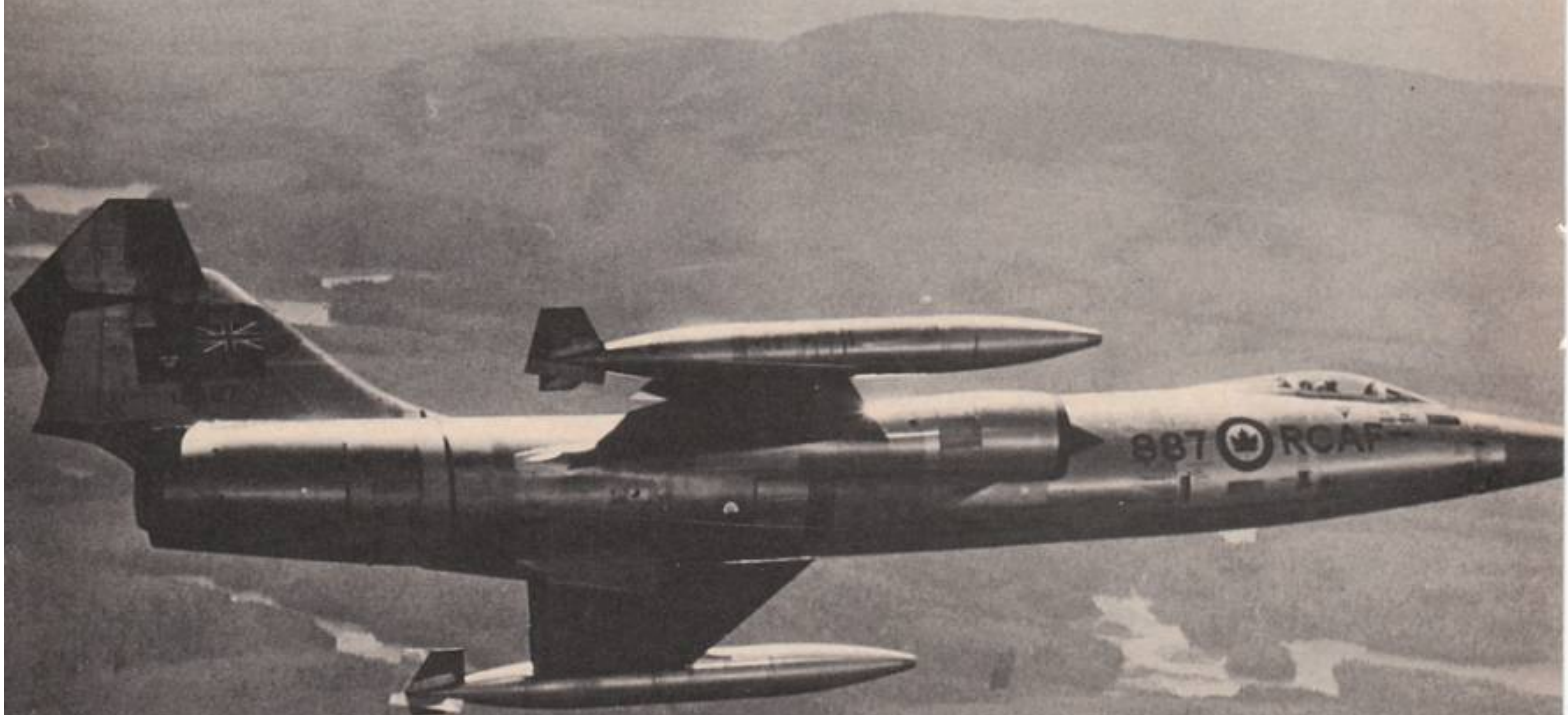


FLYING THE

CF-104 STARFIGHTER

THE CANADIAN ARMED FORCES HAVE EMPLOYED THE LOCKHEED DESIGNED CF-104 FOR EVERYTHING FROM PHOTO RECON TO NUCLEAR DELIVERY. HERE, FOR THE FIRST TIME, IS AN EXCLUSIVE REPORT ON WHAT IT IS LIKE TO FLY THE "MANNED MISSILE"



On a sub-zero, mid-winter night, at a farmyard somewhere in the Canadian prairies, the only indications of life are thin, vertically rising columns of vapor emanating from house and barns. All occupants, human, canine, and bovine, are enjoying their allotted eight or ten hours of daily hibernation.

