (14) If the pilot feels that 4.8 G's is insufficient maneuvering to defeat the threat,

he must jettison his ordnance prior to increasing the G load to prevent an over-G of his aircraft. As a result, one defensive move can cause the F-4G to have a non-effective sortie due to jettisoned ordnance. It should be noted, however, that most fighter pilots will maneuver their aircraft in whatever manner it takes to defeat an immediate threat, regardless of the G involved, if the situation dictates.

Once the aircraft has delivered its ordnance, the poll expected its maneuverability to increases substantially. With an essentially "clean" airplane (only ordnance mounting stations carried), the poll desired a maneuverability of nine G's to defeat any enemy threat.

The poll indicates the weasel of the 1990's needs a seven G level turn capability at sea level with ordnance aboard to have a reasonable chance of defeating the future threat. This figure is based on an undefined instantaneous turn rate, but one that is representative of either F-15 or F-16 current turning capabilities.

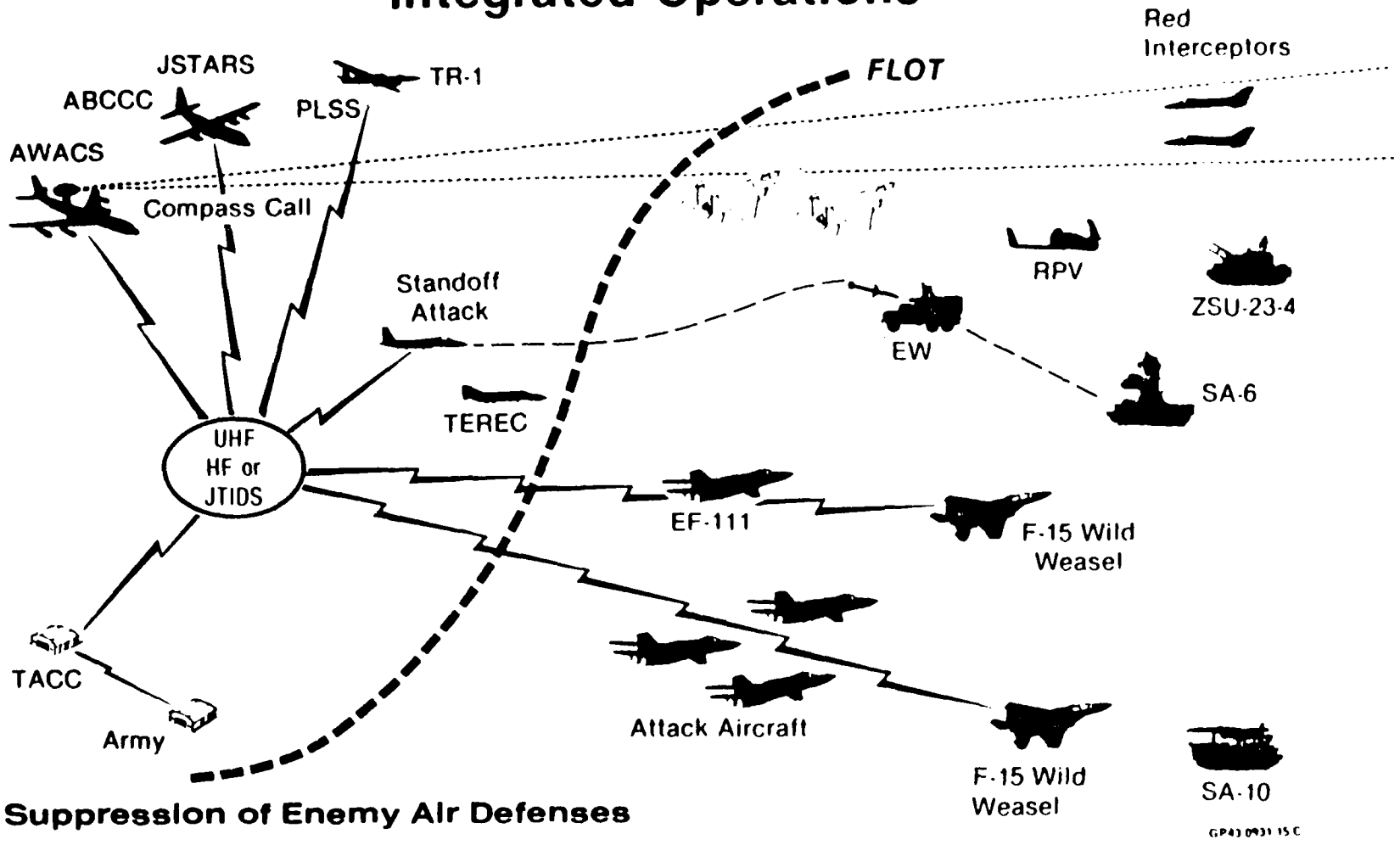
Size and stealth have already been addressed adequately. While there are important trade-offs in advantages and disadvantages of small size and stealth characteristics, Weasel tactics are such that an aircraft larger than the F-4G would be acceptable to Weasel personnel if they gain range/endurance, payload, and self-protection capabilities. None of the respondents indicated a desire for a stealth

Weasel.

Growth potential will be essential for the next Wild Weasel aircraft. Technology is providing tremendous improvements in electronic warfare capabilities on a regular basis, so the next Weasel aircraft should have room to accomodate future breakthroughs in electronics without having to sacrifice or replace current equipment carried inside the aircraft. Figure 2 shows how integrated operations on the future battlefield might occur between different weapons systems to aid the SEAD mission. Growth room will be required to accomodate this technology that is already in the process of being fielded.

FIGURE 2

Integrated Operations



Suppression of Enemy Air Defenses

Several other capabilites were revealed by the poll that were identified as being "nice to have, but not essential for 1990." They are presented for information only and will not be analyzed. The following is the list from the poll:

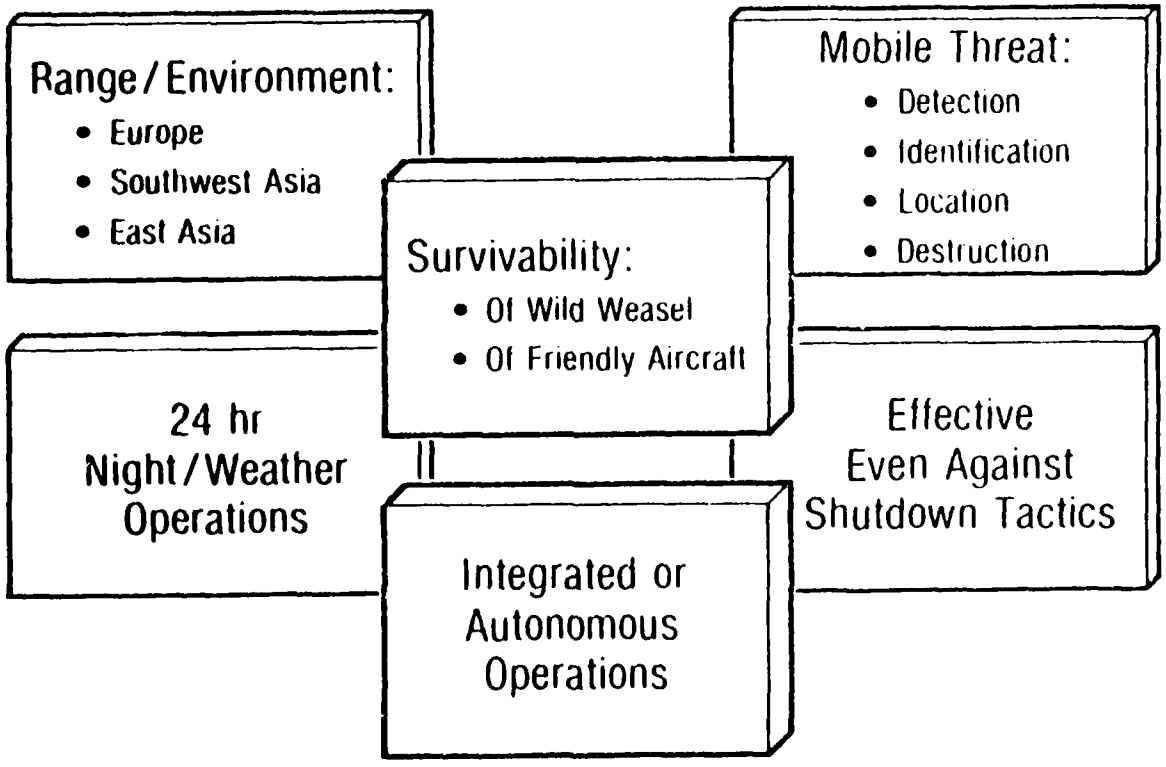
1- multiple redundant secure communications systems
2- active participation in PLSS (Precision Location Strike System), and the GPS (Global Positioning System)
3- terrain following radar coupled with an autopilot
4- capability to change the colors on the APR-38 scope for night flying
5- capability to identify enemy electronic footprints, whether the enemy system is turned on or not
6- capability to data link with AWACS
7- a follow on missile to HARM with at least 200NM range
8- continuous corrections to indicate when to launch Sidearm (a new anti-radiation missile)
9- conformal (low drag) fuel tanks for the F-4G
10- hardened, no frost canopies that will reflect microwave energy and filter laser energy for crew protection
11- ability to hand-off electronic information about enemy SAMs and AAA to other Weasel aircraft inflight
12- rearward shooting air-to-air missiles
13- passive IR detection sensors

SUMMARY

The poll clearly indicates a desire in the Weasel community for more capabilities in the Weasel aircraft for the 1990's. It needs to be faster, fly farther, fly longer, and be capable of more offensive and defensive action while performing the suppression mission. Figure 3 shows a summary of needs for any future Wild Weasel aircraft.

FIGURE 3

Wild Weasel Needs



GP43 0931 5C

ENDNOTES

1 Dennis Warner, Editor. Janes Armour and Artillery 1983-84, p. 562.

2 Ibid.

3 William W. Momyer, General, USAF. Air Power in three Wars: (WWII,Korea, Vietnam), p. 123.

4 Jim Bussert. ""Soviet Air Defense Systems Show Increasing Sophistication", p. 80.

5 Defense Intelligence Agency. Warsaw Pact Ground Forces Equipment Identification Guide: Artillery, Rockets, and Missiles. pp. 152-204.

6 Ibid.

7 Krempel, Donald M., Major, USAF. "Can the Aggressors Continue to Be Effective In The F-5E?" US Army Command and General Staff College, Masters thesis, 1984, pp. 19-38.

8 Telephone interview with Lt Col Gary Olin, 563d Tactical Fighter Squadron Director of Operations, George Air Force Base, California, 21 January, 1985.

9 Poll taken in December 1984 through March 1985 of Wild Weasel Personnel throughout the USAF.

10 Ibid.

11 Personal experience as a Wild Weasel Instructor Pilot from 1981 through 1984.

12 Telephone interview, Lt Col Gary Olin.

13 Wild Weasel Poll (See Appendix A).

14 Technical Order 1F-4G-1 Flight Manual, p. 5-10.

CHAPTER IV

COMPARING THE F-4G, THE F-15WW, AND THE F-16WW

INTRODUCTION

The purpose of this chapter is to establish the characteristics and capabilities of the F-4G, the F-15WW, and F-16WW aircraft. The F-4G is an older aircraft, while the F-15 and F-16 are the USAF's newest "F" -designated fighters. All three aircraft have served in combat, although the F-15 and F-16 have only seen combat in the service of another nation's Air Force.

