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PROJECT

Contemporary
Historical
Evaluation of
Combat
Operations
REPORT

**Air-To-Air Encounters
Over North Vietnam**

1 July 1967 - 31 December 1968

30 AUGUST 1969

HQ PACAF

**Directorate, Tactical Evaluation
CHECO Division**

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Prepared by:

Lt Col Robert B. Weaver

Project CHECO 7th AF, DOAC

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PROJECT CHECO REPORTS

The counterinsurgency and unconventional warfare environment of Southeast Asia has resulted in the employment of USAF airpower to meet a multitude of requirements. The varied applications of airpower have involved the full spectrum of USAF aerospace vehicles, support equipment, and manpower. As a result, there has been an accumulation of operational data and experiences that, as a priority, must be collected, documented, and analyzed as to current and future impact upon USAF policies, concepts, and doctrine.

Fortunately, the value of collecting and documenting our SEA experiences was recognized at an early date. In 1962, Hq USAF directed CINCPACAF to establish an activity that would be primarily responsive to Air Staff requirements and direction, and would provide timely and analytical studies of USAF combat operations in SEA.

Project CHECO, an acronym for Contemporary Historical Evaluation of Combat Operations, was established to meet this Air Staff requirement. Managed by Hq PACAF, with elements at Hq 7AF and 7/13AF, Project CHECO provides a scholarly, "on-going" historical evaluation and documentation of USAF policies, concepts, and doctrine in Southeast Asia combat operations. This CHECO report is part of the overall documentation and evaluation which is being accomplished. Along with the other CHECO publications, this is an authentic source for an assessment of the effectiveness of USAF airpower in SEA.



MILTON B. ADAMS, Major General, USAF
Chief of Staff

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WARREN H. PETERSON, Colonel, USAF
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(b) 19AF(DI)	1
(c) USAFSOF(DO)	1

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(b) DPLF	1
(c) DM	1
(d) DI	1
(e) OA	1
(f) HI	1

(2) AIR FORCES

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(b) 8AF(C)	1
(c) 15AF(DOA)	1

(3) AIR DIVISIONS

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(3) AIR DIVISIONS

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2. OIN	1
(b) 62MAWg(OCXP)	1
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 - 2. PDP-P 1
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 - (a) COH 1

k. PACAF

- (1) HEADQUARTERS
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 - (e) CSH 1
 - (f) DOTECH 5
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 - (b) 7AF
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 - 2. DIXA 1
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 - (c) 17AF
 - 1. ODC 1
 - 2. OID 1
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FOREWORD

"Air-to-Air Encounters over North Vietnam, 1 July 1967 - 31 December 1968," describes and analyzes four periods of air-to-air activity before the bombing halt on 1 November 1968. It also depicts the relative strengths of United States airpower and North Vietnamese air defenses in the months which followed their struggle for air supremacy. This publication reviews briefly events before 1 July 1967, as it is a continuation of CHECO report, "Air-to-Air Encounters over North Vietnam, 1 January - 30 June 1967."

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CHAPTER I

THE U.S. WINS ROUND ONE

On 2 August 1964, North Vietnamese torpedo boats attacked the U.S. destroyer MADDUX in international waters, and two days later repeated the attack on the MADDUX and C. TURNER JOY, another U.S. destroyer, precipitating Congressional approval of the Gulf of Tonkin Resolution on 7 August 1964. The air war in the north had begun, first with FLAMING DART, then on 2 March 1965 with ROLLING THUNDER,^{1/} the costly, often controversial, 42-month operation designed to:^{2/}

- Reduce or deny economic, material, and war supporting assistance to NVN from external sources.
- Disrupt and destroy in depth those resources that contribute to the support of aggression.
- Harass, disrupt, and impede movement of men and materials to Laos and SVN.

First Air-to-Air Encounters

Russian-built North Vietnamese MIG aircraft inevitably would rise to challenge U.S. use of their airspace. The MIGs, in fact, drew first blood on 4 April 1965, when a flight of MIG-15s and MIG-17s jumped two U.S. F-105 fighter-bombers 76 miles south of Hanoi and destroyed both. The Navy was the first to retaliate on 17 June 1965, when two F-4Bs slammed Sparrow III missiles into two MIG-17s. The Air Force quickly followed: on 10 July 1965, two F-4Cs from the 45th Tactical Fighter Squadron downed two MIG-17s with Sidewinders,^{3/} the missile destined to

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be one of the Air Force's most reliable and destructive air-to-air weapons.

MIG Threat Develops

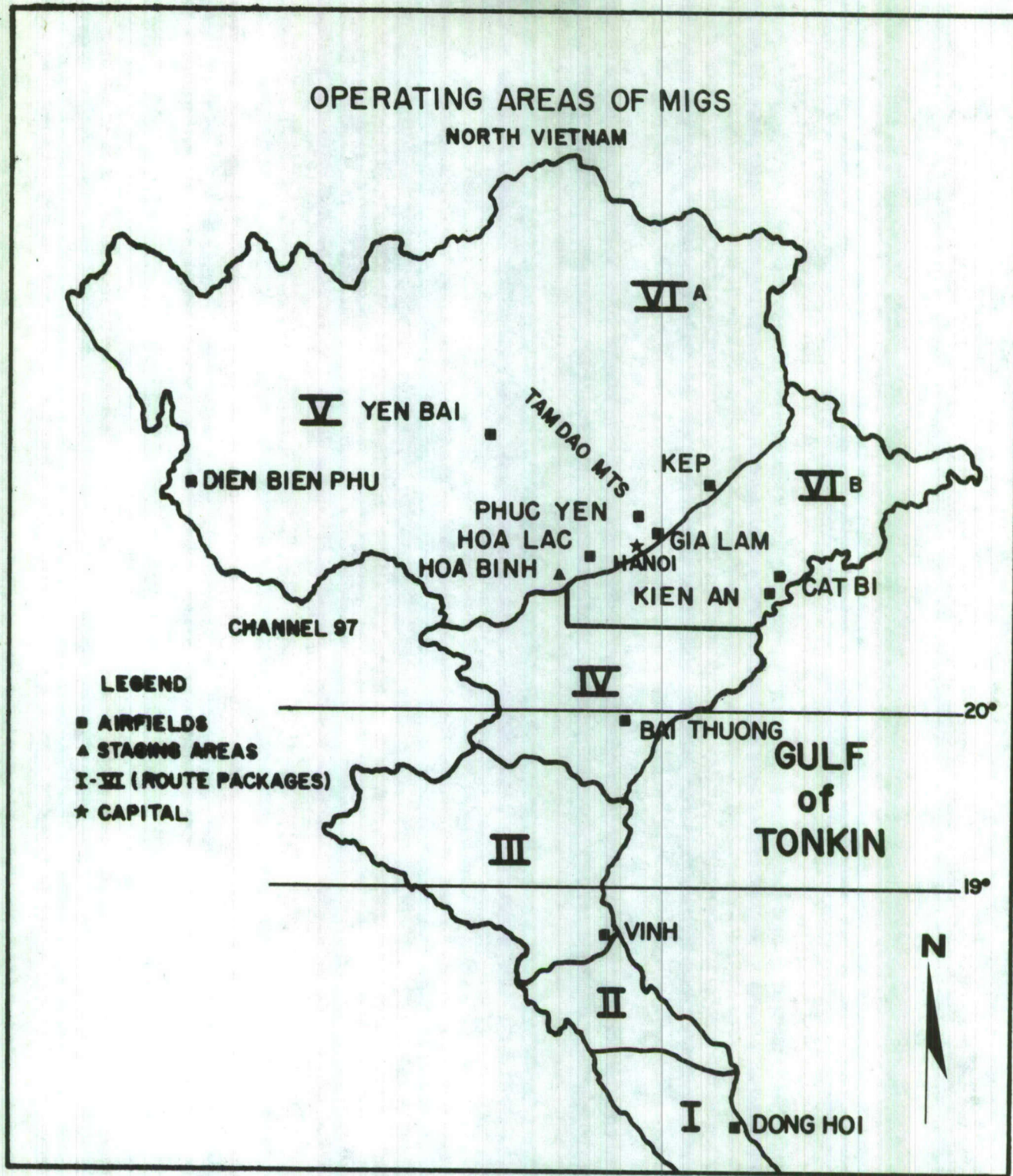
For nearly a year--until April 1966--there were sporadic encounters with MIGs but few engagements. In all, U.S. fighters shot down five MIGs, while losing four of theirs.^{4/} The MIGs were obviously in a lengthy training phase, making GCI-controlled dry firing passes, then breaking before U.S. fighters could engage.^{5/} Often, however, these maneuvers would force the U.S. strike aircraft to jettison ordnance in order to take evasive action and then attempt a counterattack. In the first ten months of 1966, 77 fighter-bombers jettisoned before reaching their targets.^{6/} At the same time, the MIGs were becoming increasingly aggressive. From April until the end of the year, the totals stood at 24 MIG kills to a U.S. loss of 9,^{7/} a favorable U.S. ratio, but a threat that clearly demanded special attention.