Into this frosty, pastoral scene, comes an alien, uninvited, but not unfamiliar, intrusion. A sound, that begins as a hint of an insane blizzard, rises incredibly swiftly into an ear splitting crescendo; then recedes, equally quickly but with a marked change of tone, a disgruntled werewolf bemoaning the escape of an intended victim.

Dogs howl, cows trample nervously, and a rural family mutter or curse

in their sleep. The mental composition of a letter to a politician may be begun. For this intrusion may come again, and again, before morning.

The disturbances are caused by one or two men, encased by roughly eight tons of metal and electronics, as well as five or more tons of kerosene. The farm is located on a training route of a banshee officially known as the CF-104 Starfighter. Anytime over ten tons of mass moves at over 750 feet per second, audible evidence of its passage will be very prominent to everything within earshot.

Through some quaint accident of design, the 104's engine, a General Electric J-79, emits a sound that is positively supernatural. A high-pitch-

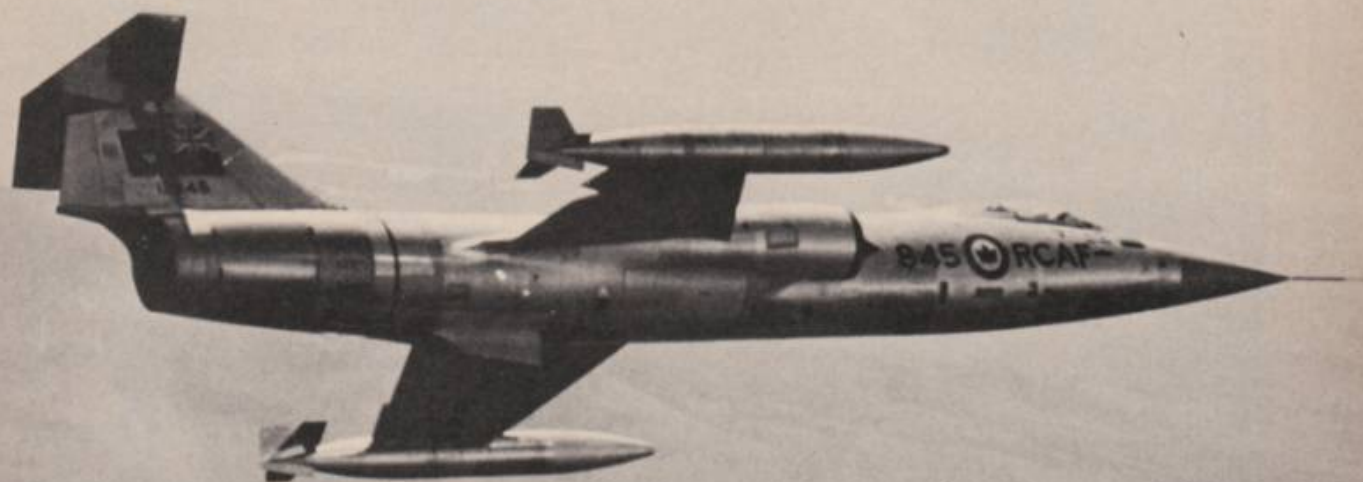
ed, wailing scream, its tone seems to vary with the angle of the ear from the turbine's fore and aft axis. It does have quality in common with most jet engines: LOUD.

One of those noisemakers for a time, I was on the instructional staff of No. 417 Strike/Attack/Reconnaissance Training Squadron at Canadian Armed Forces Base, Cold Lake, Alberta. The vehicle of training was the CF-104.

The F-104 Starfighter—designed by Lockheed in the United States and built in Canada, Germany, Italy, the Netherlands, and Japan—is flown by more Air Forces than any other jet fighter in the western world. Many versions exist; Air Superiority Fighter, All-Weather Interceptor, Ground Attack Fighter-Bomber, Nuclear Strike

WINTER

BY E. A. SEITZ



Bomber, and a Reconnaissance model. It has been called the "Missile With a Man in It," the "Wingless Wonder," the "Widow Maker," and many terms basically unprintable, endearing and otherwise. It was introduced into the Canadian Air Force in the early sixties.

It is an improbable appearing airplane. With its long coke-bottle, streamlined fuselage, and the shortest and thinnest wings ever mounted on an operational airplane, it seems more suited to a launching pad than a runway. Like the bumble bee, it has so little lifting surface that it shouldn't fly. A glider it is not.