The design of the three aircraft was based on different needs of the military. The original F-4 was first bought by the US Navy as an intercepter for their fleet. When the US Air Force bought the F-4, they utilized it in both air-to-air and air-to-ground roles. The F-15 was designed and purchased solely as an air superiority fighter. The F-16, on the other hand, was bought to supplement and finally replace the F-4 in the air-to-ground mission. Both the F-15 and F-16 have proven themselves in their designed role and both will be utilized in multirole fashion when the F-15E Dual Role Fighter begins production. (1)

COMPARING THE AIRCRAFT

In order to compare the three aircraft, the desired minimum acceptable characteristics established in Chapter III

will be used as the single standard by which the aircraft will be compared. There are several problems encountered when comparing these aircraft, the most difficult of which is the aircraft configuration, or how many of what type ordnance will be loaded for comparison. Since the poll established the desired Weasel load to be 4 HARM missiles, an internal electronic countermeasures pod (ECM pod, or suite), and chaff and flares, all three aircraft will be analyzed based on this ordnance load.

A discussion of current ECM advancements is in order. The F-15WW is designed to have an internal ECM capability on the order of the Air Force's new ASPJ system (Airborne Self Protection Jammer) that is destined for installation in the F-16 in the near future. The ASPJ system, while totally automatic, only covers radar frequencies similar to the external ECM pod carried on the F-4G. Another system, called INEWS (next-generation integrated EW system), is also under joint development between the Air Force and the Navy. INEWS is a more capable self protection system in that it will operate over the entire electromagnetic spectrum, countering threats in radar frequencies, millimeter-wave, infrared, and laser enemy threats. (2) Dramatic advancements in the ECM world occur daily, making updated aircraft protection a challenging proposition.

One problem in comparing these three aircraft is that the

contractor's proposed designs for the F-15 and F-16 are dissimilar in the way ordnance is loaded on the aircraft. General Dynamics shows the F-16 with four HARMs loaded on only two wing station pylons, while McDonnell Douglas shows the proposed F-15WW with single-loaded HARMs similar to the pylon loading characteristics of the F-4G. If the F-16 pylon were loaded on the F-4 or F-15, it would double the HARM carrying capability to 8/10 HARMs respectively, thus making the F-16 appear less capable. Since the F-16 has the option of carrying 4 HARMs on two dual missile rails on two ordnance stations, this analysis will investigate only the two tank and ASPJ three tank F-16 fuel configurations: The older F-16 aircraft cannot carry 4 HARMs and an ECM pod with a centerline tank loaded. The bomb carrying capability of a two pylon F-16 is significantly less than a four pylon F-4 or F-15; Since the standard Weasel load was established as four HARMs in Chapter III, this should be kept in mind by the reader during the F-16 analysis.

Each aircraft will be investigated by general characteristics, possible Weasel configurations, and finally analyzed by its ability to perform as compared to the standard aircraft established in Chapter III. Additionally, an "importance" factor that was established by the poll is utilized to make the final analysis of the aircraft's capabilities. The importance factor is a variable rating from

one to five, with one being unimportant and five being very important, that is used to weight each aircraft characteristic as to how essential the Weasel poll thought that characteristic was to completing the Weasel mission.

The poll established a mission profile that the future Wild Weasel aircraft should be capable of performing. The profile is Hi-Lo-Lo-High, or high altitude cruise at 25,000 feet to within 50NM of the target area flown at 480 knots, descent to sea level to fly a 50NM, 540 knot ingress, loiter in the target area at a minimum speed of 450 knots for 20 minutes, egress the same ingress 50NM again at 540 knots, climb to 25,000 feet and return at 480 knots to the original takeoff base with the Air Force required minimum landing fuel established in AF regulation 60-16.

This profile evolved because the Weasel poll determined a 25,000 foot altitude for escort ingress is high enough for favorable fuel flows by most fighters, but not so high that heavy bomb-laden fighters could not attain it. Additionally, 25,000 feet allows a pilot to trade altitude for energy if attacked. Obviously, if the aircrew encountered severe jetstream winds at this altitude, another altitude would be chosen to fly at. 480 knots was chosen because it is easy to navigate with (the package covers 8 NM per minute), and because it also is an excellent tradeoff between fuel flow and airspeed. The 540 knot ingress airspeed is based on a desire

for fast movement in a high threat environment. The poll felt that either a very low or very high altitude would be necessary for ingress, but nothing in-between. This is partly based on the 1973 Israeli experience where they lost 14% of their entire Air Force in three hours by attempting to stay at medium altitudes against SA-2 and SA-6 SAMs. When they attempted to go very low to at least defeat the SA-2, Russian made ZSU-23-4 AAA pieces literally "chewed them to pieces." (3) In summary, in a high threat environment, the poll felt they might be forced to low altitude and high speeds about 50 miles from the target area due to the longer range threats expected in the 1990's. The sea level altitude was chosen to simplify figuring fuel flows for the three aircraft. The 20 minute loiter time was established because the poll felt they could accomplish almost any forseeable Wild Weasel mission in that time period.

Although the Weasel poll did not include bombs in their standard Weasel profile, a discussion of the three aircraft's bomb carrying/delivering capabilities is in order. Significant variations in numbers carried and accuracy of delivery are covered under the discussion of the Analysis of Aircraft capabilities in relation to the poll's standard.

The F-4G

When first introduced in 1958, the F-4 Phantom performed flawlessly for the Navy. The F-4 first flew on May 27, 1958: It was such a "hot" airplane that the US Navy decided to utilize the F-4 to attempt to take the world altitude and speed records away from the Soviet Union. On December 6, 1959, the Navy succeeded with a new altitude record of 98,557 feet. (4) The next year, on September 5, 1960, a Marine F-4 established a new speed record of 1,305 miles per hour. (5) Clearly, the F-4 is an extremely high performance aircraft.

The Air Force utilized the aircraft extensively in the Vietnam conflict in both air-to-air and air-to-ground missions. It first began the Wild Weasel mission in 1969 as the F-4C Wild Weasel, and then in 1978 the Air Force modified 116 F-4Es and converted them into the F-4Gs we have today. The Air Force is in the process of transferring all F-4Cs, F-4Ds, and F-4Es into the National Guard and Air Force Reserves as they modernize their ground attack fleet with new F-16s. As a result, the F-4G will probably be the only model F-4 left in active duty status by the middle of the 1990's. This will present the Air Force with a tremendous logistical support problem with a one-of-a-kind specialized aircraft to support either in peacetime or during war.

Table 5 contains the specific characteristics of the

F-4G. Figure 4, which follows Table 5, shows the ordnance loading capabilities of the F-4G, and where specific types of ordnance can be carried on the aircraft. Note that while the ECM pod can be carried in three places, the F-4G normally carries the pod in the left forward Aim-7 missile well. Additionally, if the outboard external fuel tanks are loaded, the HARM missile load is reduced by 50%.

TABLE 5

CHARACTERISTICS OF THE F-4G (6)

SIZE	LENGTH	63 FT
	WINGSPAN	38 FT 5 IN
	* SIZE FACTOR (7)	838
SPEED	** MAXIMUM CLEAN	>MACH 2
	WITH EXTERNAL TANK	660 KNOTS MACH 2
	*** HI-LO-LO-HIGH MISSION RANGE	175 NM
SELF-PROTECTION	MISSILE STATIONS	4
	WITH ECM POD	3
	WITH CENTERLINE TANK	3
AGM MISSILE/BOMBS ORDNANCE STATIONS		4
CREW		2
G AVAILABILITY WITH 4 HARMS LOADED @ 46,000LBS		+4.8
G AVAILABILITY CLEAN @ 46,000 LBS		+6.9
GROWTH POTENTIAL		NO

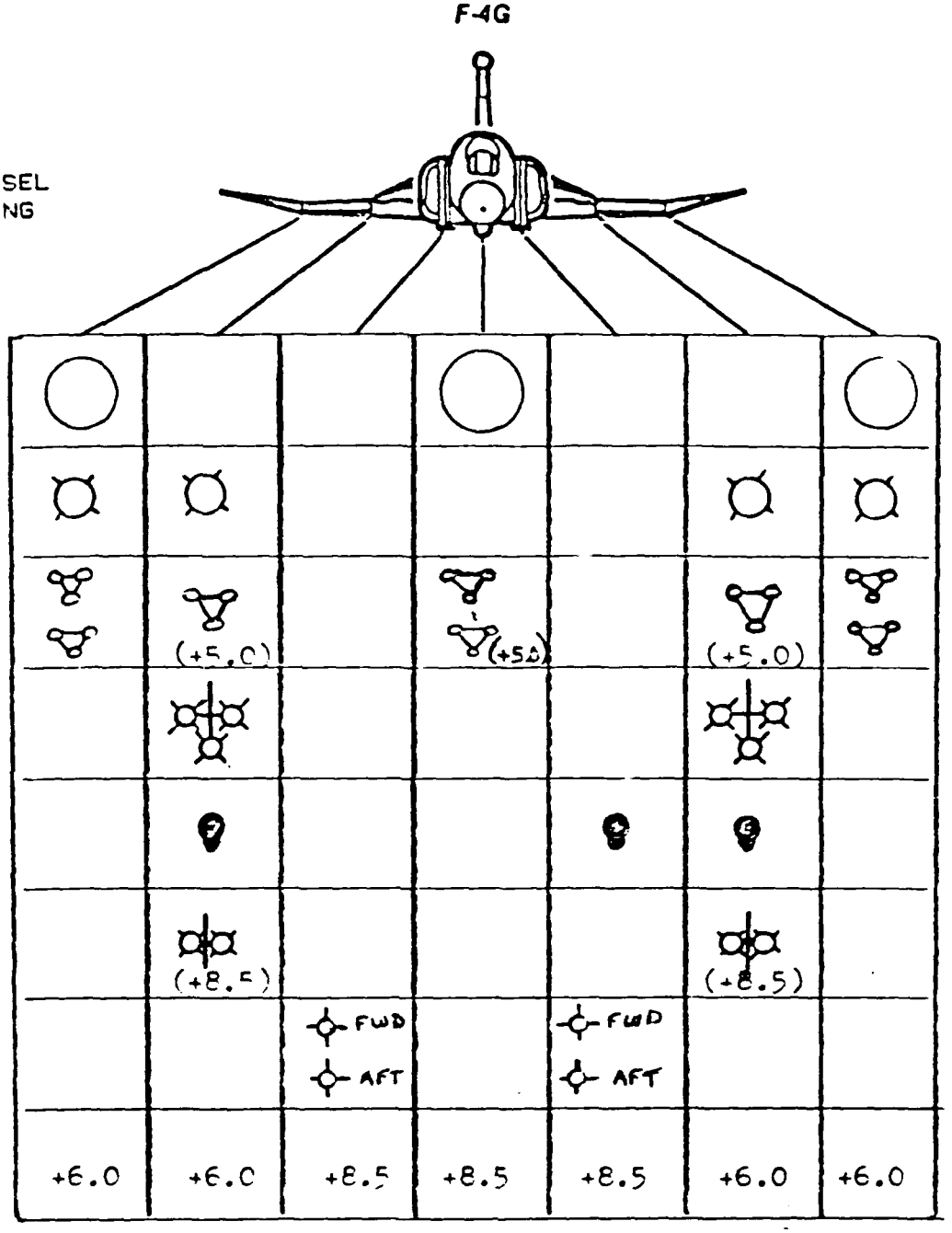
* SIZE FACTOR= $\sqrt{\text{AREA}_{\text{FRONT}}^2 + \text{AREA}_{\text{SIDE}}^2 + \text{AREA}_{\text{TOP}}^2}$

** MAXIMUM AIRSPEED WITH NO EXTERNAL STORES

*** HI-LO-LO-HI PROFILE BASED ON TAKEOFF, CLIMB TO 25,000'FROM SEA LEVEL, CRUISE AT 480 KNOTS TRUE AIRSPEED, DESCENT TO SEA LEVEL, CRUISE AT 540 KNOTS TRUE AIRSPEED FOR 50NM, 20 MINUTE LOITER IN TARGET AREA, EGRESS 50 NM AT 540 KNOTS TRUE AIRSPEED AT SEA LEVEL, CLIMB TO 25000 ' TO LAND WITH AFR 60-16 REQUIRED 20 MINUTE FUEL RESERVE AT BASE OF ORIGINATION.