U.S. Counterair Operation

Prior to JCS approval in April 1967, U.S. pilots were restricted from bombing and strafing MIG airfields. The alternative was to destroy the enemy in the air. Accordingly, Col. Robin Olds, Commander of the 8th Tactical Fighter Wing at Ubon Royal Thai Air Force Base (RTAFB), Thailand, planned and led an elaborate aerial deception called Operation BOLO. On 2 January 1967, fourteen flights of F-4Cs, along with F-105 IRON HAND aircraft for flak and surface-to-air missile (SAM) suppression

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**NVN ROUTE PACKAGES
AND
KEY AIRFIELDS**

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Figure I

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and normal electronic intelligence (ELINT), electronic countermeasure (ECM), and tanker support planes, were launched to the vicinity of the MIG airfields around Hanoi. The idea was to convince the enemy that another F-105 strike sortie was coming their way. The MIGs had been reluctant to tangle with the potent F-4C, preferring the more vulnerable and heavily laden F-105 strike planes, which they probably might force to jettison ordnance. The F-4Cs adopted a typical F-105 mission profile, including similar routes, altitudes, and radio calls. The plan worked, the MIGs rose in force to meet them, and in 12 minutes seven MIG-21s were shot down with no U.S. losses.^{8/}

Stunned by the BOLD losses plus two more MIG-21s shortly after, the North Vietnamese Air Force (NVNAF) stood down to reevaluate and begin a retraining phase. This standdown, combined with consistently poor weather in February, resulted in only two engagements with no losses to either side.^{9/}

In March, the MIGs ventured forth again as the intensity of ROLLING THUNDER was increased; despite the loss of two MIG-17s to F-105s, by the end of April, they were becoming more aggressive. When further U.S. efforts to bring out the MIGs in force failed, the Joint Chiefs of Staff (JCS) approved strikes on Kep and Hoa Lac Airfields. The first occurred on 23 April, destroying nine aircraft on the ground plus three probables.^{10/} Ensuing strikes accounted for at least 20 more, although

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Bomb Damage Assessment (BDA) was uncertain.^{11/}

MIG pilots reacted adamantly, rising in force to defend the vital Hanoi-Haiphong area--designated by the U.S. forces as Route Package VI (Fig. 1). The May totals of 72 engagements with 26 NVN losses against 2 U.S. losses reflected the intensity of their effort, as well as U.S. superiority in air-to-air combat. After losing five more MIG-17s early in June, the NVNAF again stood down to take a fresh look at the situation.^{12/} In less than six months, they had lost 51 MIGs in the air and some 30 on the ground--losses equal to the most optimistic estimate of their inventory of MIGs in both NVN and Communist China.^{13/} (Fig. 2.)

So complete was the U.S. victory that Gen. William W. Momyer, Commander, Seventh Air Force, reported on 16 August 1967 to a Senate Subcommittee that "we have driven the MIGs out of the sky for all practical purposes...If he [the enemy] comes up, he will probably suffer the same fate."^{14/} The first half of his statement was recorded fact; the second, a prediction that would hold true through October 1967.

Developments in U.S. Capability

During the first six months of 1967, there were four significant developments in the U.S. capability for air-to-air combat: (1) introduction of the ECM pods; (2) equipping of the F-4 with a gun pod; (3) arrival of the new F-4D; and (4) installation in the EC-121 of the QRC-248.

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AIR-TO-AIR AND AIR-TO-GROUND ENGAGEMENTS AND LOSSES IN NVN - 1967

MONTH	ENGAGEMENTS	LOSSES		MIGS DESTROYED ON THE GROUND	
		NVN	U.S.	CERTAIN	PROBABLE
JANUARY	16	9	0	0	0
FEBRUARY	2	0	0	0	0
MARCH	6	2	0	0	0
APRIL	50	9	7	9	3
MAY	72	26	2	15	0
JUNE	25	5	0	6	6

SOURCE: ROLLING THUNDER DIGEST, EDITIONS 3, 4;
"CHRONOLOGY OF EVENTS IN SEA."

FIGURE 2

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Introduction of ECM Pods. On 24 July 1965, a flight of F-4Cs flying close formation was attacked by an SA-2. One F-4 was shot down; the other received major damage. Throughout the remainder of the year and most of 1966, the U.S. developed counter tactics--ECM/ELINT, early warning, new formations, and evasive actions--and by 1967 was again able to fly with reasonable safety in the medium altitudes.^{15/} But the SAMs kept coming, claiming a good share of the pilot's attention as he also watched for MIGs and ground checkpoints vital to target acquisition. A partial solution came with the introduction in December 1966 of the QRC 160-1 ECM pod, a barrage jammer, effective against SAM and AAA acquisition and tracking radars. Carried for the first time by F-4s during Operation BOLO, the pods (according to the 8th TFW report) "were highly reliable and demonstrated a degree of effectiveness. The few SAMs observed were definitely not guided and the AAA (85-mm) was definitely not aimed."^{16/} By March 1967, all F-105s were pod-equipped, and by May 1967, all F-4s were also pod-equipped.^{17/}

The SUU-16 Gun Pod. During the same period, the F-4 was equipped with the SUU-16 gun pod. Located on the aircraft center line, it allowed short range kill capability to complement the medium range, infrared heat-seeking AIM-9 Sidewinder missile, and the long range, radar beam riding AIM-7 Sparrow missile. Too often, pilots had found in maneuvering to fire a missile, they became too close to a MIG to fire, or were so

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positioned that their radar was filled with ground clutter. In these situations, the gun pod satisfied a long-awaited need.^{18/}

Arrival of the F-4D. The third improvement in U.S. capability came on 28 May, when the 555th Tactical Fighter Squadron at Ubon received 20 F-4Ds. U.S. pilots were to wait nearly 18 months, however, for the E model with its internal gun.^{19/}

Installation of the QRC-248. Finally, the MIG fighting potential of the U.S. was substantially boosted by the installation, completed in May 1967, of the QRC-248 equipment in the EC-121D COLLEGE EYE aircraft.^{20/}

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CHAPTER II

THE NVN THREAT

After their heavy losses in May and early June of 1967, the NVNAF entered a retraining phase, their customary action when things were not going well. For example, after their April-May 1966 air offensive against U.S. support planes--chiefly ELINT/ECM aircraft such as the EB-66--when they lost five MIG-17s and one MIG-21 to the F-4C MIGCAP, they withdrew to hone their all-weather GCI procedures, the basic tactic the MIG-21s were to employ for the remainder of this reporting period.^{1/}

Summary of Operations, July through September 1967

As the U.S. Navy and Air Force took advantage of the good weather in July to mount more than 11,000 attack sorties in NVN, MIG engagements fell to the lowest figure--twelve--since March. It was also a retraining period for the NVNAF. Throughout the three-month period, the MIGs engaged only when they possessed one or more of the advantages of (1) numerical superiority--usually two on one; (2) advantageous position such as higher altitude or cloud cover; and (3) the element of surprise. The U.S. incurred no losses to MIGs while shooting down three MIG-17s, with one MIG-17 and one MIG-21 listed as probable kills.^{2/}

The latter probably occurred at 1600 hours on 27 July some 35 NM west of Hanoi. Blue Flight, flying MIGCAP for a strike mission, was at