From the date of the official announcement by the Department of National Defense that the P-104 had been selected to replace the F-86

Sabre in our Air Force, every "Tiger" in the outfit began maneuvering for an assignment to its cockpit. It was like announcing that parachutes were now available to a bunch of would-be Sterling Mosses who had been tinkering with Volkswagen Beetles.

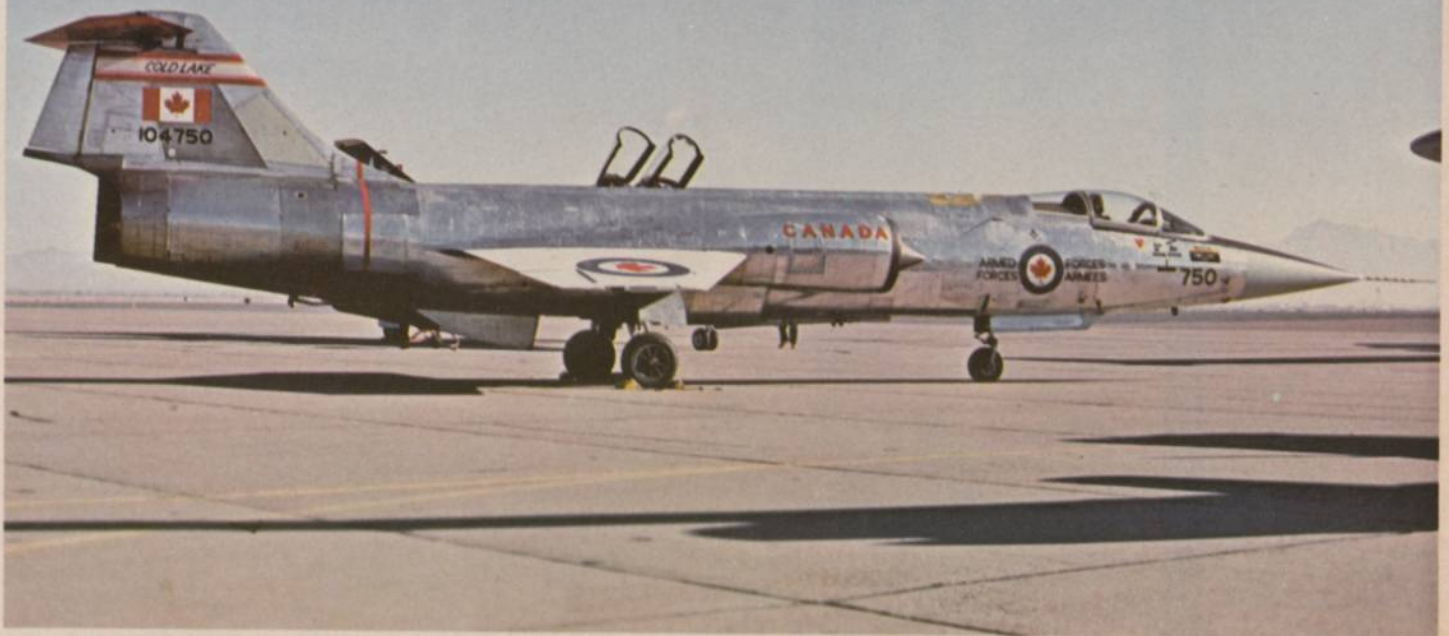
Along with the rest, I applied at the earliest opportunity. At that time I had approximately 3,000 hours in single-engined jets: Vampire, T-33, and F-86. I'd not flown anything equipped with an after-burner. I was numbered among the fourth group of trainees to be checked out in the "thing."