FIGURE 4

F-4G WILD WEASEL
WEAPONS LOADING



() DENOTES DIFFERENT G RESTRICTION

UTILIZATION OF THE F-4G

Even though the F-4G is our newest Wild Weasel aircraft, it is not without some very critical limitations. The F-4G is normally configured with a single centerline external fuel tank, while the remaining four ordnance stations are loaded with Shrikes, Standard ARMs, High Speed Anti-radiation Missiles (HARM), or bombs. With this configuration, the F-4G has less range than a similarly configured two-tank F-4C/D/E, A-7, F-16, F-18, F-15, F-111, or A-4 attack aircraft. (8)

Since the F-4G sometimes ingresses to the target area a few minutes ahead of the main package (to suppress ground threats while the package passes through), and is expected to remain in the area to protect their egress, the fuel required often exceeds that available. If more external fuel is loaded on the aircraft, two weapons stations are lost along with a significant percentage of its manueverability and "G" (gravity forces) available. While it is not the intent of this study to discuss tactics, it should be noted that if the F-4G ingressed with or behind the main package, it would have more fuel available for Weaseling. In this situation, any aircraft ahead of the Wild Weasels would suffer from reduced Wild Weasel suppression of enemy defenses.

One solution, as practiced today, is to have more Weasels relieve the first flight to go home while the second flight covers the strike package during its egress. Since Wild

Weasel aircraft are already in short supply, and since this option doubles the number of Weasels required, this solution will ultimately leave other flights with no Weasel protection whatsoever.

Another option is to protect the strike package during ingress or egress, but not during both. This option leaves the entire package vunerable for half the mission, which is less than desirable. Red Flag exercises at Nellis Air Force Base, Nevada, have shown that ground threats can be effectively suppressed with Weasels in the area. Without Wild Weasel support, SAMs and AAA have scored large numbers of simulated aircraft kills. (9)

Additionally, the APR-38 system was designed to detect the threats encountered in the 1970s, while the Russians continue to field more sophisticated and complicated electronic threats of the 1980s. The Air Force is trying to meet the new, exotic electronic challenge with the PUP (Performance Update Program), where both the F-4G and the APR-38 will get updated software and hardware. The most significant improvements are:

1) Expansion of the APR-38 computer from 64K to 256K storage capacity.

2) APR-38 frequency extension, capability against agile and low probability of intercept radars, capability against ground based jammers, dense environment processing capability,

and APR-38 integration with a new inertial navigation computer called the ARN-101. (10)

AIRCRAFT ANALYSIS

Table 6 shows how the F-4G compares to the Wild Weasel standard aircraft that was established in Chapter III. Note that the F-4G registers a 0% capability in 5 of the fourteen criteria established by the poll.

TABLE 6

F-4G AIRCRAFT ANALYSIS

CRITERIA	STANDARD	F-4G	% CAPABILITY OF STANDARD	WEIGHT FACTOR *
SPEED CRUISE	540	540	100%	4
DASH	SUPERSONIC	SUPERSONIC	100%	4
RANGE/STATION TIME	500/20 MIN	175/20 MIN	35%	5
SELF-PROTECTION				
ALL-ASPECT MISSILES	4	3	75%	5
INTERNAL GUN/ECM POD	YES/YES	NO/NO	0%/0%	3
AUTOMATIC ECM POD	YES	MANUAL	0%	4
AUTOMATIC CHAFF/FLARES	YES	MANUAL	0%	4
AGM MISSILE/BOMB STATIONS AVAILABLE	4	4	100%	5
MISSILE/BOMB STATIONS AVAILABLE WITH ECM POD, CHAFF & FLARES LOADED	4	4	100%	5
CREW	2	2	100%	5
G AVAILABILITY WITH 4 HARMS LOADED @ 46,000 LBS	+7.0	+4.8	69%	4
G AVAILABILITY WITH NO HARMS LOADED @ 46,000 LBS	+9.0	+6.9	77%	4
GROWTH POTENTIAL	YES	NO	0%	3
SIZE FACTOR	N/A	838	N/A	2

*Established by the poll: 1= unimportant, 5= very important

DISCUSSION

Although the F-4 is capable of 540 knot cruise at sea level, it pays a severe penalty in fuel consumption over the fifty nautical mile route. This penalty amounts to approximately 11% of total fuel carried, meaning that 22% of the total fuel is utilized during the ingress and egress. It should be no surprise to anyone that the F-4's 1957 design J-79 turbojets are not very fuel efficient by 1985 standards.

With a 20 minute station time, the F-4G is capable of a 175NM combat radius (range) with the standard configuration. This represents only 35% of the 500NM range established by the poll. The F-4G has a severe range/endurance deficiency to complete the Wild Weasel mission of the 1990's, as defined by the poll.

In the area of self-protection, the F-4G is capable of launching either the AIM-7E or AIM-7F Sparrow missiles (the AIM-7F is also carried by the F-15). With the ECM pod loaded in the left forward missile well, the F-4G can only carry three AIM-7s. Additionally, if a single AIM-7 is carried in the right forward missile well, it cannot be fired normally without jettisoning the centerline tank. The F-4G does not normally carry AIM-9 heat seeking missiles because of fin interference on the inboard pylons between the AIM-9 and the AGM-45 Shrike missile. Whether or not this interference exists between the AIM-9 and the HARM on the inboard pylons

could not be established due to classification.

The F-4G has no internal gun or internal ECM pod. The aircraft does not lose any AGM missile ordnance stations by carrying the ECM pod because the pod is carried in an AIM-7 missile well. This causes the F-4G to rate 75% in self-protection missiles. If the pod were carried on a wing station, it would cause the F-4G to drop to 75% in AGM missile stations, while rising to 100% in self-protection missiles. Since both criteria rate a 5 in importance, no net gain is realized by moving the ECM pod to the wing.

The chaff and flares system on the F-4G is the ALE-40. It can carry chaff and flares under both wings, located on the inboard pylons. The system can be operated by either crewmember; the individual settings are made by the pilot, while the programs run by the computer are set by the EWO. The F-4G has a capable self-protection chaff and flares system, but it is not automatic.

While the F-4G is capable of 5 ordnance stations, it normally flies with a centerline tank on the center ordnance station to provide more range/endurance. The remaining ordnance stations are all HARM compatible.

The F-4G is normally crewed with a Pilot and an Electronic Warfare Officer.

At a nominal weight of 46,000 pounds, the F-4G has a G availability of 4.8 with HARMs aboard, or 6.9 with no HARMs

aboard. With HARMs aboard, G availability will rise to 6.0 as fuel burns down, but the aircraft will most likely be out of the target area by then. With no HARMs aboard, the G available eventually rises to 8.5 as the fuel weight burns down. The weight of 46,000 pounds was chosen because that is very close to the weight the aircraft will have when it arrives in the target area with the standard profile.

While the F-4G is considered to be a large fighter in relation to world standards, the poll did not consider the aircraft too large to accomplish the Wild Weasel mission. The F-4G has no apparent stealth characteristics, which also was deemed as unimportant or even undesirable by the poll. Thus it may be concluded that the F-4G meets the poll standards in both of these areas.

The bomb-carrying capacity of the F-4G is tremendous. With no external tanks loaded, the aircraft can deliver 24 Mark 82 500 pound general purpose bombs to the enemy. In the normal Wild Weasel configuration, that number drops to 18 MK 82s with the centerline tank installed.

The F-4G has several bombing modes. By using manual or Dive Toss bombing, the pilot overflies the target he is attempting to destroy. Dive toss bombing accuracy is not up to the new technology computer systems in the F-15 and F-16, but should be improved significantly when the ARN-101 computer is installed in the aircraft.

ANALYSIS

The F-4G has accomplished the Wild Weasel mission well. For the 1990's threat scenario, it falls well short of desired criteria to accomplish the mission in nine of the fourteen areas considered by the poll.

The most critical shortcoming for the F-4G is range/endurance. This can be directly attributed to the F-4G's high fuel consumption rates and limited fuel carrying capacity. If the aircraft is uploaded with three external fuel tanks to overcome this shortcoming, the HARM load drops to 50% of the desired ordnance with only two ordnance stations available.

THE F-15WW

The F-15 Eagle is the first fighter to be bought strictly for air superiority since the Air Force purchased the F-86 Sabre in 1948. (11) It was designed to counter new Soviet air-to-air threats being fielded in the 1970's, and was the result of the Air Force's FX or "experimental fighter" program.

Interestingly, the Air Force criteria in designing the FX was "not a pound for air-to-ground" to prevent a design attempt for an aircraft that could fly all Air Force missions satisfactorily, but none of them superbly. (12) The first prototype of the F-15 flew on July 27, 1972.

The Air Force felt the F-15 was such a capable fighter that it was decided to utilize the aircraft to attempt to set new time to climb records. From January 16, 1975 through February 1, 1975, the F-15 set 8 new time to climb records. Five of the previous records had been set by the F-4 Phantom, and three of the old records had been set by the Russian MIG-25 Foxbat. The largest new record margin was 33% over the F-4, followed by 28% over the Foxbat when the F-15 climbed to 65,617 feet in only 122.94 seconds! (13)

One of the F-15's more exceptional capabilities are the result of two F-100 engines that produce 50,000 pounds of thrust. When the aircraft weighs less than 50,000 pounds,

this produces a thrust-to-weight ratio in excess of 1 to 1 and enables the aircraft to accelerate even when going straight up. (14)

The F-15E is the dual-role fighter selected by the Air Force to supplement the F-111 in deep interdiction and inclement weather interdiction roles. Production of the F-15E is scheduled for 1986 with the first delivery scheduled for 1988. (15) The F-15E is programmed to have an 81,000 pound takeoff weight capability, so the greater than 1 to 1 thrust to weight ratio won't apply until a lot of ordnance and fuel have been used. One by-product of the F-15E program is that it has spawned a natural baseline airframe for a follow-on Wild Weasel aircraft. McDonnell Douglas has provided an F-15 Wild Weasel proposal to the Air Force that includes a lot of the design development from the F-15E program. (16)

CONTINUED IMPROVEMENTS

McDonnell Douglas has continued to improve the F-15 throughout the production schedule. As the aircraft progressed from the "A" model to the improved "C" and "D" models in 1979, the Air Force continued improvements through the Multistage Improvement Program (MSIP) for C, D, and the new F-15E configuration. One significant improvement was the provision for Fuel and Sensor Tactical (FAST) Pack conformal fuel tanks (also known as CFTs) for the F-15. These FAST Pack

tanks, which first flew on July 27, 1974, attach to the outside of each air intake and stretch along the fuselage underneath each wing. The fuel tanks each hold an additional 4,875 pounds of fuel (about 750 US gallons). (17) Incredibly, the FAST Pack tanks add only slightly increased profile aerodynamic drag. (18) Since the AIM-7 Sparrow missile points are made inaccessible by the FAST Packs, new AIM-7 attach points are provided on the tanks. As an alternative, up to 4,400 pounds of bombs or other ordnance can be carried on other attach points on the FAST Packs. These points also are HARM compatible.