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half strength, Blue 1 and Blue 2 having air aborted. Blue 3 and Blue 4 were flying northwest at 12,000 feet when the strike force called a bogey at 10 o'clock. They saw two MIG-21s pass left to right three-quarters of a mile ahead in descending turns, apparently looking for a straggler in the strike force below or perhaps trying to make the strike force jettison ordnance. Blue Flight followed. When Blue 3 "had one MIG centered at 3,000 feet," the MIG used its afterburner just as Blue 3 launched a Sidewinder. The missile "tracked straight ahead until motor burn-out, then turned right directly after the MIG-21." When last observed, the missile was "in full guided flight approximately 200 feet directly after the MIG-21, but no detonation was observed." When the second MIG started a left descending turn, both F-4s dived after him, and at 9,000 feet, in a 25-degree dive, "150-KT overtake with interlocks in and full systems lock-on," Blue 3 let loose a Sparrow, which "appeared to track immediately." The MIG continued his left descending turn, headed for an undercast at 6,000 feet. "The missile was last seen tracking 2,000 feet behind the MIG-21 in a lazy pursuit curve." The MIG was therefore "classed as a probable kill."^{3/}

In August and September, months of heavy U.S. strikes, mainly against the rail line running northeast from Hanoi to Communist China and lines of communication (LOCs) between Hanoi and the port city of Haiphong, MIG activity remained at a low level. In 32 engagements, the NVNAF

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lost four planes and the U.S. lost three.^{4/}

Not having ventured out frequently during the summer of 1967, the MIGs had been flying training flights and practicing intercepts whenever the U.S. forces were not in Route Package VI. Accordingly, in the action of 23 August 1967, for the first time a new and extremely effective MIG tactic was used. Intelligence sources revealed that the MIG-21s had been practicing the same tactic on the strike force for the past ten days. Basically, the new procedure of the MIG-21s was to take off from Phuc Yen or Gia Lam and proceed south at low level, until they were approximately abeam of the F-4 force. The F-4 radar covered an area 60° on either side of the nose, so the MIGs kept at low level until beyond the radar envelope. At that time, their GCI control advised climbing, which they did in afterburner to 25-28,000 feet. This put them on a high perch above the strike force and on the right, rear quarter. They next began a high speed diving turn down into the strike force's rear elements. Airspeed of the strike force at this point was 450-480 KIAS, with airspeed of the MIGs well over Mach 1. As the MIG-21 launched his Atoll missile, he either zoomed back to altitude or often just pressed straight through. In any event, the high differential in airspeed made it impossible for the F-4 force to accelerate fast enough to counter the attack.^{5/}

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Ten days earlier, the first engagement with a CHICOM MIG was recorded. A Navy F-4B on a Search and Rescue (SAR) mission near the CHICOM border was jumped by four MIG-19s. The MIGs launched four missiles and made an unsuccessful cannon pass before the F-4 escaped into an undercast.^{6/}

With most of their force safely located in Communist China, the NVNAF was relatively free to develop tactics and procedures that were to work well for them as long as the U.S. continued attacks in Route Packages V and VI.

NVNAF Tactics Development

In early 1967, it was common for U.S. pilots to encounter as many as 10 to 15 MIGs a day. Both forces would break formation and engage in what amounted more often than not to one-on-one dogfights. By midyear, however, MIG pilots had come up with a better idea and had acquired the air discipline to stick to their plan. Henceforth, they would fight only on their own conditions.^{7/}

The MIG-21s would orbit in three areas, 30 NM northwest of Phuc Yen and 30 NM southwest of Phuc Yen to counter USAF strikes from Thai bases, and slightly south of Phuc Yen to cover USAF and Navy strikes from the Gulf of Tonkin.^{8/} They attacked in pairs from high altitude (25-40,000 ft.) diving through the F-4 MIGCAP at mach 1.3 to harass the

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U.S. AND NVN LOSSES July - Sept 1967

1967 MONTH	SAM		MIG			AAA / AW		
	Nr of Firings	U.S. LOSSES	Engag- ements	LOSSES		Total Posi- tions	Total OCC. Posi- tions	U.S. Loss- es
				NVN	U.S.			
JULY	298	6	12	3	0	34,632	8,511	31
AUGUST	441	8	16	4	2	34,964	8,796	29
SEPTEMBER	169	2	16	0	1	35,140	8,964	13

Figure 3

SOURCE: ROLLING THUNDER DIGEST 5.

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ingressing F-105 strike force before the F-4s could counter.^{9/} A variation was a single pass, radar vectored attack against egressing flights. The latter occurred as far west as Dien Bien Phu, particularly against single planes or flights of two.^{10/}

At the same time, the MIG-17s would form a wheel formation below 10,000 feet, hoping to lure someone into a dogfight. Neither the F-105 nor the F-4 had much of a chance in a turning fight against the MIG-17 with its light wing loading.^{11/}

Though their force was smaller after the massive losses in early 1967, the MIGs with their refined tactics were now capable of more frequent and wider range attacks. During September alone, they forced 48 strike planes to jettison ordnance, compared to the highest previous monthly total of 28.^{12/}

The MIG threat, however, represented but one element of the hostile air environment over North Vietnam.

Air Environment over NVN

From the beginning of the ROLLING THUNDER operation, U.S. pilots had much more to worry about than the possibility of MIG attacks. During the period of July-September 1967, admittedly one of reduced MIG activity, the U.S. lost 3 planes to MIGs, but 16 to Surface-to-Air Missiles (SAMs), and 73 to antiaircraft artillery/Automatic Weapons (AAA/AW). (Fig. 3.)^{13/}

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Effect of the SA-2 Threat

Before the Cuban missile crisis of 1962, the Soviet SA-2 had represented a threat of unknown magnitude to U.S. air operations. In early 1965, U.S. strike aircraft had operated at low levels, hoping to escape enemy detection. Heavy losses to enemy ground fire, however, had driven them up to medium altitude (15,000 to 20,000 ft. AGL). Then in July 1966, the SA-2 threat became reality and target approach altitudes dropped down again to 500-1,500 ft. AGL. U.S. pilots braved the intense ground fire to escape the dreaded SA-2. Later in the year, however, they were able to successfully out-maneuver the airborne SAM and immediately went back to 6-9,000 ft. AGL to escape AW fire. Finally, with installation of the ALQ-71 pods in early 1967, altitudes were again raised to 8-17,000 feet.^{14/}

The pod formation, along with beacon jamming, evolved as the best tactic to defeat the SA-2 system. Pilots held their position in the formation, unless the missile was definitely directed toward a particular aircraft. In that case, the pilot could maneuver vertically to cause the missile to miss the aircraft. The pod formation was held until the roll-in point for visual bombing or throughout bomb release for radar bombing.

After breakup of the pod formation, or when an aircraft penetrated SAM defenses without benefit of the pod formation (i.e., WILD WEASEL,

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recon, etc.), it was necessary to out-maneuver the missile. To do this, the aircraft was maneuvered to place the missile as close to the three or nine o'clock positions as possible, and a descending flight path was initiated to increase airspeed. This attitude was held until the missile passed the high point in its trajectory and started descent toward the aircraft. When the missile was committed to an attack and within a close range of the aircraft, the aircraft initiated a high G pull up. This forced the missile into a turn beyond its capability and caused it to tumble and usually self-destruct. Timing for the maneuver was very critical for if it were initiated too early, the missile could easily follow the aircraft. If the maneuver were initiated late, the separation was inadequate to prevent damage or destruction from missile detonation.^{15/}

Though U.S. pilots could out-maneuver the SA-2, losses to SAMs increased significantly throughout 1967 because of (1) the constantly growing number of sorties flown; (2) the construction of additional SAM sites; and (3) the doubling of NVN SAM battalions to man them. In 1966, the U.S. lost 10 aircraft to SAMs; in 1967 they lost 30.^{16/} In January 1966, NVN had 64 sites manned by 12 battalions; by July 1967, they had 235 sites manned by 30 battalions.^{17/} These sites, of course, were not operational all the time. The North Vietnamese would fire from one position, then pick up and move quickly to another site to avoid retaliation.