We began the course in the art of flying the 104, but over a hundred and fifty hours of ground training was to be endured before we got to fly that wingless, near-airplane. It is

The CF-104 was able to offer high-speed performance at low altitudes and the Canadian pilots excelled at minimum altitude delivery of nuclear weapons. The thrust-weight ratio of the CF-104 is superior to any other Canadian aircraft. (Canadair #35264)

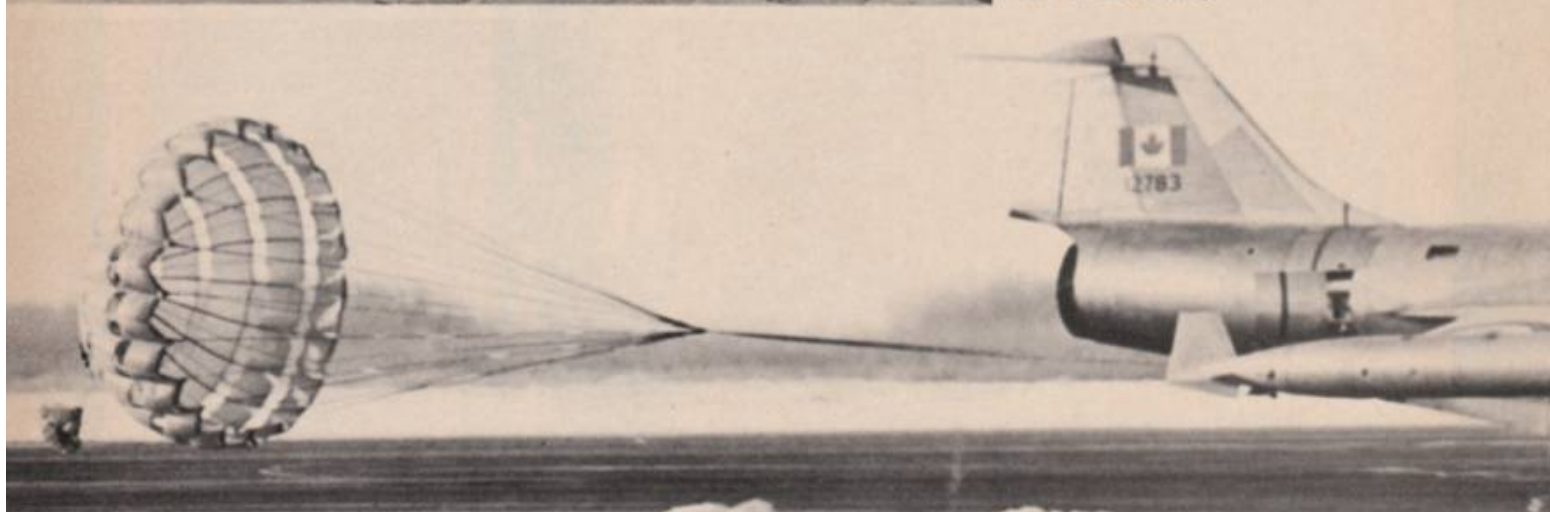
a complex piece of machinery, its sophistication being matched only by much larger aeroplanes. Fuel, electrical, and hydraulic systems, stability augmentation, automatic pitch control and auto-pilot systems, inertial, dead reckoning, and radar navigation systems had to be fully understood in all phases of their usage before we were allowed near the flying hardware. Additionally, check lists and emergency procedures had to be committed to memory. The simulator was invaluable in this phase.

CF-104, CAF #104750, shown at Williams AFB. The wings have been painted white to insure a smooth surface. The large wing roundel is also noteworthy. The Canadian Armed Forces decided, after the Starfighter had been in service for sometime, to change the serial designations to include a 104 before the CAF serial number. Thus, 12750 became 104750. (M. Roth/Centurion Enterprises)



A number of two-seat CF-104s are operated by the CAF for crew training. S/n 104666 is shown carrying a full complement of fuel tanks. (D. Cross)





The author rolls his Starfighter high over Alberta with the North Saskatchewan River in the background. Most pilots agree that the F-104 can roll much faster than any pilot would want to.

The check list for the 104 is of the thickness of a short pocket novel. In the Emergency Section, seventeen items are considered "critical," and twenty-one are so-called "less critical." On studying these, it is small comfort to find that the final solution to roughly half of these is the word "Eject"! Warning lights are all over the cockpit, however, there is a MASTER Caution Panel that illuminates whenever any of the Bird's innards feel an illness coming on. Needless to say, all attention is given any warning lights.

When airborne, the pilot of a single-seat combat airplane rarely finds it practical, or even possible,

Close-up portrait of the author flying the CF-104 Starfighter. The photo was taken from another CF-104 using a 70mm Vitner photo recce camera. (E. A. Seitz)

CF-104 in normal landing configuration at CFB Cold Lake with the drag chute deployed. If the braking parachute did not deploy, there is the distinct possibility that the Starfighter would roll off the end of the runway.

to consult a printed list of Emergency Instructions. The critical emergencies are usually over, one way or another, before the list can be taken in hand, let alone read. To cite one example, a pilot taking off for a routine Maintenance Test Flight felt and heard his engine explode on lift off. Just seconds from eternity he reacted correctly, and survived.