The F-15E program involves procuring 392 F-15s with the first delivery scheduled for 1988. (19) The current F-15G proposal is flexible to Air Force needs and includes the choice of either removing or retaining the 20mm gun (with fewer rounds that the regular F-15 has).

Another attractive aspect of the F-15E/F-15WW package is logistical support capabilities. The F-15E is advertised as having 96% commonality of parts by weight with the F-15 fleet already in the field. Additionally, the F-15E has 87% commonality by spare parts within the logistics system now in place. (20) While specific logistic commonality percentages for the F-15WW were not available, the F-15E statistics are logically close enough for rough estimation, with exclusion of the APR-38 threat detection system which will only be in the

Weasel F-15.

Table 7 contains the specific characteristics of the F-15WW. Figure 5, which follows Table 7, shows the ordnance loading capabilities of the F-15WW. Note that the F-15WW can carry 5 HARMs when no centerline tank is aboard. Table 8, which follows Figure 5, shows how the F-15WW compares to the Weasel standard aircraft that was established in Chapter III. The significant aspect of this Figure is that the F-15WW does not register a single 0% capability in any of the fourteen rated criteria.

TABLE 7

CHARACTERISTICS OF THE F-15WW (21)

SIZE	LENGTH	63 FT 9 IN
	WINGSPAN	42 FT 9 3/4 INCHES
	* SIZE FACTOR (22)	1107
SPEED	** MAXIMUM CLEAN	>MACH 2.5
	WITH EXTERNAL TANK	660 KNOTS MACH 2
	*** HI-LO-LO-HIGH MISSION RANGE	482 NM
SELF-PROTECTION	MISSILE STATIONS	8
	WITH ECM SUITE	8
	WITH CENTERLINE TANK	8
AGM MISSILE/BOMBS ORDNANCE STATIONS		5
CREW		2
G AVAILABILITY W/4 HARMS LOADED (ALL WEIGHTS)		+9.0
G AVAILABILITY CLEAN (ALL WEIGHTS)		+9.0
GROWTH POTENTIAL		YES

* SIZE FACTOR= $\sqrt{\text{AREA}_{\text{FRONT}}^2 + \text{AREA}_{\text{SIDE}}^2 + \text{AREA}_{\text{TOP}}^2}$

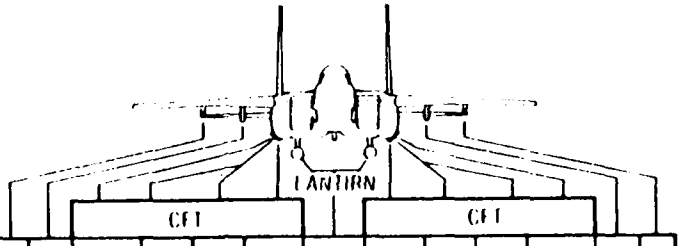
** MAXIMUM AIRSPEED WITH NO EXTERNAL STORES

*** HI-LO-LO-HI PROFILE BASED ON TAKEOFF, CLIMB TO 25,000'FROM SEA LEVEL, CRUISE AT 480 KNOTS TRUE AIRSPEED, DESCENT TO SEA LEVEL, CRUISE AT 540 KNOTS TRUE AIRSPEED FOR 50NM, 20 MINUTE LOITER IN TARGET AREA, EGRESS 50 NM AT 540 KNOTS TRUE AIRSPEED AT SEA LEVEL, CLIMB TO 25,000 ' TO LAND WITH AFR 60-16 REQUIRED 20 MINUTE FUEL RESERVE AT BASE OF ORIGINATION.

FIGURE 5

F-15 Wild Weasel Weapons Loading

Tangential Carriage and BRU-26A/A Multiple Rack



Store		9	8	Outbd Row	Fwd Msl	Aft Msl	Inbd Row	5	Inbd Row	Aft Msl	Fwd Msl	Outbd Row	2	1	Quantity
Air to Air Missiles	AIM 7I				✖	✖				✖	✖				4
	AIM 9I /M		✖										✖		4
	AIM 120/A		✖		✖	✖				✖	✖		✖		8
Anti-Radiation Missile	AGM 88		•					•					•		5
	Sidearm		✖										✖		4
Dispenser Weapons	CBU 87, 89, 92														25
	MK 20														26
Guided Weapons	GBU 12B/B, C/B GBU 22/B														15
	GBU-10C/B, D/B		•					•					•		7
	GBU 24/B		•					•					•		5
	GBU 15/AGM 130		•					Data Link					•		2
	AGM 65A/B/D on LAU 88														6
External Fuel	610 Gal Tank		•					•					•		3

TABLE 8: F-15WW AIRCRAFT ANALYSIS

CRITERIA	STANDARD	F-15WW	% CAPABILITY OF STANDARD	WEIGHT FACTOR *
SPEED CRUISE	540	540	100%	4
DASH	SUPERSONIC	SUPERSONIC	100%	4
RANGE (NM)/STATION TIME	500/20 MIN	450/20 MIN	90%	5
SELF-PROTECTION				
ALL-ASPECT MISSILES	4	6	150%	5
INTERNAL GUN/ECM SUITE	YES/YES	**YES/YES	100/100%	3
AUTOMATIC ECM SUITE	YES	AUTO/MANUAL	100%	4
AUTOMATIC CHAFF/FLARES	YES	AUTO/MANUAL	100%	4
AGM MISSILE/BOMB STATIONS AVAILABLE	4	5	120%	5
MISSILE/BOMB STATIONS AVAILABLE WITH ECM POD, CHAFF & FLARES & TANK LOADED	4	4	100%	5
CREW	2	2	100%	5
G AVAILABILITY WITH 4 HARMS LOADED (WEIGHT NOT A FACTOR)	+7.0	+9.0	129%	4
G AVAILABILITY WITH NO HARMS LOADED (WEIGHT NOT A FACTOR)	+9.0	+9.0	100%	4
GROWTH POTENTIAL	YES	YES	100%	3
SIZE FACTOR	N/A	1107	N/A	2

*Established by the poll: 1= unimportant, 5= very important
**design flexible based on Air Force desires to include or exclude 20 mm internal gun. ECM pod, or "suite" is internal in both cases.

DISCUSSION

The F-15WW can accomodate a 540 knot cruise ingress at sea level easily. In comparison to the F-4G's consumption of 11% of total fuel during ingress, the F-15WW will consume only 9%. The F-15WW's fuel efficient turbofan engines allow impressive cruise speeds and conservative fuel flow rates.

A twenty minute station time a sea level still allows the F-15WW to penetrate in excess of 450NM (combat radius) with the standard configuration (includes FAST Packs and centerline tank). As compared to the F-4G, which has a 35% capability of the poll's range desires, the F-15WW rises to at least a 90% capability rating, an impressive improvement but still short of the Weasel community's goal.

The self- protection capabilities of the F-15WW are formidable. Since the functions of the F-4G ECM pod will be provided internal to the F-15WW, no AIM-7 stations are lost as was the case with the F-4G. HARM carriage on the CFTs, or FAST pack tanks, however, will preclude carrying Aim-7 missiles on those attach points. The heart of the F-15WW's defensive systems is the APG-70 radar. This radar would solve the F-4G's radar detection range problem discussed in a previous chapter. The APG-70 can detect radar targets (enemy fighters) in excess of 90 miles, thus allowing the Weasel pilot up to 11.3 minutes (at 480 knots and no closing velocity) to change his attack plans if MIGs are detected in

his working area. (23) Another outstanding capability of the F-15WW's APG-70 radar is its ability to get information on emitters from the APR-38. Once the APG-70 is locked onto the emitter, the location of the emitter can still be handed off to anti-radiation missiles, even if the transmitter is subsequently turned off. As a result, the enemy is still in big trouble even if he goes "off the air."

The F-15 employs the latest AIM-7 missiles, the AIM-7F and the AIM-7M, which is an improved Sparrow missile. The success of the F-15 platform in an air-to-air role has been measured by the Israeli Air Force for the US: Their F-15s attained 56 kills on various Soviet fighters, including three MIG-25 Foxbats, with no F-15 losses. (24)

While present production F-15s carry 940 rounds of 20mm, the F-15E will carry less due to ECM equipment taking up room that the ammunition drum occupied. If the Air Force decides to buy the F-15WW equipped with the 20mm internal gun, it also will have less than 940 rounds available.

If the Air Force buys the AIM-120 AMRAAM air-to-air missile, it will be 100% compatible with the F-15WW, and can be carried in similar numbers to the AIM-7F.

The chaff and flares system on the F-15WW will combine the best of both worlds: In addition to the pilot's capability to manually dispense chaff and flares, he can also direct the ECM suite to dispense them when the suite deems

chaff or flares is necessary. Another mode is available where the ECM suite detects a threat, and asks the pilot's permission to dispense chaff. After the suite displays the threat to the pilot, if the pilot concurs, the suite then dispenses chaff. The ECM suite, of course, also has a totally automatic mode where it electronically jams threats whenever it feels the aircraft is in danger. These features in the self-protection systems in the F-15WW are exactly what the Weasel community indicated a desire for in the poll discussed in chapter III.

The F-15WW is capable of carrying bombs on five different stations. When carrying HARMs, without a centerline tank, the F-15WW can carry a total of five. When the centerline tank is added, the HARM load is reduced to four, but approximately 80NM of combat radius is added to the Hi-Lo-Lo-Hi mission profile. (25).

The F-15WW is capable of +9.0 G at all operating weights (the F-15E will be certified to a gross takeoff weight of 81,000 pounds, and has an ordnance capability of 24,500 pounds). (26) G availability, as concerns the F-4G crew in the target area, will not be a factor to the F-15WW crew because they do not have to jettison/fire ordnance or reduce fuel weight to utilize their 9 G's available.

The F-15WW is a large fighter by anybody's standards. While it does not have stealth characteristics, it's size is

very detrimental to mission success in one aspect: Both enemy AAA/SAM gunners and enemy pilots will gain visual acquisition easier because of its large size factor. The poll, however, established that large size was a relatively unimportant characteristic in the overall accomplishment of the Wild Weasel mission.

One explanation for the poll's lack of concern over an increase in size for the Wild Weasel aircraft might be due to the changes that technology is providing to evolving Weasel tactics. While it was once required to overfly a visually acquired target to drop bombs accurately enough to insure its destruction, standoff tactics are becoming more and more feasible with computer-assisted deliveries. Long-range loft, once considered grossly inaccurate, is becoming more viable via on-board computers. With the advent and advances of anti-radiation missiles, stand-off out-of-SAM/AAA-range attacks may soon be an exclusive Weasel tactic. While size *may become* totally insignificant in the suppression business against ground targets, it will probably never become insignificant against air-to-air threats.