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Another method used to counter the SAM threat was WILD WEASEL. The first aircraft (WILD WEASEL I) were F-100Fs, which flew their first sortie on 3 December 1965. They were followed later by the WILD WEASEL III F-105F aircraft. Since their primary mission was SAM suppression for the strike force, they accompanied them. During WILD WEASEL attacks, SA-2 sites usually stopped transmitting to prevent SHRIKE antiradiation missile homing on the radar. This suppression of the firing of SAM missiles led to evolution of the escort role (IRON HAND). Site attacks, of course, were still carried on after the strike force had been escorted out of SAM attack range. The Hunter/Killer role, however, was secondary, to be accomplished after the work of protecting the strike force had been completed.^{18/}

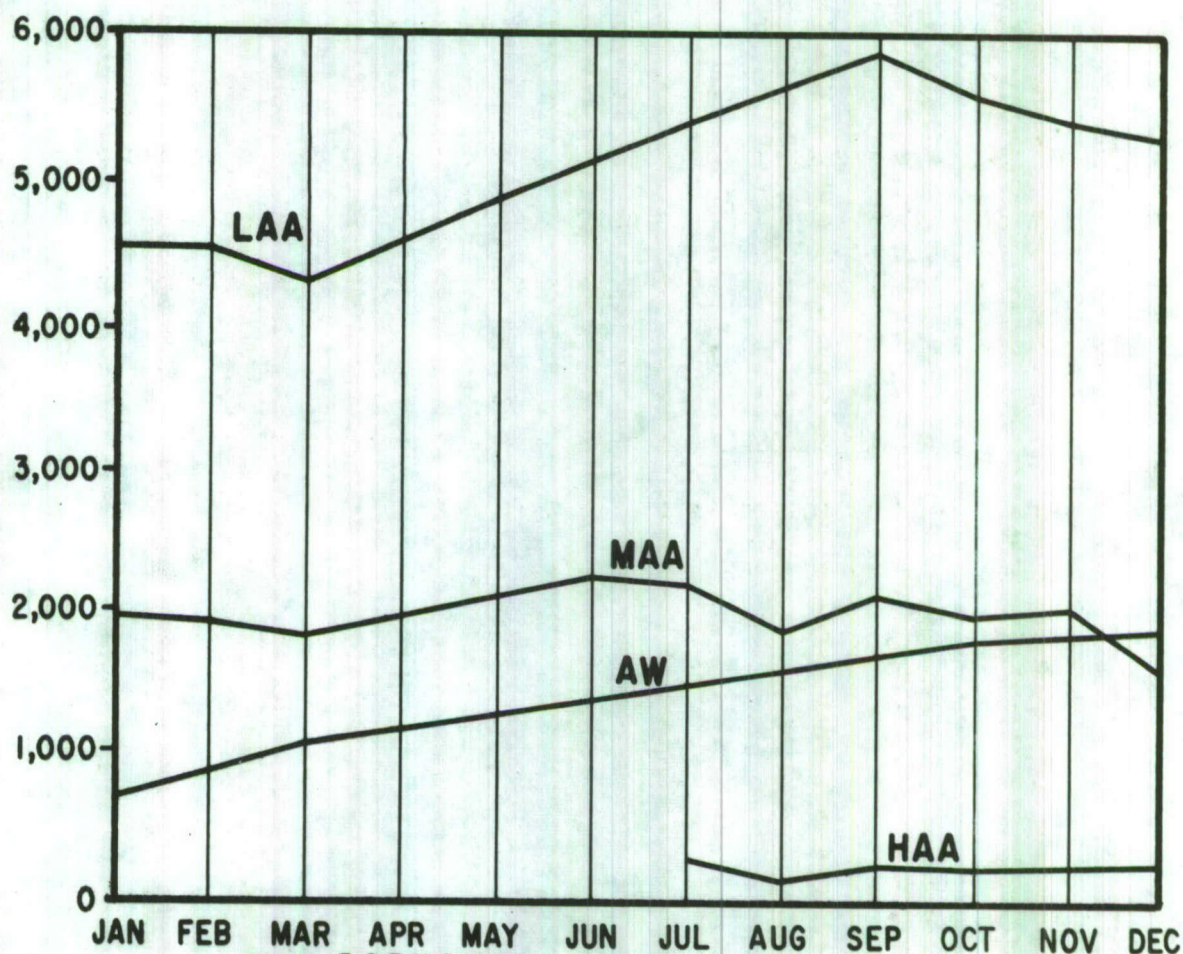
Since WILD WEASEL was a new concept, many variations in tactics were tried and losses initially were great. Through trial and error, however, by early 1968, certain tactics and procedures had been established and losses to SAMs were reduced as proved by these statistics:^{19/}

<u>Date</u>	<u>NVN SAM Firings</u>	<u>Air Force Losses</u>
Nov 67	237	9
Dec 67	179	0
Jan 68	62	1
Feb 68	123	2
Mar 68	131	0

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NVN ANTI-AIRCRAFT ARTILLERY ORDER OF BATTLE, 1967



— LEGEND —
HAA - ALL AAA WEAPONS 100-MM OR ABOVE
MAA - 85-MM WEAPONS
LAA - 37/57-MM WEAPONS
AW - ALL AUTOMATIC WEAPONS

SOURCE: ROLLING THUNDER 6, pg 49.

FIGURE 4

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AAA/AW Threat

Throughout the war NVN AAA/AW consistently accounted for the vast majority of U.S. combat aircraft losses. In 1967, for example, 158 U.S. aircraft were victims of ground fire, while 88 were downed by MIGs and SAMs. ^{20/}

General Earle G. Wheeler, USA, Chairman of the JCS, testified ^{21/} the following in August 1967 before a Senate Subcommittee:

"I might point out that veterans of both World War II and Korea, who have experienced the flak around the tougher targets in North Vietnam, have stated that it far exceeds anything they have seen. Statistics on gun densities and rates of fire bear them out."

The 8th Tactical Fighter Wing's Tactical Doctrine stated: ^{22/}

"The enemy defensive environment includes the largest concentration of surface-to-air missile sites in the world, more AAA sites than the allied forces faced in Europe in WW II, and one of the most, redundant air defense radar networks in existence."

The number of weapons, as well as the consistent growth in the total, is shown in Figure 4. Success for the NVN gunners was dependent upon altitudes flown by U.S. aircraft. As we have seen, these altitudes were largely a compromise. The 8th TFW's Tactical Doctrine recommended 10-20,000 ft. AGL: 20,000 feet was below the most effective altitude of the SA-2; 10,000 feet was above most ground fire; the F-4 had performance advantages below 15,000 feet against the MIG-21, and above that

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figure against the MIG-17.^{23/} One study concluded that more than 85 percent of the fatal hits from AAA/AW up through 57-mm were at, or below, 6,000 feet, with the most dangerous weapons being 12.7-mm and 14.5-mm AW and 37-mm and 57-mm AAA.^{24/} Tactics against AAA/AW included jinking (random changes of heading and altitude) against aimed fire and high speed against barrage fire.^{25/}

In the area of concentrated fire around Hanoi and Haiphong, survival often depended more on luck than tactics. Col. Robin Olds, 8th TFW Commander, after graphically describing the air environment, concluded that much of the NVN ground-to-air success was made possible by the various U.S. restrictions on target types and locations. By gradually increasing the pressure, the U.S. allowed the North Vietnamese gunners the time and experience to become "the best in the world. We taught them," Olds added.^{26/}

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CHAPTER III

THE MIGS ACHIEVE PARITY

While the NVNAF was developing and refining methods to counter ROLLING THUNDER strikes, U.S. tactics against the MIGs had finally become relatively fixed. U.S. tactical doctrine--the product of theoretical studies, testing in CONUS, and, most important, considerable experience in NVN--undoubtedly enumerated the best ways to utilize existing equipment. In most fighter wings, tactical doctrine publications grew thicker, but said essentially the same things from mid-1967 on. Typical examples were those of the 388th TFW for the F-105, and the 8th TFW for the F-4.

F-105 Tactics

The normal pod formation, designed for mutual ECM support, is shown in Figure 5. The F-105, like the F-4, carried the ALQ-71 and ALQ-87 barrage jammers and Radar Homing and Warning (RHAW) gear to detect when they **were** being tracked by AAA or SAM radars. WILD WEASEL aircraft usually did not carry pods, because of interference to the WILD WEASEL receivers. At the flight commander's discretion, they carried either QRC 160-1s or QRC 160-8s, which were turned on only as a last resort. After the restriction in bombing to below 20:00 degrees north latitude, however, the WILD WEASEL crews carried the QRC-335 pods into the lower Route Packages as a test program. The QRC-335 pod included both deception jamming and noise jamming according to the

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program selected. None of these pods were used primarily against acquisition radars, but were used to jam the tracking radar and the missile tracking receiver. The greatest success was realized in these areas, rather than against acquisition radars.^{1/}

For force MIG defense, the F-105 employed the Fluid Four formation.^{2/} For both offense and defense, the F-105s basic unit was the flight of four, "employed as two supporting elements." On offense, elements maneuvered so that one or the other was threatening the MIGs at all times. On defense, each element cleared the other.^{3/} Recommended tactics for offensive and defensive situations are quoted directly from the tactical doctrine:^{4/}

"Offensive:

(1) The F-105 enjoys three important advantages over the MIG; pilot proficiency, fire power and low altitude high speed capability. MIGs, as a general rule, should be engaged any time they are spotted forward of the three to nine o'clock position and heading within the same quadrant as the F-105.