The first five CF-104s for the Royal Canadian Air Force, later Canadian Armed Forces, high over a wilderness area in Canada. The Starfighter was the first operational Canadian fighter to be equipped with an afterburner and the incredible performance took many trainees by surprise. (RCAF)

The gear of the CF-104 is designed to retract in a split-second. Note the ventral fin and the arrestor hook. The first CF-104 flew on 26 May 1961. (Lockheed)

The total time from brakes off, take-off roll, explosion, ejection, to parachute landing, was under thirty seconds. He was slightly singed by the final explosion of his erstwhile conveyance.

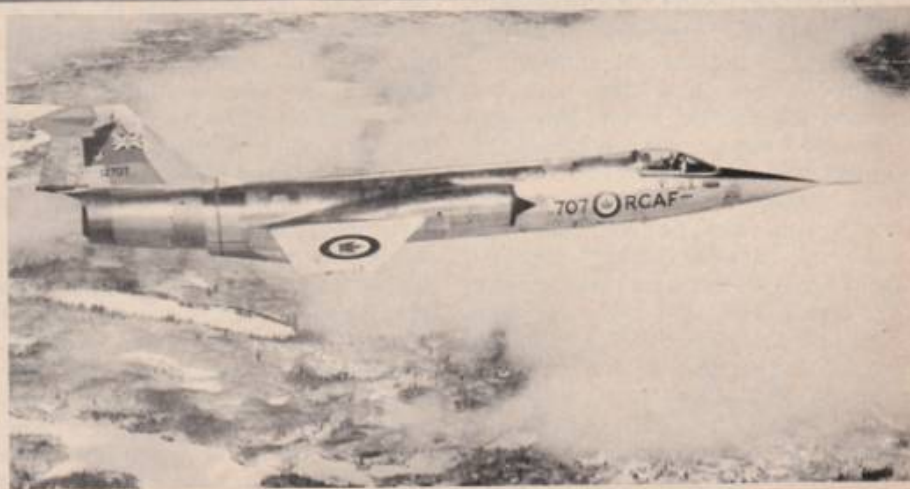
Check lists are studied, emergencies visualized and practiced in the simulator, then committed to the soul, or should it be vice-versa? Check lists are studied after emergencies, to confirm the rightness of your actions to yourself, and to a Board of Inquiry, if the incident was serious enough. If a pilot has done his homework, he will react to a given situation as instinctively as a striking snake. Then, having done all in his power to make up for the fallibility of man-made gadgetry, he either leaves the machine to its own devices or lands it with or without expending some perspiration. Either way he will feel cleansed. A cockpit full of adrenalin is a magnificent destroyer of over-confidence.

The big day finally came, my first flight in a CF-104. Two versions of the Starfighter are available, single



and two-seaters. The first three trips would be in the dual, with an instructor riding shotgun. This was a good thing. After that first flight, most of us were saying "Hail Mary's" for that guy in back. Oh, most of us would like to think we could have gotten the thing up and down without bending it, but it would have

While operating in Canada the CF-104 pilots had to fly over some of the most inhospitable wilderness on the face of the earth. The single-engined Starfighter gave good service and the maintenance problems were kept to a minimum. The CF-104 is shown departing from CAF Cold Lake on a training mission. (RCAF #137550)



An RCAF Starfighter is shown in company with F-104s of Germany and Japan. German Starfighters were produced by ARGE Sud, the South Group, that coordinated the manufacturing programs that took place at four Lockheed-licensed German factories—Messerschmitt, Dornier, Heinkel and Siebel. (Lockheed)

been a wild ride. You see, very few Canadian pilots had had any previous experience with afterburners. To pilots not accustomed to the acceleration of an AB, the takeoff performance of the 104 is not just surprising, it has a demoralizing effect similar to riding a runaway train.