ANALYSIS

The F-15WW would be a formidable threat in the Wild Weasel mission. For the 1990's scenario, it only falls short in one of the fourteen criteria (see Table 8) established by

the poll, and achieves a 90% capability in that criterian.

The F-15WW's ability to dispense chaff and flares automatically with the ECM suite is a quantum leap into the future. It satisfies 100% of the poll's desires in that area and is the only aircraft of the three considered with that capability. Automatic chaff and flares dispensing becomes increasingly important especially because of the F-15's large size, and therefore higher susceptability to sustaining hits in the target area without such protection.

THE F-16WW

The Air Force began concept-formulation studies for a new high technology fighter as early as 1965. The Advanced Day Fighter (ADF) was originally specified to be superior to the MIG-21 Fishbed in both thrust-to-weight ratio and in turning capabilities. (27) When the MIG-25 Foxbat appeared, the Air Force changed their fighter procurement plans and the Lightweight Fighter (LWF) evolved.

The LWF was specified to fight in a regime the Air force deemed as the combat arena of the future - from 30,000 to 40,000 feet of altitude, and speeds of .6 to 1.6 Mach. General Dynamics Corporation submitted the YF-16 proposal while Northrop Corporation submitted the YF-17 plans for competition for the LWF role.

Both General Dynamics and Northrop utilized similar design characteristics: Both used moderately swept wings, and had wing roots with long extensions. This design allows excellent air flow over the aircraft's wings even at extremely high angles of attack, thus providing superb manueverability in all regimes of flight. (28)

Another radical innovation in the F-16 design is intentional center-of-gravity instability. In aircraft, the closer the center-of-gravity and the center-of-lift in the wings get, the more longitudinally unstable the aircraft

becomes. Although stability suffers, maneuverability substantially increases. To "tame" the F-16's "unstableness", General Dynamics designed a full-time fly-by-wire stability augmentation and flight control system. (29) As a result, pilot inputs are processed by computers and translated into flight control movements. One by-product of this fly-by-wire system is the potential to prevent any aircraft over-G situations by instructing the computer to not deliver any more G than the aircraft can withstand, regardless of how bad the pilot wants to turn. In short, the aircraft cannot be over-G'ed in some computer modes because the computers simply won't allow it.

Logistically, the F-16 was attractive because it uses the same F-100 turbofan engine as the F-15. Again, the F-100 provides enough thrust to exceed a 1 to 1 thrust-to-weight ratio and allows the F-16 to accelerate going straight up in some regimes.

The F-16 first flew on January 24, 1974, only 22 months after General Dynamics received the contract. (30) The YF-16 was selected over the YF-17 for the LWF role, and full scale production began almost immediately. Additionally, many foreign sales contracts began about the same time period, and Israel, Egypt, Pakistan, Venezuela and Korea all placed orders for export model F-16s.

At Red Flag Exercises at Nellis Air Force Base, Nevada,

the F-16 is routinely utilized in a multi-role fashion. It is common for them to ingress to the target area as a strike or attac asset, and then "swing" into an air-to-air role after they release their bombs. The aircraft's AIM-9 missiles and 20mm gun give it an all-aspect and close-in dogfight capability that makes it well-suited for this role.

On July 7, 1981, the Israeli Air Force demonstrated the precision bombing capabilities of the F-16. On that date, they utilized 8 F-16s to destroy the Osirak nuclear reactor that was under construction near Baghdad, Iraq. (31) That raid underscored the navigation, surgical bombing, and range capabilities of this remarkable aircraft.

CONTINUED IMPROVEMENTS

The USAF plans to include an ASPJ (Airborne Self Protection Jammer) system in F-16 aircraft beginning in 1986. (32) The ASPJ system should have similar characteristics to the self protection ECM suite in the F-15WW, and will allow the ASPJ F-16WW to fly with three external fuel tanks. Whether the USAF would elect to modify these new aircraft or older existing ones cannot be determined, so both the two and three tank F-16WW aircraft configurations will be examined.

Table 9 contains the specific characteristics of the F-16. Figure 6, which follows Table 9, shows the ordnance

loading capabilities of the F-16 and where each type of ordnance can be carried on the aircraft. Tables 10 and 11, which follow Figure 6, show how the F-16 and the F-16 (ASPJ) compare to the Weasel standard aircraft established in chapter III. Notice that the F-16WW registers a 0% capability in three of the fourteen criteria, while the ASPJ F-16WW only has two 0% capability criteria areas.

TABLE 9 (33)

CHARACTERISTICS OF THE F-16 WILD WEASEL PROPOSAL

SIZE	LENGTH	49 FT 6 IN
	WINGSPAN	31 FT 0 IN
	* SIZE FACTOR (34)	586
SPEED	** MAXIMUM CLEAN	>MACH 2
	WITH EXTERNAL TANKS	600 KNOTS MACH 1.6
	*** HI-LO-LO-HIGH MISSION RANGE	250 NM (A) 320 NM (B)
SELF-PROTECTION	MISSILE STATIONS	2
	WITH ECM POD	2
	WITH EXTERNAL TANK	2
	WITH EXTERNAL TANKS	2
AGM MISSILE/BOMBS ORDNANCE STATIONS		4
CREW		2
G AVAILABILITY WITH 4 HARMS LOADED @ 28,000LBS		+5.5
G AVAILABILITY CLEAN @ 28,000 LBS (2 TANKS)		+9.0
G AVAILABILITY CLEAN @ 28,000 LBS (3 TANKS)		+6.5
GROWTH POTENTIAL (WITH AIRCRAFT MODIFICATION)		**** YES

$$* \text{ SIZE FACTOR} = \sqrt{\text{AREA}_{\text{FRONT}}^2 + \text{AREA}_{\text{SIDE}}^2 + \text{AREA}_{\text{TOP}}^2}$$

** MAXIMUM AIRSPEED WITH NO EXTERNAL STORES
*** HI-LO-LO-HI PROFILE BASED ON TAKEOFF, CLIMB TO 25,000'FROM SEA LEVEL, CRUISE AT 480 KNOTS TRUE AIRSPEED, DESCENT TO SEA LEVEL, CRUISE AT 540 KNOTS TRUE AIRSPEED FOR 50NM, 20 MINUTE LOITER IN TARGET AREA, EGRESS 50 NM AT 540 KNOTS TRUE AIRSPEED AT SEA LEVEL, CLIMB TO 25,000 ' TO LAND WITH AFR 60-16 REQUIRED 20 MINUTE FUEL RESERVE AT BASE OF ORIGINATION. (A)=TWO EXTERNAL WING TANKS, (B)=3 EXTERNAL TANKS WHEN CONFIGURED WITH ASPJ (AIRBORNE SELF PROTECTION JAMMER)
**** NO GROWTH POTENTIAL EXPECTED WITH ASPJ INSTALLED

FIGURE 6

THE F-16 WILD WEASEL ORDNANCE LOAD

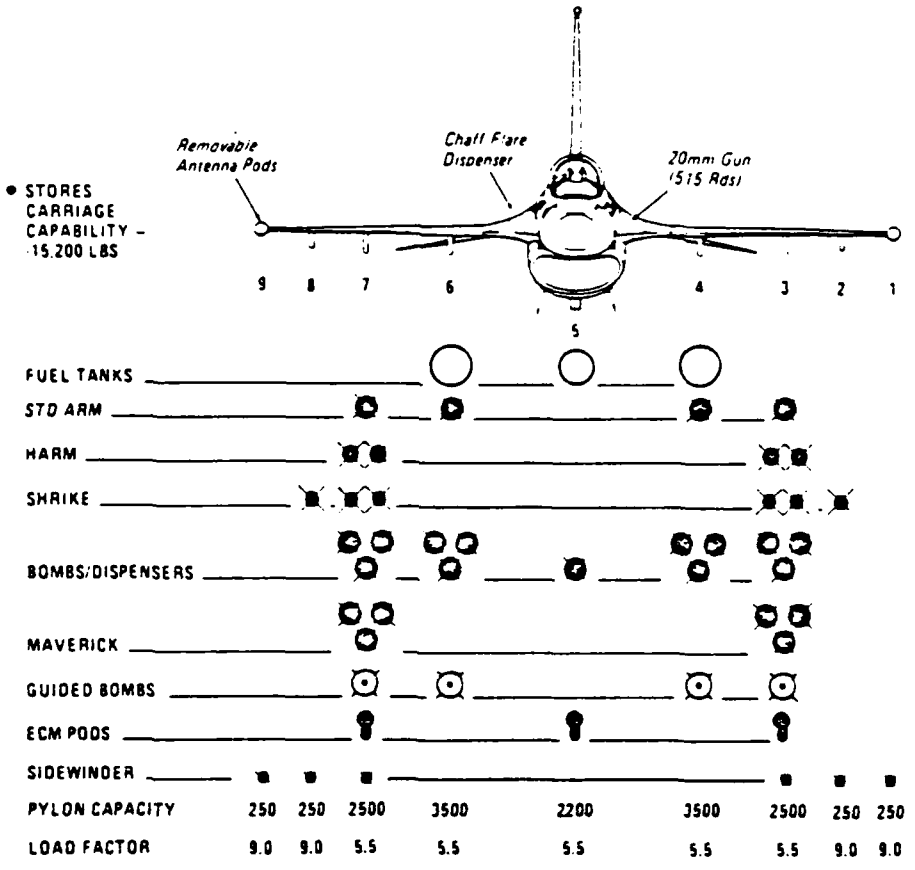


TABLE 10 : F-16 WW AIRCRAFT ANALYSIS

CRITERIA	STANDARD	F-16WW	% CAPABILITY OF STANDARD	WEIGHT FACTOR *
SPEED CRUISE	540	510	94%	4
DASH	SUPERSONIC	SUPERSONIC	100%	4
RANGE (NM)/STATION TIME	500/20 MIN	250/20 MIN	50%	5
SELF-PROTECTION				
ALL-ASPECT MISSILES	4	2	50%	5
INTERNAL GUN/ECM POD	YES/YES	YES/NO	100/0%	3
AUTOMATIC ECM POD	YES	MANUAL	0%	4
AUTOMATIC CHAFF/FLARES	YES	MANUAL	0%	4
AGM MISSILE/BOMB STATIONS AVAILABLE	4	4	100%	5
MISSILE/BOMB STATIONS AVAILABLE WITH ECM POD, CHAFF & FLARES & TANKS LOADED	4	2	50%	5
CREW	2	2	100%	5
G AVAILABILITY WITH 4 HARMS LOADED @ 28,000 LBS	+7.0	+5.5	79%	4
G AVAILABILITY WITH NO HARMS LOADED @ 28,000 LBS	+9.0	+9.0	100%	4
GROWTH POTENTIAL	YES	YES	100%	3
SIZE FACTOR	N/A	586	N/A	2