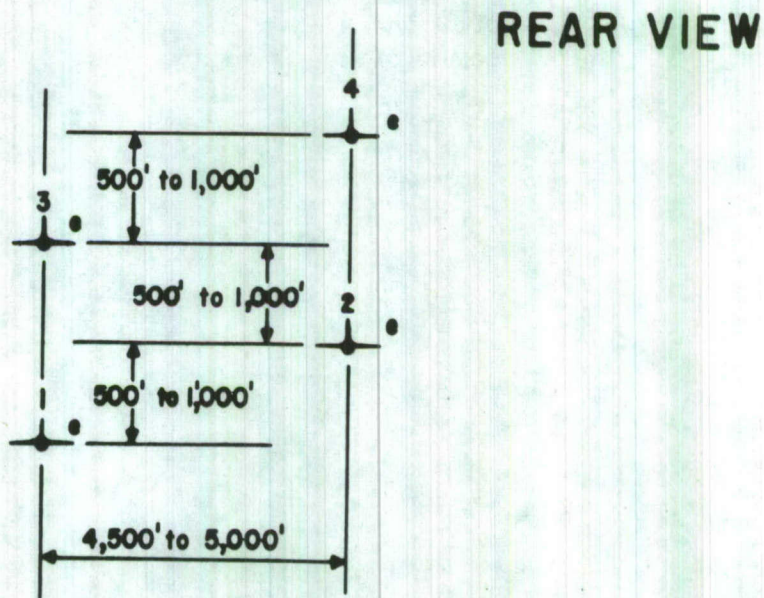
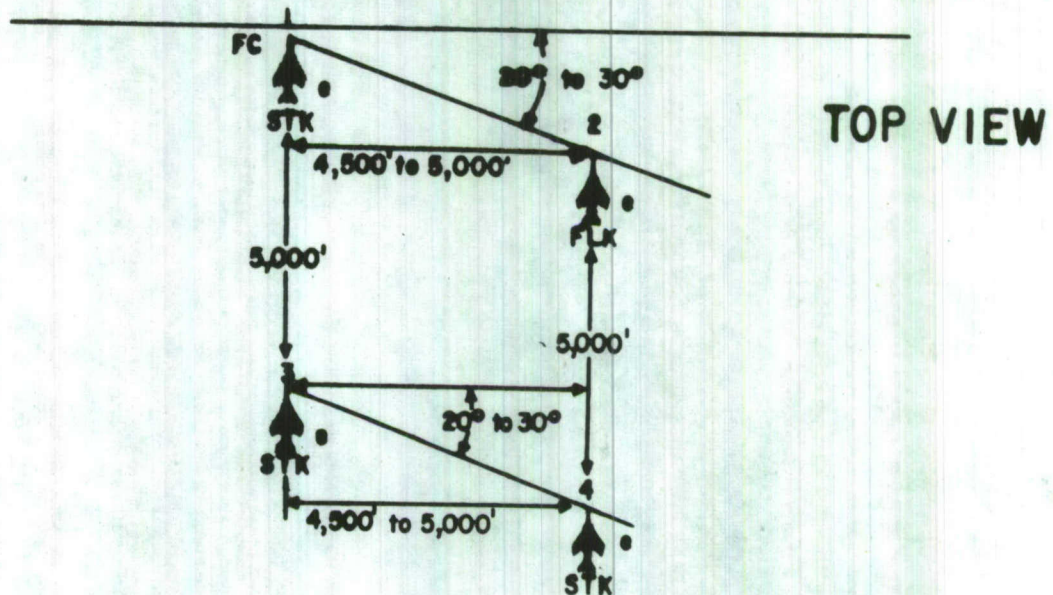
(2) When anticipating an engagement with a MIG, the F-105 should always keep the action below 16,000 feet, and the F-105 speed should never be allowed to drop below 450 KCAS.

(3) As you position for a firing pass on the MIG, do not attempt to maneuver on the aircraft itself unless you are close to gun range. Instead, maneuver toward an optimum missile launch range point in his blind 5-7 o'clock low position. From this position you can run him down if you remain undetected, and perhaps maneuver with him slightly if his evasive tactics are weak. Keep a high air-speed during this phase--MACH 1.1-MACH 1.3.

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NORMAL POD FORMATION FOR MUTUAL ECM SUPPORT (388 TFW)



SOURCE: 388 TFW COMBAT TACTICS, pg 16

FIGURE 5

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(4) Plan to use the AIM-9 first, and then press into gun range if necessary. Press the attack to success or until the MIG breaks. If he does, he will appear to "swap-ends" and you will definitely overshoot. Fly your overshoot down and away into a separation maneuver using maximum power. If the second element is in a position to occupy the MIG, look for a chance to reposition for another attack, but never try to out-turn or out-climb a MIG.

"Defensive:

(1) If you are under attack, turn into the attackers while the range is still greater than six miles. MIGs will normally have to abort their pass because it is a GCI set-up based on your predicted course. When MIG-17s and MIG-21s are simultaneously vectored into the attack, MIG-17s will normally continue the attack--using their relatively unrestricted visibility and excellent turn radius in an attempt to salvage the attack.

(2) If the attackers are between six and three miles, make a hard, slightly descending turn into them using afterburner. The resulting pass is not favorable to either aircraft and separation is quite rapid.

(3) If the attackers are inside three miles, an immediate break is necessary. Use maximum power, get the nose well down, and separate as fast as possible....

(4) In the event a MIG is 'cornered' at your six o'clock, the high speed, high G roll under to the deck is the most effective last ditch maneuver. If you elect to use it, be sure you have enough altitude for the 'Gs' you are pulling--the altitude lost in this maneuver is extreme. The F-105's best escape maneuver is to go fast; if you are supersonic below 16,000 feet you are separating. We do not recommend any 'oneshot' rapid energy loss maneuvers....Recovery is dangerously long and slow.

(5) Flight leaders may sometimes call for jettison of drop tanks in an effort to fool the MIG pilots into thinking they are aborting; however, do not jettison tanks and ordnance unless directed or prebriefed to do so....If the tactical situation deteriorates...and the flight leader fails to call for jettison, use your

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own judgment--automatically jettison if you deem it necessary for survival....

(6) Below 10,000 feet, the F-105 is the fastest, most stable aircraft flying over North Vietnam--use this capability."

F-4 Tactics

The F-4s flew pod formations when the threat from radar-controlled AAA and SAMs was high. But their favorite formation for MIG hunting was the Fluid Four, designed to provide complete visual coverage to the rear, up to three miles (Fig. 6.)^{5/} Areas of visual search responsibility for each pilot in each aircraft were clearly itemized. As the formation name implies, the F-4s moved randomly in both vertical and horizontal planes, while maintaining the same basic formation.