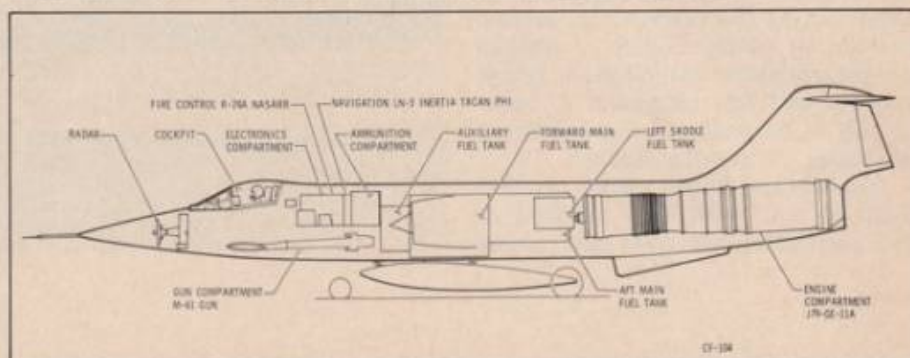
The flight itself? After a month A CF-104 shown at Edwards AFB. The Starfighter has been fitted with a camera/recon package and a long nose probe for flight data information. Canadair, Ltd., with headquarters in Montreal, was the prime contractor for the CF-104 and constructed enough aircraft to fill eight squadrons. (Lockheed)

The main features of the CF-104 are illustrated in this cutaway drawing. It is interesting to note that more than two-thirds of the fuselage is devoted to engine and fuel cells. (Lockheed)

of preparation, strapping in, starting, and taxiing were almost anti-climatic. Pre-takeoff checks just like the simulator, whaddya know?

Now, a firm grip on stick and throttle, and let's do it! On the brakes, throttle to full military power—100% rpm, all vital gauges in the green, and release brakes. The Starfighter starts a sprightly roll forward, but as the throttle goes outboard and full forward, it sags as the jet exhaust nozzle opens wide. Then—Wham! That conglomeration of metal and people trembles with energy as a white-hot fire ignites in its tailpipe. Inertia protests and I am slammed back into my seat as the bird leaps forward. There are five engine gauges you are expected to check before reaching the line-speed marker, a distance-to-go indicator two thousand feet ahead. This is where a pre-computed airspeed must be showing, or the takeoff aborted.

The cockpit is a blur, and I've missed the marker. I hear the voice from the back . . . "Line speed OK. Rotate now. Gear up. GEAR UP!" My, he's impatient. "OK, flags up and watch your attitude. Pull the nose up. Look at your Mach!" Christ, I can't see over the nose now. I missed the line speed, and the 170K rotation, and the 190K liftoff, and almost the 260K gear speed. And now he's yakking about the Mach! Where in hell's that ASI? There! We're just supersonic going up through 12,000 feet. I pull the nose up to what ap-



pears vertical before the Mach Meter bleeds back subsonic.

The voice again: "Remember, we want to level off at 35,000. You want to start lowering the nose about 3,000 feet early." By the time I find the altimeter again and react we are through forty grand. The Man takes over long enough to pull the throttle out of Burner, and level off. Had I entertained thoughts of flying this bomb without benefit of dual instruction?

Level, without AB, the 104 flies very much like any other jet fighter. There is one very marked difference, however. Sub-sonic, at over 35,000, this bird can take very little "G" before a gentle airframe buffeting begins. Yes, stall warning even though the TAS is over 500K. There really isn't very much wing out there. A few turns and other ordinary maneuvers show that while it is surprisingly heavy on the controls, it is fantastically responsive; a hint of aileron deflection and it's inverted. Three-sixty degrees of rotation take place before the stick can be fully moved right or left. An aileron/rudder limiter is in effect when the gear is up and/or the flaps are out of

Land position. Without this limiter, at Mach 2, full aileron deflection would rotate this bird at over 700 degrees per second.

We do some stall approaches, and I mean only approaches to the stall. If the 104 is full stalled, its high tailplane is made ineffective by interference of airflow from the wing. Some lift from the unstalled fuselage tends to bring the nose up further. The airplane then tries to walk on its tail, like a swordfish walking on water trying to spit out a hook, then goes into an exotic maneuver called "Pitchup," from which it can take up to 35,000 feet to recover. Very few pilots intentionally submit themselves to that kind of excitement.