*Established by the poll: 1= unimportant, 5= very important

TABLE 11 : F-16WW (ASPJ) AIRCRAFT ANALYSIS

CRITERIA	STANDARD	F-16WW	% CAPABILITY OF STANDARD	WEIGHT FACTOR *
SPEED CRUISE	540	510	94%	4
DASH	SUPERSONIC	SUPERSONIC	100%	4
RANGE (NM)/STATION TIME	500/20 MIN	320/20 MIN	64%	5
SELF-PROTECTION				
ALL-ASPECT MISSILES	4	2	50%	5
INTERNAL GUN/ECM SUITE	YES/YES	YES/NO	100/100%	3
AUTOMATIC ECM SUITE	YES	MANUAL	100%**	4
AUTOMATIC CHAFF/FLARES	YES	MANUAL	0%	4
AGM MISSILE/BOMB STATIONS AVAILABLE	4	4	100%	5
MISSILE/BOMB STATIONS AVAILABLE WITH ECM POD, CHAFF & FLARES & TANKS LOADED	4	2	50%	5
CREW	2	2	100%	5
G AVAILABILITY WITH 4 HARMS LOADED @ 28,000 LBS	+7.0	+5.5	79%	4
G AVAILABILITY WITH NO HARMS LOADED @ 28,000 LBS, (3 TANKS)	+9.0	+6.5	72%	4
GROWTH POTENTIAL	YES	NO	0% (35)	3
SIZE FACTOR	N/A	586	N/A	2

340NM=F-16 with 3 external tanks and ASPJ internal jammer installed
*Established by the poll: 1= unimportant, 5= very important
**ASPJ F-16 has internal automatic ECM "pod", or "suite"

DISCUSSION

The F-16WW cannot fly at 540 knots in military power at sea level with the standard Weasel ordnance load due to aerodynamic drag. According to the F-16 flight manual, the highest speed the F-16WW can attain in military power, at sea level, in this configuration, is 510 knots. It should be noted that the F-16WW could attain 540 knots by utilizing afterburner, but that the aircraft's range would be reduced with the increased fuel flow that afterburner utilization causes. As was the case with the F-15WW, the F-16WW's F-100 powerplant provides high speeds with a minimum of fuel consumption with low aerodynamic drag configurations. The ingress phase of the standard Weasel profile consumes 9.6% of total fuel with two external tanks loaded, and 8.2% with 3 external tanks loaded. This compares favorably to the F-4G's 11% figure and the F-15WW's 9% figure.

The twenty minute station time at 450 knots restricts the F-16WW to approximately a 250NM combat radius with two external tanks. This range only satisfies 50% of the poll's desired range goal. The 250NM range represents only a 43% increase in range over the F-4G and is 44% less than the F-15WW's capability.

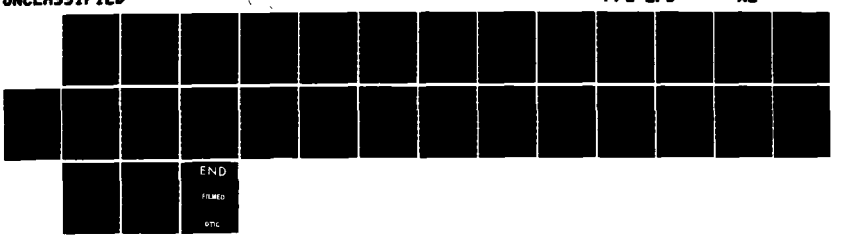
With three external tanks and an ASPJ modified aircraft, the F-16WW's range jumps out to 320NM. This figure represents a 82% increase over the F-4G's capability, but is only 71% of

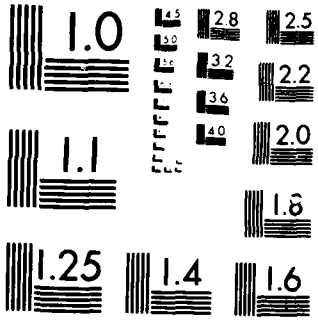
the F-15WW's capability.

Several configurations should be discussed for the F-16WW. With two external tanks, and the ECM pod loaded on the centerline station, the aircraft meets 100% of the AGM missile requirements, and meets 50% of the range requirements. If the ECM pod is moved to the wing, the HARM load drops to 50% from 100%, and range drops to less than 50% (assuming the aircraft could fly assymetrically with only one wing tank). If only a centerline tank is carried on the F-16WW, the ECM pod must be carried on the wing. This configuration dictates that only two HARMs can be carried, thereby reducing both range and ordnance load. In a one wing tank configuration, if HARMs could somehow be mounted on the centerline station, the HARM load would rise back to 100%, but range would remain at less than 50% with a resultant net decrease in effectiveness with this load in all cases (unless all self protection AIM-9s were downloaded and HARMs somehow were loaded on the outboard pylons, stations 2 and 8). Richardson's book F-16 depicts a HARM/SHRIKE capability on station 2 or 8, with no supporting prose to explain that capability. Major Huff's "The F-16 Wild Weasel: A Feasibility Study" depicts Shrike compatibility on stations 2 and 8, but specifically excludes depicting a HARM capability there. Assuming a HARM could be loaded on station 2 or 8, with either a two tank or three tank configuration, the missile/bomb stations capability would rise to 150% in the

AD-A164 727 WHAT USAF AIRCRAFT SHOULD BE THE WILD WEASEL OF THE 1990'S?: AN ASSESSMEN..(U) ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS M J WEITZEL 07 JUN 85 2/2

UNCLASSIFIED F/G 1/3 NL





analysis section, while the self-protection all-aspect missile capability would fall to zero. Since both criteria have a weight factor of 5, a zero gain/loss is achieved by assuming more HARM station capability on 2 and 8 because the F-16WW becomes defenseless except for the 20mm gun. This seems an unlikely prospect given the threat the Wild Weasel of 1990 will face, so only a four HARM F-16WW configuration option will be addressed further.

The F-16WW is very capable in self-protection assets. While its 2 AIM-9 missiles have a shorter range than the AIM-7 radar type, they are all-aspect and extremely reliable. Although the F-16WW has six stations that are AIM-9 compatible, the wingtip stations will be loaded with antenna pods on the F-16 Weasel model, and the middle pylons will be loaded with HARMs. This leaves stations 2 and 8 to carry AIM-9s, giving a maximum AIM-9 load of 2. Additionally, the F-16WW is AIM-120 AMRAAM compatible, and that missile could be loaded on the F-16 Weasel as a mix with or total replacement for its 2 AIM-9s.

The 20mm gun in the F-16WW provides the same close-in dogfight capabilities that the F-15 has. Currently, the F-16 carries 510 rounds of ammunition. Any possible reduction in rounds for the Wild Weasel proposal is unknown.

The APG-66 radar on the F-16WW is an extremely capable radar that can detect MIG-25 size targets at 50 miles. (36)

The radar utilizes new radar technology and incorporates a "flat plate" planar array antenna. (37) Also, the radar is one of the smallest in the world with such high performance characteristics.

The chaff and flares system currently utilized in the F-16WW is the ALE-40 (same as in the F-4G). The chaff and flares themselves are carried internally below the horizontal stabilizer. Like the F-4, the system can be initiated by either crewmember. While the system is a capable one, it suffers from a limited number of chaff and flares that can be carried, in addition to the requirement for manual initiation. The system has no automatic tie-in with the ECM pod, and therefore does not meet the desired criteria outlined by the Weasel poll.

ASPJ modified F-16's will have a significantly improved jamming system that should greatly increase the aircraft's survivability. The only drawback to the system is that it appears too expensive to retrofit on older aircraft and requires modification of the aircraft structure. It is unknown whether the USAF would opt to build ASPJ F-16 Wild Weasels or utilize older models of the F-16. The ASPJ system itself satisfies the Weasel poll's desire for totally automatic jamming, with minimal inputs.

The F-16WW has a total of nine ordnance stations. The wingtip stations carry only AIM-9 missiles or radar-detection

pods for the proposed Wild Weasel version. The outboard pylons are also only stressed for AIM-9 weight missiles, but will also accomodate the AIM-120 AMRAAM missiles. The middle and inboard wing pylons are stressed to carry the heaviest ordnance that the F-16WW can deliver. In a two-tank configuration, with the ECM pod located on the centerline station, the F-16WW can carry six Mark 82 500 pound general purpose bombs to the target area. When configured with only a centerline tank, or with three external tanks, the maximum Mark 82 500 pound general purpose bomb load remains at six, thereby making it logical to carry two or three external tanks (ASPJ only) to extend the aircraft's range.

The F-16WW's bomb delivery systems are unparalled in accuracy. The aircraft's reputation for pinpoint, surgical bombing has resulted in their "aimdot" for bomb placement being nicknamed as the "deathdot". Wherever the pilot puts his "deathdot", the computer is so good it can usually render a "shack" or pinpoint hit regardless of the aircraft's flight parameters.

At a nominal weight of 28,000 pounds, (weight expected in the target area), configured with two external tanks, the F-16 is capable of +5.5 G of manuevering until the ordnance aboard is delivered. At that time, the G availability jumps to +9.0. If the aircraft were configured with one centerline tank, and the ECM pod is moved to the wing, the aircraft's G

restrictions remain the same, although the HARM carrying load capacity is reduced by 50%.

At a weight of 28,000 pounds with an ASPJ modified F-16WW, the aircraft is capable of +5.5 Gs until the ordnance aboard is delivered. At that time, the G availability only rises to +6.5 based on the 3 tank manueverability restrictions for that configuration.

The size of the F-16WW is one of it's most attractive features. From an angle, the aircraft is only 60% of the size of the F-4. (38) The smaller size complicates enemy radar detection, visual acquisition, and enemy probability of hit problems significantly. One study that assessed the Southeast Asia 23mm AAA threat concluded that an F-4 is four times more likely to be shot down than an F-16 based on size and ability to sustain more direct hits and remain airborne. (39)

ANALYSIS

The F-16WW could perform the Wild Weasel mission of the 1990's more effectively than the F-4G, but less effectively than the F-15WW. The aircraft measures short of the poll's desired characteristics in 6 out of the fourteen areas. The most critical area, as was the case with the F-4G, is range/endurance. With either the one or two tank configuration, the aircraft outperforms the F-4G, but falls a full 44% behind the F-15WW in range. With the ASPJ F-16WW and

three external tanks, the aircraft's range extends to 320NM, only 29% less than the F-15WW's capability.

AIRCRAFT COMPARISON

Table 12 contains the Aircraft Comparison Payoff Matrix where all three aircraft are quantitatively compared. The percentage of capability that each aircraft achieved in relation to the Weasel standard established in Chapter III is utilized as a raw data score to compare the aircraft. Each category of raw data is multiplied by the weight factor, or how important the poll determined each characteristic to be to the successful completion of the Wild Weasel suppression mission. The resultant number of this multiplication process is called payoff utility points. These points are simply a measure of utility, or a measure of return in total aircraft performance that the USAF would receive from each different aircraft.

While table 12 compares the three aircraft with the F-16 in the two external tank configuration, table 13 will compare the aircraft again, but will compare the F-16 in the proposed ASPJ and three external tank configuration. The total points appear for each aircraft at the bottom of each column.

The reader should remember that the "importance" factor, or weight factor, was established for each criteria by the Wild Weasel poll. The weight factor ranges from one to five,

with one being unimportant and five being very important. This "weighting" action is commonly found in Department of Defense decision-making, and is used in this thesis to favor the criteria that the poll considered essential to completing the Weasel mission. Thus a 0% capability in a criteria "weighted" as a 4 does not hurt an aircraft's total score in utility points as much as a 0% capability in a criteria "weighted" as a 5.