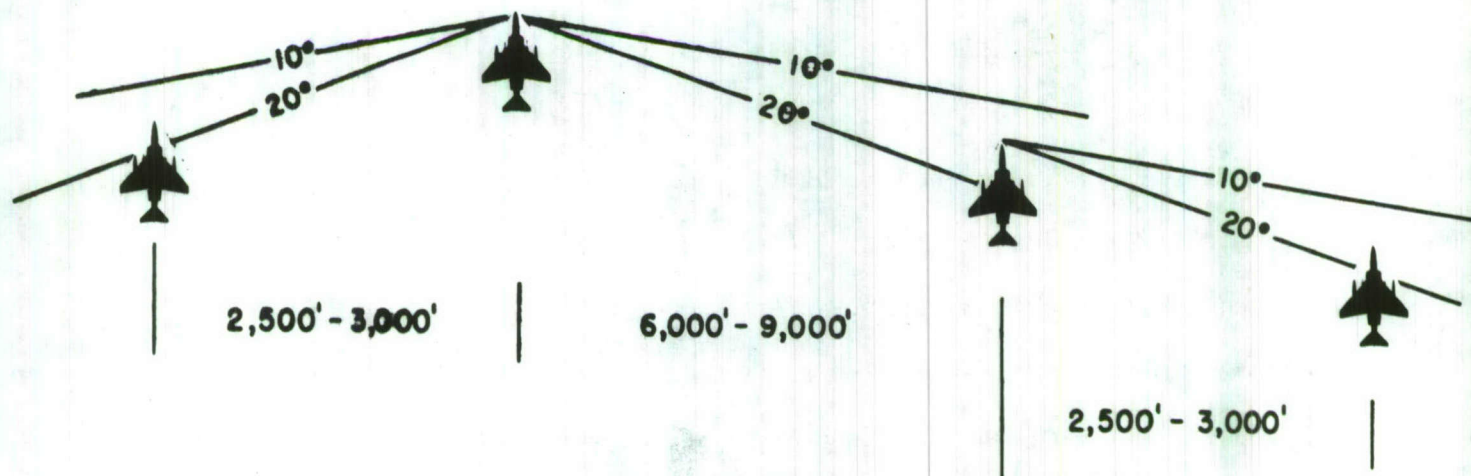
When in their usual role of MIGCAP, four F-4s were designated as "fast CAP" and were armed with only Sparrows and Sidewinders for minimum drag. Below them was another flight designated "slow CAP," carrying a gun pod, Sparrows, and AIM-4 Falcon missiles. When encounterering MIG-21s the fast CAP would break first with the slow CAP in reserve should the MIGs succeed in closing with the strike force.^{6/}

The ideal range to initiate an attack on MIG-21s making a diving attack was found from experience to be 20 NM. If the attack were initiated farther than 20 NM, the MIGs would reposition for another pass. Closer, there was insufficient time to set up for a missile launch, and

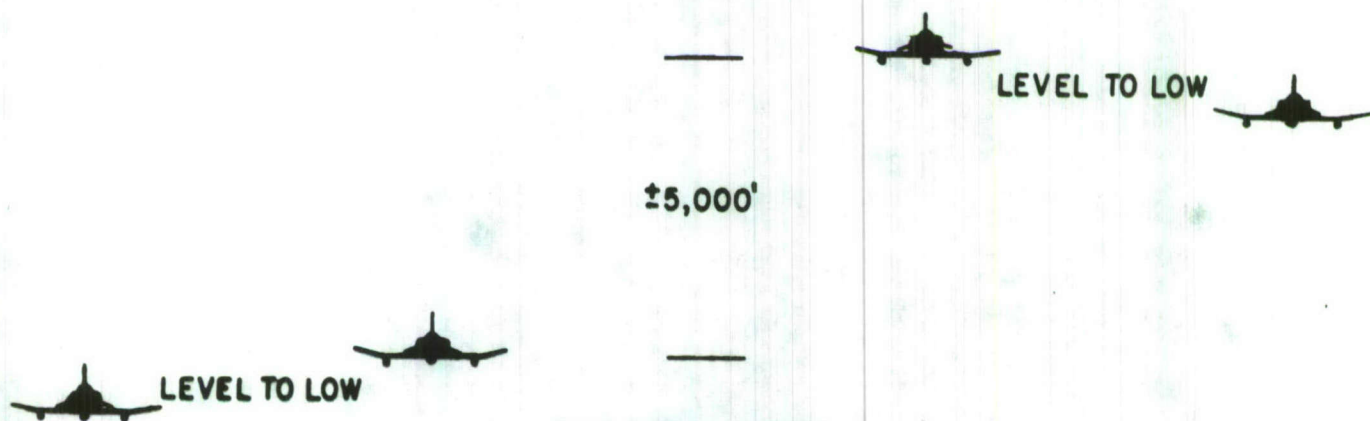
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FLUID FOUR FORMATION



TOP VIEW



REAR VIEW

SOURCE: 8 TFW TACTICAL DOCTRINE, pg 3-25

FIGURE 6

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the MIGs would break through the CAP to the strike force below. ^{7/}

Specific instructions from the tactical doctrine for fighting the MIG-17 and MIG-21 were as follows: ^{8/}

"MIG-17...The attack should be made by maneuvering in the vertical until the opportunity for a firing pass occurs. Do attempt to turn with the MIG-17. Make a single pass, maneuvering to the optimum missile launch position, fire and break off and work in the vertical plane to reposition. As the lead element disengages, the supporting element can initiate an attack. If the advantage is lost and the MIG-17 becomes the attacker, a defensive turn must be made into the threat followed by a descending acceleration. The F-4D can unload Gs and accelerate away from a MIG-17 at almost anytime. The element not under attack should also accelerate and disengage. Re-enter the fight on your own terms. When engaged with MIG-17s, either offensively or defensively, use the three advantages available to the F-4D over a MIG-17: acceleration, zoom and speed."

* * * * *

"MIG-21...The attack should be made in a Fluid Four formation. This has a tendency to box the MIG in and normally places one of the elements close to his rear hemisphere blind area. Both elements should work to force the fight to an altitude below 15,000 feet. Continue to work as a flight; force the fight as low as possible and maneuver toward the blind area. Don't attempt a horizontal turning fight. Use the vertical to gain a firing position. If the MIG-21 has the advantage, disengage. Make a break into the attack if a missile has been launched. A hard turn will suffice if the MIG is only approaching the launch envelope. Continue with a slicing descending turn to drag the fight to a lower altitude. If the MIG attempts to continue the attack the supporting element should be able to 'sandwich' him. If mutual support is not available from the other element, accelerate to max speed at low altitude and disengage."

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With these tactics, U.S. fighter pilots felt confident to mix with the MIGs any time they might come up again in force.

Summary of Operations, October through December 1967

The MIGs were not long in coming. While the number of U.S. attack sorties per month steadily dropped from the August figure of 11,744 to a December total of 5,758--caused mainly by the onset of the Northeast Monsoon--the number of MIG engagements rose from 16 in both August and September to 34 in December. Engagements doubled while strike sorties were cut in half.^{9/}

October was a crucial month--the NVNAF lost a total of 20 MIGs. U.S. pilots blasted two MIG-21s and six MIG-17s out of the air, and twelve more MIGs were destroyed or damaged during a newly authorized strike on Phuc Yen Airfield on 24 October. U.S. pilots were determined to maintain the overwhelming air superiority they had fought so hard for earlier in the year. The MIGs claimed only three U.S. fighters.^{10/}

From past experience, the NVNAF should have again stood down, but this time they kept coming and in the next two months were to achieve a slight edge in the air battle. The total score was six MIGs to nine U.S. losses in air-to-air encounters. The NVNAF lost six MIG-17s; the U.S. lost four F-105s, two F-4Bs, and three F-4Ds.^{11/}

In retaliation, U.S. strikes kept hitting the NVN jet-capable

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airfields, except for Hanoi's International Airport, Gia Lam. There was serious damage to ground support equipment, but cratered runways were soon repaired. At the end of December, all jet-capable fields except Cat Bi were serviceable. Despite their drastic October losses, the NVNAF managed to secure enough replacements that their MIG inventory actually rose from 75 to 100 during the three months.^{12/}

The unexpected success of the MIGs can be partly attributed to their tenacity, but it also indicated improved pilot and GCI controller proficiency. In November, U.S. pilots reported that the MIG-21s making high speed passes were perfectly positioned before they could make the visual identification required by U.S. Rules of Engagement for MIGCAP aircraft.^{13/} By December, the MIG-21s were coordinating their high attacks with the low attacks of the MIG-17s. They attacked from different quadrants in multiple passes in an at least partially successful effort to confuse the MIGCAP. When an F-4 flight dashed off after a flight of MIGs, another would bear in on the strike force from a different heading.^{14/}

U.S. pilots countered this newest twist by dividing the strike force in order to make simultaneous attacks from opposite directions, or widely spaced attacks from the same direction, splitting the MIG reaction. For the most part, the plan worked, but occasionally it backfired. Capt. R. B. Battista, then with the 433d TFS, recalls "two really big

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MIG days" during this period. The first occurred during a planned two-pronged attack from different directions. One force found the primary target obscured and looked for its secondary target. This move, however, put them on nearly the same heading as the other force. The large number of U.S. aircraft and the unavoidable confusion caused by the sudden shift in targets drew the MIGs in force. The second day, a widely spaced attack with identical approach headings was planned. The lead force found the target obscured and turned around. The second force, hearing the lead force's report, turned somewhat later, mixing with the lead force and, again, caused unavoidable confusion. Without warning, four MIG-21s screamed down through the F-4s, firing their Atoll missiles.^{15/} The Atoll, similar to the U.S. Sidewinder, had proved to be the best weapon of the MIGs; it was used almost exclusively for the remainder of this reporting period.