In a stall approach the most important instrument is the Automatic Pitch Control gauge, really an angle of attack indicator. It is monitored through airframe buffeting, Stick Shaker, and Kicker. These last two are just what they are called. At a certain angle of attack the APC system sets up a vibration in the control column. At five knots or so above the stall, a forty pound force pops the stick forward. If you argue with the kicker, you may tumble

through five or six miles of sky whether it's available to you or not. Not unnaturally, this device is out of action in landing configuration. You wouldn't want the stick to flip out of your hand twenty feet up during a minimum speed landing. However, the Shaker is never out of the circuit. You haven't lived until you've seen that stick blur during final turn while riding as a passenger in the back of a two-seater.

Next on our schedule is supersonic flight, and we proceed to the range area under radar control. Clearance received, I move the throttle to full AB. It lights and the bird lurches forward. I watch the Mach Meter with fascination. The indicator reaches one; the altimeter and vertical speed indicator twitch; and we exceed the speed of sound. There is a new sensitivity in the 104, its airframe seems to announce that it is now in the element for which it was built.

Acceleration is fairly slow until we reach Mach 1.5, then begins increasing rapidly. The IAS is approaching 700K. Since we're at 35,000, that speeds over 1,000K true. The two-seat CF-104D with wing tip fuel tanks installed is limited to Mach 1.8. This is because the fuselage, with its bulbous, two-cockpit canopies is now providing more than enough lift for level flight. The wings are nearing a negative angle of attack. Tip tanks aren't stressed for a negative angle of attack at those speeds. This is not the case in the single-seater, with its smaller canopy. On reaching the red-line, I simply pull the throttle out of Burner. Deceleration is brisk, but the bird will remain supersonic for some time at full military power.

"I have control. I want to show you something." The instructor takes over and bends the 104 into a fairly hard turn, holding the angle of attack just below Shaker range. It responds happily, but without AB, speed falls off rapidly. Holding the turn, he says, "Watch the Mach and tell me if you notice anything as we go subsonic."

I watch. The needle retreats through one, and right now there is a positive stall warning airframe shudder. "If you should ever have occasion to do some violent supersonic maneuvering, and your APC systems are out, remember there is no airframe stall warning above Mach One! You have control." Yeah! The guy in ground school did say that supersonic airflow breaks away in a clean shock wave, not in rough burbles like



Pilots of the Canadian wing assigned to NATO are shown ready to demonstrate their nuclear bomb carrying CF-104s. The CAF has since withdrawn from the nuclear capability role. (NATO)

ordinary wrecked air. Point taken; supersonic snap rolls are a thrill I can do without.

Half to two-thirds of our fuel has been burned up. It is time to return to the roost for a couple of attempts at landing. Ninety per cent rpm, takeoff flap down when speed is below .85, and point her back to the circuit.

The circuit and landing are flown in the F-104 very much like any other jet fighter, which is quite unlike the procedure in conventional airplanes. The pattern is joined at the Initial Point, three miles from the landing end of the runway. Over the button, the machine is hauled around into variations of a 360 degree slowing and descending turn to a landing. There are a number of operational reasons for this type of pattern, not the least being that is the fastest way to bring down a large number of aircraft, singly, or in formation.

We hit the Initial at the prescribed 325K, advise the tower, and aim down the runway. Now! Over the button, bank and pull three "G," and the speed bleeds to 260K as we roll out downwind. That's undercarriage speed and down it goes. Abeam the button at 240K, I select flaps to Land position, and roll into Base turn. Maintain power and at least 200K in the turn. Should be lined up a mile back and 300 feet up. Let the airspeed drop to 170, and fly her down. "Don't cut power on roundout," the

Man said. Speed brakes out and she greases on with a dual squeak of tires.

Touch and go. We do it again. Flaps up to position, speed brakes IN, three zots of forward trim on the stick-mounted button, and full Mil power. Shed of the majority of its parasitic fuel load, the 104 doesn't know its Burner isn't lit. We're airborne again in less time than it takes to tell it. Three hundred knots and haul it up into 45 degrees climb and 60 degrees bank. Man! It wants to accelerate even in this attitude. Throttle back to settle downwind at gear speed. Wheels, flaps and 170 on final. This is going to be a full stop and I momentarily forget the much-memorized drill. Over the button habit takes over. Crunch! We collide with the runway, bringing an oath from the back seat. My face is red. I've been briefed a hundred times if once: you NEVER close the throttle on landing the F-104 till you're on, or within six inches of the ground.