The disparity in the total payoff utility points in Tables 12 and 13 are a direct result of the "weighting" action discussed above. As previously mentioned, the F-15WW has no 0% capability scores in any of the fourteen criteria, which accounts for 1,100 points of the F-15WW's lead over the 2 tank F-16WW, and 700 points of it's lead over the ASPJ F-16WW. The rest of the F-15WW's lead in payoff utility points are a direct result of overall superior performance in the remaining criteria established by the Wild Weasel poll.

TABLE 12: AIRCRAFT COMPARISON PAYOFF MATRIX

AIRCRAFT		F-4G		F-15WW		F-16WW 2 TANKS	
DATA SCORE / CRITERIA	WT. FACTOR	RAW DATA	UTILITY POINTS	RAW DATA	UTILITY POINTS	RAW DATA	UTILITY POINTS
SPEED — CRUISE	4	100	400	100	400	94	376
SPEED — DASH	4	100	400	100	400	100	400
RANGE/20 MIN LOITER	5	35	175	90	450	50	250
PROTECTION — ALL-ASPECT MISSILES	5	75	375	150	750	50	250
PROTECTION — INTERNAL GUN/ECM POD	3	0/0	0/0	100/100	300/300	100/ 0	300/ 0
PROTECTION — AUTOMATIC ECM POD	4	0	0	100	400	0	0
PROTECTION — AUTO CHAFF/FLARES	4	0	0	100	400	0	0
AGM MISSILE/BOMB STATIONS AVAILABLE	5	100	500	120	600	100	500
MISSILE/BOMB STATIONS AVAILABLE WITH ECM POD CHAFF & FLARES LOADED	5	100	500	100	500	50	250
CREW	5	100	500	100	500	100	500
G AVAILABILITY WITH 4 HARMS LOADED AT 20 MIN LOITER WEIGHT	4	69	276	129	516	79	316
G AVAILABILITY WITH NO HARMS LOADED AT 20 MIN LOITER WEIGHT	4	77	308	100	400	100	400
GROWTH POTENTIAL	3	0	0	100	300	100	300
TOTAL PAYOFF UTILITY POINTS		F-4G = 3,434		F-15WW= 6,216		F-16WW= 3842	

TABLE 13: AIRCRAFT COMPARISON PAYOFF MATRIX

AIRCRAFT		F-46		F-15MM		F-16MM (ASPJ) 3 TANKS	
DATA SCORE / CRITERIA	WT. FAC-TOR	RAW DATA	UTILITY POINTS	RAW DATA	UTILITY POINTS	RAW DATA	UTILITY POINTS
SPEED — CRUISE	4	100	400	100	400	94	376
SPEED — DASH	4	100	400	100	400	100	400
RANGE/20 MIN LOITER	5	35	175	90	450	64	320
PROTECTION — ALL-ASPECT MISSILES	5	75	375	150	750	50	250
PROTECTION — INTERNAL GUN/ECM POD	3	0/0	0/0	100/100	300/300	100/100	300/300
PROTECTION — AUTOMATIC ECM POD	4	0	0	100	400	100	400
PROTECTION — AUTO CHAFF/FLARES	4	0	0	100	400	0	0
AGM MISSILE/BOMB STATIONS AVAILABLE	5	100	500	120	600	100	500
MISSILE/BOMB STATIONS AVAILABLE WITH ECM POD (OR ASPJ AND EXT TANKS)	5	100	500	100	500	50	250
CREW	5	100	500	100	500	100	500
G AVAILABILITY WITH 4 HARMS LOADED AT 20 MIN LOITER WEIGHT	4	69	276	129	516	79	316
G AVAILABILITY WITH NO HARMS LOADED AT 20 MIN LOITER WEIGHT	4	77	308	100	400	72	288
GROWTH POTENTIAL	3	0	0	100	300	0	0
TOTAL PAYOFF UTILITY POINTS		F46 = 3,434		F-15MM = 6,216		F-16MM = 4,200	

AIRCRAFT COMPARISON PAYOFF MATRIX ANALYSIS

In the major area of speed, two of the three aircraft were awarded the maximum payoff utility points. Although all the aircraft are capable of achieving the poll's performance desires, the fuel consumption rates in relation to total fuel carried varied significantly between the aircraft. The F-15WW uses the least fuel in proportion to total fuel carried for most of the flight events in the standard scenario outlined in chapter III.

The Range/20 minute loiter criteria area shows the F-15WW as the most capable. Its 90% capability of meeting the poll's 500NM desired combat radius is superior to the F-4G and F-16WW's performance by 55% and 22% respectively.

The self-protection area is again won by the F-15WW. The ASPJ model F-16WW is competitive with it's internal automatic ECM pod, or ECM "suite" as it is sometimes called, but still lacks automatic chaff and flares dispensing modes. Both the F-15WW and ASPJ F-16WW meet the poll's internal gun and internal ECM suite requirements, which the F-4G does not. In the area of self-protection all-aspect missiles, the F-15WW is clearly superior with its carrying capacity of six self-protection missiles. Four of these all-aspect missiles could be downloaded to carry SIDEARM anti-radiation missiles,

thus increasing the maximum F-15WW anti-radiation missile load to nine (five HARMS and four SIDEARMS).

G availability with HARMs loaded, as measured at combat weight, was another criteria where the F-15WW excelled. The F-15WW exceeded the poll's desires by 29% with it's 9G capability. In comparison, the F-4 only meet 67% of the poll's desires, with the 2 tank F-16WW registering slightly better at a 79% capability. The 3 tank ASPJ F-16WW only demonstrates a 67% capability in this criteria.

When comparing G capabilities with no HARMs aboard, the F-15WW and 2 tank F-16WW configurations were equal at 100% capability of the poll's desires. Both aircraft exceed the F-4's 77% capability in this area. Ironically, both the F-4G and F-15WW exceed the ASPJ 3 tank configured F-16WW's 72% capability due to the 3 tank F-16's maneuverability restrictions in this configuration. If the ASPJ model F-16WW were only flown with two tanks, it's G capability with no HARMs aboard would rise 28%, but it's range capability would fall by 14%. Since range rated a 5 in importance, this would reduce the ASPJ F-16WW's raw data score by 70 points. The G availability with no HARMs aboard is rated as a 4 in importance and would therefore raise the ASPJ 2 tank F-16WW by 28 points in that criteria for a total raise of 112 utility points. The sum increase of 112-70 equals 42 points and is negligible to the ultimate payoff matrix results.

In the area of growth potential, the F-15WW and the 2 tank F-16WW are tied in capability. The ASPJ F-16WW and F-4G have already had their fuselages thoroughly exploited with equipment, and have little room for additional growth.

ENDNOTES

1 E. Kozicharow. "USAF selects F-15 as Dual Role Fighter," Aviation Week and Space Tachnology, March 5, 1984, p. 18, and personal experiences at Red Flag Exercises, Nellis Air Force Base, Nevada, from 1982-1984.

2 Gowri S. Sundaram. "Modern Airborne Electronic Warfare." International Defense Review, Vol 18, No 2, 1985, p. 168.

3 Unclassified briefing given to US Army Command and General Staff College course Officers, by Randall K. bigum, Major, USAF, on 1 March, 1985, Subject: Arab-Israeli War (Yom Kippur), 1973.

4 Gunston, B. F-4 Phantom, p. 8.

5 Ibid.

6 U.S. Air Force. Technical Order 1F-4G-1 Flight Manual, 1978, pp. 1-1 through 5-22.

7 Major Byron L. Huff, USAF. "The F-16 Wild Weasel: A Feasibility Study," MMAS Thesis, US Army Command and General Staff College, Fort Leavenworth, Kansas, 1979, p. 47.

8 Telephone interview with Lt Col Gary Olin, USAF, 563rd Tactical Fighter Squadron Director of Operations, George Air Force Base, California, 18 January, 1985.

9 Michael Skinner, Red Flag: Air Combat for the 80's, p. 123, and personal experiences at Red Flag from 1981-1984.

10 U.S. Air Force. "Supporting Data for Fiscal Year 1985 Budget Estimates: Descriptive Summaries," submitted to Congress February, 1984, pp. 709-713.

11 Michael J. Gething. Modern Fighting Aircraft: F-15, 1983. p.61.

12 Ibid., p. 4.

13 Ibid., p. 10.

14 Ibid., p. 3.

15 Kozicharow, "USAF Selects F-15", p. 18.

16 Telephone interview with Mr. Harold Davies, McDonnell Douglas F-15 representative, from December 1984 through April, 1985.

17 Gething, F-15., p. 20.

18 Ibid., p. 20.

19 Kozicharow, "USAF Selects F-15", p. 18.

20 Ibid.

21 U.S. Air Force. Technical Order 1F-15A-1 Flight Manual, 1976, pp. 1-1 through 5-22.

22 Huff, "F-16 Feasibility Study," p. 47.

23 Gething, F-15., p. 31.

24 Kozicharow, "USAF Selects F-15", p. 19.

25 McDonnell Douglas, Form GP33-0922-4.

26 Kozicharow, "USAF Selects F-15", p. 18.

27 Richardson. Modern Fighting Aircraft: F-16, p. 4.

28 Ibid., p. 8.

29 Ibid.

30 Ibid., p. 9.

31 Ibid., p. 52.

32 Ibid, pg. 31.

33 U.S. Air Force. Technical Order 1F-16A-1 Flight Manual, 1981, pp.1-1 through 5-22.

34 Huff, "F-16 Feasibility Study," p. 47.

35 Major Mike Sromek, USAF. "The F-16 Evolution". USAF Fighter Weapons Review, Winter, 1984, p. 16

36 Richardson, F-16., p. 32.

37 Ibid., p. 31.

38 Huff, "F-16 Feasibility Study", p. 42.

39 Ibid., p. 43.

CHAPTER V

CONCLUSIONS, RECOMMENDATIONS FOR FUTURE STUDY, AND SUMMARY

CONCLUSIONS

The expected enemy threats for the 1990's were established through unclassified research. A poll of experienced Wild Weasel officers was conducted to determine exactly what characteristics the Wild Weasel aircraft for the 1990's should possess to meet and defeat these expected threats. Next, the F-4G, the F-15WW, and the F-16WW individual aircraft characteristics were compared to the desired characteristics extablished by the poll. Based on these comparisons, the F-15WW demonstrated superior characteristics in 7 of fourteen criteria against the ASPJ 3 tank F-16WW configuration, with the remaining 7 characteristics tied in capability. When compared against a 1 or 2 tank F-16WW configuration, the F-15WW was superior in 8 of the fourteen criteria, and tied in capability with the remaining six criteria. The F-15WW demonstrated the most capability of satisfying the Wild Weasel poll's desires, with the ASPJ 3 tank F-16WW in second place, the 1 or 2 tank F-16WW in third place, and the F-4G in last place.

This study concludes that the current F-4G Wild Weasel

aircraft should be replaced by the F-15WW to serve as the Wild Weasel aircraft for the 1990's.

RECOMMENDATIONS FOR FUTURE STUDY

This study focused on the Wild Weasel aircraft characteristics that will probably be necessary to defeat the enemy threat in the 1990's. Further studies should be initiated to determine when the F-4G should be replaced in relation to Air Force budgetary restraints. Considerations to the F-4's maintenance costs, spare parts availability, attrition of F-4G airframes, weapons system reliability, and US contingency committments should also be analyzed and related to phasing out the F-4G and phasing in the F-15WW.