In two months, the NVNAF had at least achieved parity with the U.S. in the air battle. U.S. kills were all MIG-17s that accepted the challenge to dogfight, a situation in which U.S. pilots had long ago proved their superiority. Since the majority of the NVN kills was produced by MIG-21s making ground-controlled high speed passes, it was reasonable to assume they would continue this tactic in 1968.

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CHAPTER IV

THE LAST OF THE BIG AIR-TO-AIR WAR

During the first quarter of 1968, air activity over NVN dropped off considerably. Partially because of the New Year and Tet standdowns, but chiefly because the Northeast Monsoon was in full swing, the number of combat sorties was reduced by one-third from the previous quarter. As a result, dependent figures--SAM firings and kills, MIG engagements and aircraft losses, AAA/AW activity and kills--dropped also. MIG pilots appeared more confident after their recent successes, but U.S. pilots were determined to reclaim air superiority.^{1/} Since U.S. tactics and pilot proficiency had already been honed to a keen edge, they looked to equipment improvement to help maneuver events their way. One such development was the "special" pod.

The Special Pod

Since the arrival of the SA-2 missile in NVN, U.S. tactics and equipment had steadily reduced effectiveness of the SAM. Specific numbers regarding aircraft lost to SAMs understandably differed: one SAM could generate more than one firing report, and sometimes it was difficult to say whether an aircraft was lost to AAA or a SAM. The figures were valuable, however, for determining a trend, and the trend undoubtedly favored the U.S. In 1965, it took at least 16 SAMs to

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destroy a U.S. plane, in 1966 at least 31,^{2/} and in 1967 at least 55.^{3/}

By late 1967, however, it became apparent that the North Vietnamese were improving their procedures. Instead of relying chiefly on their Fan Song, track-while-scan radar, which the U.S. ECM pods had been jamming effectively, they took data from GCI and acquisition radars and predicted future U.S. aircraft positions. With this information, they required minimum time in search mode prior to launch of the SAM.^{4/}

The U.S. countered with the "special" pod. The normal ALQ-71 and ALQ-87 pods had four transmitters, two designed to barrage jam the Fan Song and two to jam AAA radars. A slight modification permitted the pod to direct all four transmitters against the missile beacon as received by the Fan Song, depriving the SA-2 of guidance to its target. So effective was the specific pod that one pilot called it "a real breakthrough," and conjured up the scene of SAMs dropping everywhere harmlessly from the sky. Even allowing for overstatement, the special pods were a significant anti-SAM development, and by the end of December 1967, they were in general use over NVN.^{5/}

Summary of Operations, January through March 1968

Because of the monsoon weather--February produced the "poorest flying conditions...during the past three years"--the U.S. turned largely to medium and high altitude strikes using all-weather bombing equipment. COMMANDO CLUB missions were directed to the bomb release points by

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ground controllers using radar and bombing computers; COMMANDO NAIL missions used on-board radar bombing equipment, a system similar to the Navy's A-6 blind bombing equipment. As a consequence, MIG engagements were few and far between, averaging little more than one every two days. The MIG inventory rose to 18 in-country and 100 in Communist China, but they were used sparingly.^{6/}

When used, however, the MIGs were effective, striking down ten U.S. aircraft while losing nine of their own. All kills were recorded in the first two months; in March there were only five engagements, with no losses for either side. MIG aggressiveness fed on its recent success. Pairs of MIG-21s made multiple runs on U.S. MIGCAP and strike aircraft, and several times single planes screamed down on the U.S. force without benefit of ground control.^{7/}

One such attack occurred early in February. A flight of four F-4 MIGCAP aircraft from Ubon were egressing, when a MIG-21 suddenly appeared making a pass from the rear quarter high. The flight broke up and went after the MIG. Three F-4s missed with missiles, but the fourth, suddenly finding the MIG directly in front of him, got a full systems lock-on with interlocks in and guided a Sparrow squarely into the MIG.^{8/}

U.S. forces kept up the pressure on MIG airfields, hitting Kep, Kien, Hoa Lac, Cat Bi, and Phuc Yen in the northern Route Packages. The

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MIGs, however, began to show signs of moving their effort farther south. An EB-66 was downed close to the Laos border on 14 January, and MIGs were sighted between Bai Thuong and Vinh Airfields in Route Packages III and IV. Vinh was attacked, rendering the runway unserviceable, but the packed earth strip along the west shoulder of the runway was repaired and extended to 6,700 feet in October-November 1968. It served as the landing surface for MIGs and transport aircraft. Clearly NVN confidence and presumably their pilot proficiency were growing.^{9/}

But while the SAM threat declined during the quarter--the North Vietnamese launched 75 missiles for each kill--the MIG threat grew alarmingly. Of the possible causes of U.S. combat aircraft losses--MIGs, SAMs, AAA/AW, and unknown--the MIG percentage was a mere one percent in 1965, rose to three percent in 1966, grew to eight percent in 1967, and leaped to twenty-two percent during the first three months of 1968.^{10/} With this growing threat and with the bad weather finally breaking, the time seemed right for another major effort against the MIGs. Just then, on 31 March 1968, President Lyndon B. Johnson announced the first of the bombing restrictions.

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CHAPTER V

THE MIG AIR WAR DWINDLES AND DIES

The first restriction, implemented on 1 April 1968, stopped all bombing north of 20° N latitude, roughly midway through Route Package IV. The second restriction, declared two days later, moved the line south to 19° N latitude, permitting strikes only in Route Packages I, II, and the southern third of III. (Fig. 1.) Nearly all of NVN became a MIG sanctuary; Vinh and Dong Hoi were the only jet-capable airfields south of the line, and the NVNAF had not used these for MIGs. The enemy began moving his fighters back in-country from Communist China.^{1/}

COLLEGE EYE Task Force

By the fall of 1967, the EC-121D COLLEGE EYE aircraft had expanded their original MIG warning function to include flight following for U.S. strike and MIGCAP aircraft. From orbits in Laos and the Gulf of Tonkin, two aircraft directed fighters to air refueling rendezvous points, assisted in SAR operations, and provided warnings of imminent CHICOM border crossings.^{2/}

From their original MIG alert on 10 July 1965, when the USAF scored its first MIG kills, the EC-121s continued to provide timely MIG warnings. On 6 February 1968, for example, two F-4Cs from the 8th TFW were vectored to a joint MIG kill. Six days later two more F-4Cs

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recorded one kill and one probable after being vectored to a range of three NM from the MIGs.^{3/}

In August 1967, an EC-121K experimental aircraft, designated RIVET TOP, joined the Task Force. Originally conceived as an ELINT collection platform, RIVET TOP contained such advanced equipment that it was quickly directed to take its turn in the COLLEGE EYE orbits, and its stay in SEA, originally planned for 120 days, was extended until well into 1969. Overall, it provided MIG range and bearing information that contributed to 13 MIG kills and 5 probables before the bombing restrictions.^{4/} In addition to usual MIG warning calls, RIVET TOP provided U.S. fighter pilots with useful reports when MIGs were taxiing, taking off, and going afterburner.^{5/}

So successful was RIVET TOP that some of its specialized equipment, designated RIVET GYM, was installed in four COLLEGE EYE aircraft in late 1968 to give them "essentially the same capability for MIG warning" as RIVET TOP.^{6/}

Summary of Operations, April through December 1968

The bombing restriction changed the air-to-air war dramatically. Though the U.S. sortie rate rose steadily from an average of 5,000 per month in the first three months of 1968 to 11,931 in October, there were only 18 encounters between MIGs and U.S. fighters during the remaining nine months of the year. The NVNAF, no doubt anticipating a

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resumption of U.S. strikes in Route Packages V and VI, spent April and most of May repairing their northern airfields. When they were finally ready to sweep south on 23 May, they got a taste of what U.S. forces had experienced for many months, when one MIG-21 was eliminated from the sky by a Navy Talos ground-to-air missile. Below 19° N, the MIGs faced U.S. fighters, Navy SAMs, minimal GCI support, and jamming of their VHF radio channels. In the 18 encounters, U.S. pilots shot down six MIGs, while losing two F-4s.