As both friendly and enemy weaponry grow more sophisticated, more and more of the electromagnetic spectrum is utilized in employing these weapons. Defensive tactics and effective countermeasures to these threats should be studied before such weapons are fielded against US fighters.

Finally, because the Wild Weasel mission is often performed in small cells of 2 to 8 aircraft, methods of employing more sophisticated combat power multipliers for the Wild Weasels needs to be investigated. As previously mentioned, forward firing chaff, decoy drones, and enhanced use of the electromagnetic spectrum for defense against radar-directed threats will increase the Wild Weasel's

survivability.

SUMMARY

The Soviet Union has continued to develop and deploy an impressive, capable array of surface-to-air missiles, anti-aircraft artillery, and air superiority fighters for use in any hostilities against the United States. The Soviet systems that we face today are vastly superior to those that we faced in Vietnam, and also superior to those that the Israeli's faced in 1973.

As the battlefield becomes increasingly dense and lethal with radar-directed threats, the USAF can counter these threats with the use of Wild Weasel aircraft. This was proven in Vietnam when the USAF significantly reduced combat losses to radar-directed ground threats through the use of Wild Weasel aircraft.

As the current Wild Weasel aircraft, the F-4G, nears the end of the F-4's active duty life cycle, a newer, production line replacement was considered. A thorough aircraft analysis of the F-4G, F-15WW, and F-16WW aircraft was conducted to determine which aircraft was best suited to defeat the threat of the 1990's.

The analysis in this study has shown that the F-15WW possesses the best available qualities for defeating the enemy threat of the 1990's. A strong fleet of these remarkable aircraft will maximize our friendly aircraft survivability in

a hostile radar environment. This will ultimately ensure our capability to deter conventional aggression against the United States.

APPENDIX A

APPENDIX A

WILD WEASEL OPINION POLL

RATING FROM 1 TO 5: 1=NOT VERY IMPORTANT, 5=VERY IMPORTANT

1. How important is smaller size to the successful completion of the Wild Weasel mission?

2. How important is speed to the successful completion of the Wild Weasel mission?

   a. What cruise speed should the Wild Weasel of the 1990s be capable of?

   b. What dash speed should the Wild Weasel of the 1990s be capable of?

3. How important is self-protection capabilities to the next Wild Weasel?

   a. What type/how many self-protection missiles should the aircraft have?

   b. Should the Wild Weasel of the 1990s have an internal gun, external gun, or no gun?

   c. If the Wild Weasel needs a gun, what caliber would be appropriate?

4. Is it essential for the Wild Weasel to carry an ECM system, whether internal or external?

   a. Is it acceptable to lose a weapons station or missile station to carry an ECM system?

   b. Should the ECM system be internal to the aircraft?

c. How important is it for the ECM system to be totally automatic?

d. Should the ECM system be capable of dispensing chaff automatically also?

4. How many Wild Weasel munition weapons stations should the aircraft have?

a. How many Wild Weasel munitions weapons stations should remain if one is used to carry an external ECM pod?

5. With the aid of electronic wizardry, could the Wild Weasel mission of the 1990s be accomplished by a pilot alone?

6. How important is maneuverability for the Wild Weasel of the 1990s?

a. How many Gs should the aircraft be capable of pulling with 4 anti-radiation missiles aboard?

b. How many Gs should the aircraft be capable of pulling with no anti-radiation missiles aboard?

c. With ordnance aboard, roughly how many Gs do you think you will need to survive the threat of the 1990s?

7. What typical profile should the ideal Wild Weasel aircraft of the 1990s be designed to meet? (Include combat unrefueled radius, altitudes, and combat load).

8. After the ingress in the previous profile, how much

loiter/station time should the next Wild Weasel aircraft have?

9. Is the APR-38, with the Performance Update Program installed, a good enough system through the 1990s?

10. What characteristics would you like to see incorporated in the next Wild Weasel aircraft if it were designed from the ground up?

RANGE OF ANSWERS FROM THE WILD WEASEL POLL

1. 95% of the officers polled said that the Wild Weasel of the 1990's could be larger than the F-4G and would suffer no mission degredation as a result of the larger size. 5% of the poll said the next Wild Weasel aircraft should be smaller than the F-4G.

2. The range of recommended cruise speeds for the 1990's Weasel was from 450 knots to 750 knots. 75% of the poll recommended that the cruise speed should be 540 knots, using military power.

The range of recommended dash speeds for the 1990's Weasel was from 500 knots to supersonic. 88% of the poll recommended that the dash speed should be supersonic.

3. 100% of the poll recommended that the 1990's Weasel carry a minimum of 4 all-aspect self-protection missiles.

a. 38% of the poll said that the 1990's Weasel did not need to carry/have any type of a gun, while 62% said that the

aircraft should carry an internal gun. 95% of the "yes" respondents for an internal gun recommended that it be a 20mm gun, while 5% recommended that it should be a 30mm gun.

4. 100% of the poll recommended that the 1990's Weasel should have an ECM system. 86% of the poll recommended that the ECM system should be internal.

5. 100% of the poll recommended that the 1990's Weasel should be a two crewmember aircraft.

6. The range of recommendations for G availability with 4 HARMs aboard ranged from 5Gs to 10Gs. 88% of the poll recommended that the minimum G with missiles aboard should be 7Gs.

The range of recommendations for G availability with no HARMs aboard ranged from 7Gs to 10Gs. 75% of the poll recommended that the minimum G with no missiles aboard should be 9 Gs.

7. 93% of the poll recommended that the 1990's Weasel should have at least 4 AGM Missile/bomb stations, while 7% recommended that the aircraft should have 6 stations.

100% of the poll recommended that the 1990's Weasel should carry an ideal minimum load of 4 anti-radiation missiles, preferably a follow-on advanced HARM-type missile.

The range of recommendations for range/station time are as follows:

a. The range of recommendations for range was from 300NM to 1000NM. 75% of the poll recommended that the Weasel have a range of at least 500NM.

8. The range of recommendations for station time was from five minutes to over one hour. 90% of the poll recommended that the station time be a minimum of 20 minutes.

9. The characteristics of the F-4G PUP program are discussed in the F-4G section of Chapter IV. The PUP's effectiveness, however, may be classified and will not be discussed here.

10. 100% of the poll recommended that the Weasel aircraft for the 1990's should have internal fuselage room to incorporate future technology as it becomes available. A complete list of suggestions for the Weasel of the 1990's is in Chapter IV.

BIBLIOGRAPHY

BIBLIOGRAPHY

PERIODICALS

Kozicharow, E. "USAF Selects F-15 as Dual Role Fighter," Aviation Week and Space Technology, March 5, 1984.

Robinson, C. A. "Defense Dept Backs F-4 Upgrade Program," Aviation Week and Space Technology, 8 January 1984.

Robinson, C. A. "Soviets Deploying New Fighters," Aviation Week and Space Technology, 28 November, 1983.

Ropelewski, R. R. "F-15 Fighter Abilities Evaluated," Aviation Week and Space Technology, 26 April, 1982.

"Soviets Reshape Structure for Air Attack, Defense," Aviation Week and Space Technology, 4 April, 1983.

Sweetman, B. "F-4G Wild Weasel," International Defense Review, no. 16 (1983).

Sundaram, Gowri S. "Modern Airborne Electronic Warfare," International Defense Review, Vol 18, No 2, 1985.

Taylor, J. W. "Gallery of Soviet Aerospace Weapons," Air Force Magazine, March, 1983.

Taylor, J. W. "Gallery of USAF Weapons," Air Force Magazine, May, 1983.

"Wild Weasels Prepare to fly the F-4G," Defense Electronics, X (January, 1978).

GOVERNMENT PUBLICATIONS

U.S. Defense Intelligence Agency. "Warsaw Pact Ground Forces Equipment Identification Guide: Artillery, Rockets, and Missiles," February, 1982.

U.S. Air Force. "Supporting Data for Fiscal Year 1985 Budget Estimates: Descriptive Summaries," submitted to Congress February,1984.

U.S. Air Force. Technical Order 1F-4G-1 Flight Manual. Washington, D.C., 1 October 1977.

U.S. Air Force. Technical Order 1F-15A-1 Flight Manual. Washington, D.C., H15 January, 1984.

U.S. Air Force. Technical Order 1F-16A-1 Flight Manual. Washington, D.C., 9 October, 1981.

U.S. Department of Defense. "Soviet Military Power, 1984," April, 1984.

FC 100-181. U.S. Air Force Basic Data. Fort Leavenworth, Kansas: U.S. Army Command and General Staff College, May 1984.

Draft FM 100-2-3. Soviet Army Troops Organization and Equipment. U.S. Army Command and General Staff College, August 1982.

Hanak, Walter, Editor. Aces & Aerial Victories (The United States Air Force in Southeast Asia, 1965-1973). US Government Printing Office, 1976.

Sromek, Mike, Major, USAF. "The F-16 Evolution". USAF Fighter Weapons Review, Winter, 1984. Commandant, USAF Fighter Weapons School, 57th Fighter Weapons Wing, 1984.

UNPUBLISHED PAPERS

Huff, Byron L., Major, USAF. "The F-16 Wild Weasel: A Feasibility Study", MMAS Thesis, US Army Command and General Staff College, Fort Leavenworth, Kansas, 1979.

Krempel, Donald M., Major, USAF. "Can The Aggressors Continue To Be Effective in the F-5E?," MMAS Thesis, US Army Command And General Staff College, Fort Leavenworth, Kansas, 1984.

Rash, Richard A., Lt Col, USAF. "Electronic Combat: Making The Other Guy Die For His Country!", Research Report, Air War College, Maxwell AFB, Alabama, 1983.

Ruckert, W.C. The World's Missile Systems., 2d Edition, General Dynamics, October, 1975.

BOOKS

Anderton, D.A. The History of the U.S. Air Force. New York: Crescent Books, 1981.

Foss, Christopher F., Editor. Jane's Armour and Artillery. Jane's Publishing Co., Ltd., 1984.

DISTRIBUTION LIST

Air University Library
Maxwell Air Force Base
Alabama, 36112

Armed Forces Staff College
Norfolk, Va. 23511

Combined Arms Research Library
US Army Command and General Staff College
Fort Leavenworth, Kansas 66027

Defense Documentation Center
Cameron Station
Alexandria, Va. 22314

HQ USAF/XOE
Washington, D.C.

HQ Tactical Air Command/DOFE
Langley Air Force Base, Va. 23665

HQ Tactical Air Command/DRWF
Langley Air Force Base, Va. 23665

3rd Tactical Fighter Wing/DO (PACAF)
Clark Air Base, Philippines

37th Tactical Fighter Wing/DO (TAC)
George Air Force Base, California 92392

52d Tactical Fighter Wing/DO (USAFE)
Spandahlem Air Base, Germany

561st Tactical Fighter Squadron/CC
George Air Force Base, Ca. 92392

562d Tactical Fighter Squadron/CC
George Air Force Base, Ca. 92392

563d Tactical Fighter Squadron/CC
George Air Force Base, Ca. 92392

Colonel Lawrence R. Brehm
Senior Air Force Representative
USAF Section
US Army Command and General Staff College
Fort Leavenworth, Kansas 66027

Colonel John R. Breitlow
3221 Homer Road
P.O. Box 328
Winona, MN. 55987

Major Donald M. Krempel
USAF Section
US Army Command and General Staff College
Fort Leavenworth, Kansas 66027

END

FILMED

4-86

DTIC