Using their sanctuary north of 19°, the MIGs made occasional hit-and-run forays south of the line through June. They shot down two F-4s and lost one MIG-21 in air duels.^{7/} But on subsequent sweeps on 8 and 9 July, they lost one MIG-17 and one MIG-21 and, characteristically, stood down to reevaluate their tactics.^{8/}

On 29 July, the NVNAF renewed their sweeps, cautiously staying above 18° 30' N, and lost one MIG-17. They returned on 1 August and lost a MIG-21. In the next engagement on 25 August, there was an exchange of ordnance with no damage. On 17 September, two Navy F-8s engaged two MIG-21s near Vinh. No one was hurt, but one F-8 ran out of fuel before it could recover to the carrier. Two days later two MIG-21s jumped four F-8s chasing a flight of MIG-21s; the F-8s shot down one of the MIG-21s. Finally, during a fight between F-8s and MIG-21s near Vinh on 22 September, one MIG was downed by a Talos SAM, and the MIGs

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halted their activity.^{9/} In October, radar spotted an occasional MIG below 19°, but U.S. pilots were unable to close nearer than 45 NM. When all bombing in NVN was halted on 1 November, the NVNAF moved GCI and air surveillance equipment to Vinh, but only as a precaution. By December, their MIGs were reduced to chasing U.S. Bumpy Action reconnaissance drones near Hanoi.^{10/}

The air war against the MIGs had drawn to an inconclusive end. Despite their relative success in late 1967 and early 1968, the NVNAF realized their procedures and tactics were valid only close to home. U.S. tactics remained unchanged.

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CHAPTER VI

FINAL DEVELOPMENTS

There are at least three elements in the air-to-air combat capability equation: tactics, equipment, and proficiency. For the U.S. forces, the first element, tactics, was a constant before the end of 1968. The other two elements, however, were variables.

A study conducted by the Institute for Defense Analysis concluded in April 1968 that "opportunities for further reduction of losses in SEA appear to be more in the line of new or modified systems than in revision of tactics."^{1/} One systems improvement was the "Dogfight Sparrow,"

an AIM-7 air-to-air missile, that had a better maneuvering capability and could be launched as close as 2,000 feet from the target aircraft.^{2/}

Another was the arrival in the theater on 17 November 1968 of the first squadron of F-4Es.

The F-4E

After extensive training at Eglin AFB, the 469th TFS deployed to Korat RTAFB. By June 1969, there were four squadrons in the theater--two at Korat and two at Da Nang--flying extensively as MIGCAP for strike forces in northern Laos, so as to provide similar duty in NVN should operations begin there again.^{3/}

The F-4E was the long-awaited new model F-4 with an internal gun

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to replace the cumbersome gun pod, more powerful engines, and a cleaner configuration. The gun was a 20-mm Vulcan cannon with two rates of fire-- 4,000 and 6,000 rounds per minute. The aircraft carried 633 rounds of ammunition, or about six to nine seconds of fire, but that time span, according to Capt. Pete Hayes, Weapons and Tactics Officer of the 469th TFS, represented more than enough firepower for MIG killing. "The F-4E," he added, "was the best air-to-air weapons system in the theater...and in the inventory." Like the F-4D, the E model could carry chaff in the speed brakes for a one-time dispense just prior to a turn to confuse enemy radars.^{4/}

Anxious for an opportunity to show what the F-4E could do against the MIG-21, E model pilots by June 1969 had received MIG threat warnings while flying MIGCAP for reconnaissance aircraft in Route Package I, but had yet to have an encounter. They expected the MIG-21s to stick with proven tactics, coming in with a high element first, followed by a low pass, with the MIG-17s staying low in great numbers.^{5/}

To counter the MIGs, the E model, while an improvement over the D model, still depended upon the basic F-4 advantages in vertical maneuvers-- dives and zooms. The pilots planned to fire a Sparrow first, follow it with a Sidewinder, and then if necessary close with the gun. Their basic formations were a pod formation almost line abreast for SAM threat areas and the Fluid Four, which they considered the best defensive, and

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a reasonably good offensive formation for MIG hunting.^{6/}

U.S. Pilot Proficiency

The second U.S. variable in the combat capability equation, pilot proficiency, caused U.S. pilots some concern.

New F-4 aircraft commanders--the front-seaters in the two-place planes--were arriving from up-grade training in CONUS with only six Air Combat Maneuvering (ACM) training missions, rather than the 24 formerly required. On arrival in SEA, they found themselves far too busy flying MIGCAP and strike sorties to be scheduled for further ACM training.^{7/}

One partial solution would have been ACM at the end of combat missions, a practice common before the 1 November bombing halt. Lt. Col. Robert F. Titus, Commander of the 389th TFS at Da Nang, described the procedure:^{8/}

"We take full advantage of the fuel remaining after an in-country strike to wring our men out a little bit. Nothing extreme, maybe nothing more than 4-G maneuvering turns, a reversal, diving and climbing turns, to give him a feel for what type maneuvering he will be required to maintain in an actual combat situation."

By mid-1969, however, the situation had changed. After the crash of an F-100 with undetected battle damage while shooting low approaches, the fighters were restricted from ACM after all combat missions except COMMANDO NAIL and COMBAT SKYSPOT. Since these missions were scheduled only when the weather precluded visual bombing in the target area, however, chances were great that poor weather would prevail also in the

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fighters' local flying areas. In actuality, they got very little practice.^{9/}

Clearly, the ACM restriction represented a worthwhile attempt to reduce accidents, but the pilots believed the risk was small and well worth taking to maintain their proficiency. Maj. Perry Smith voiced the opinion of all the 555th TFS pilots interviewed, when he said they were "getting very rusty," adding that they were convinced they could check each other out for battle damage in the air and keep the risk low enough to justify ACM.^{10/} The belief that air-to-air combat proficiency had seriously declined, and the recommendation that ACM restrictions be modified were stated also in the (SNF) Hard Headed Tactics Conference Final Report, dated 20-22 March 1969, Udorn RTAFB. This document reported the proceedings of a tactics conference attended by representatives from fighter units worldwide.

Captain Hayes agreed, noting that when the 469th TFS arrived at Korat, its pilots had just completed four grueling months of ACM experimentation and training. The 469th was "the best trained squadron ever" to come to SEA. Since their arrival, they had flown Fluid Four whenever they could, but with so little ACM, their proficiency had steadily declined.^{11/}

The plus in the equation provided by the F-4Es improved performance was apparently balanced by a minus in pilot proficiency, the latter

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necessarily sacrificed to more demanding theater requirements. If MIG encounters again became a regular part of the air war, attention would be given in the theater to regaining necessary proficiency.

Conclusion

By mid-1967, it was clear that by gradually increasing the scope and intensity of airstrikes in NVN, U.S. forces had given the enemy an opportunity to assemble and train the most formidable ground-to-air defense in history. Likewise, by gradually increasing attacks on his MIG force, while at the same time permitting him sanctuary over and in Communist China, U.S. forces allowed the enemy to develop tactics and operating procedures which by the end of 1967 made the MIG capability in air-to-air combat at least equal to that of the U.S. If the April 1968 bombing restrictions and the November 1968 bombing halt had not occurred, U.S. forces would have been compelled to develop new equipment or tactics to combat the new tactics of the enemy. By June 1969, with an almost complete loss of pilots with air-to-air combat experience, and severe restrictions placed on Air Combat Maneuvering training, U.S. pilots were not fully prepared to face the MIG pilot deep in his own territory. The plus in the U.S. airpower equation was the arrival of four squadrons of F-4Es.

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GLOSSARY

AAA/AW	Antiaircraft Artillery/Automatic Weapons
ACM	Air Combat Maneuvering
AGL	Above Ground Level
BDA	Bomb Damage Assessment
CHICOM	Chinese Communist
CONUS	Continental United States
ECM	Electronic Countermeasure
ELINT	Electronic Intelligence
GCI	Ground-Controlled Intercept
IFF	Identification Friend or Foe
KCAS	Knots Calibrated Air Speed
KIAS	Knots Indicated Air Speed
LOC	Line of Communication
MIGCAP	MIG Combat Air Patrol
NVN	North Vietnamese
NVNAF	North Vietnamese Air Force
RHAW	Radar Homing and Warning
RP	Route Package
RTAFB	Royal Thai Air Force Base
SAM	Surface-to-Air Missile
SAR	Search and Rescue
TFS	Tactical Fighter Squadron
TFW	Tactical Fighter Wing
VHF	Very High Frequency