Why not? Because the F-104 uses BLC, or Boundary Layer Control, to permit it to fly slower in landing configuration. BLC is a powerful blast of air over the upper surface of the flaps when they're in Land position, i.e., leading edge at 30 and trailing edge at 45 degrees of depression. BLC draws its air from the engine compressor, and requires at least 83% rpm to maintain. If engine power is cut to its 67% idle rpm, the airplane isn't about to stall, it already has—you are falling. Normal touchdown is 150 to 155 knots. Minimum, but absolute minimum, touchdown is 140K. At this speed supporting lift is transferred to the wheels, regardless of runway location.

There are, however, many occasions when power is cut after roundout. In most emergency landings the pilot will use only Take Off flap selection, which is 15 degrees of depression for both leading and trailing edges. This involves a final approach speed of 195K and a touchdown of 170 K, and up to 2,000 feet more landing roll. With flaps in TO, the airplane is much more responsive and a go-around is infinitely less scary than with it all hanging out.

An emergency in itself, and the bane of their existence to the instructors who have to demonstrate it, is the totally flapless landing. Without flap the Starfighter's miniature wing is fully appreciated, or cursed, depending on point of view. The airplane is unhappy at anything under

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CF-104

(Text continued from page 47)

300K, and that's the speed you maintain till you're lined up, as far back as possible. On final, speed is reduced to 260K, and gear is lowered. Then a minimum of 235K is held till roundout. Touchdown occurs at 195K, with the Stick Shaker chattering like a rattlesnake's alarm. The drag chute, deployed at its upper limit of 185K, is wonderfully effective, and very necessary. Its failure would result in coming to a stop with cherry-red brakes, and/or a set of blown tires.

Yes, the power can be cut before touchdown in both TO and flapless landings, since BLC is not a factor. Not too far back, however, as in both types of landing, and particularly the latter, the attitude is very nose high and a great deal of support is obtained from lift vectored engine thrust. It still drops rapidly when power is cut. It is this landing attitude that frightens instructors demonstrating the flapless landing. They can't see the runway until they're over it.

It is noteworthy that the F-104 was used in training X-15 pilots in landing that rocket ship.

With the required dual completed, all solo is flown in the single-seater. It is only slightly different. It is somewhat heavier, carrying more internal fuel, has an auto-pilot, and has a higher limiting speed with tip tanks installed. It is in the single that I reach Mach 2 for the first time. That this is the limiting speed is not due to lack of thrust to push it faster, but rather due to a rise in temperature at the engine air intakes. When the critical temp is reached, a red light that says SLOW begins flashing in the cockpit. This occurs at

just about Mach 2. To my knowledge, no one has ignored this warning and continued to accelerate. I guess that peculiar combination of curiosity, guts, and stupidity is pretty rare. Who really wants to find out what happens when the front of an engine starts to melt at about 1,400 mph?

The airplane's raw excitement recedes as training progresses but over-confidence remains well buried. Ever lurking in the back of the mind is the hard fact that if anything goes a little wrong in a 104, your corrective action must be correct the first time! Or your \$2,000,000 go-cart can be destroyed, bruising you in the process.

The machine is as reliable as its designers and builders could make it. However, since men and materials are fallible, and Acts of God aren't always benevolent, a pilot must be prepared for the occasional unpleasant surprise. The F-104 has been described as unforgiving. I don't like that word. Critical, yes, but 99.9 per cent of its panics can be survived if the right action is taken at the right time.

It is perhaps a mixed blessing that the characteristics of an ailing F-104 make for easy decisions. It has been said that if this bird flames out, it lands straight ahead, regardless of current position or altitude. In truth, it has an engine-out glide ratio of three-to-one, or a half mile forward for every thousand feet of altitude. It takes a minimum of 12,000 feet (15,000 is a more realistic figure) to complete one 360 degree gliding turn. With its minimum glide speed at 245K, the idea of bellying it into the nearest pasture just isn't on. First impact would result in a ball of fire. To make it to a runway, you must have your flameout pretty close to home, and fate is rarely that cooperative. So if that engine quits, give it back to the taxpayers and

walk home.

Preoccupation with emergencies lessens as time is logged in training. It is in some navigation phases of its purpose in life that the CF-104 gives drivers some of their greatest thrills. Strike and attack are basically low-level roles; the lower, the better. Ordinarily low flying is an anathema to authority, civil or military. It is akin to speeding in a school zone. Violators can suffer the extreme penalty.

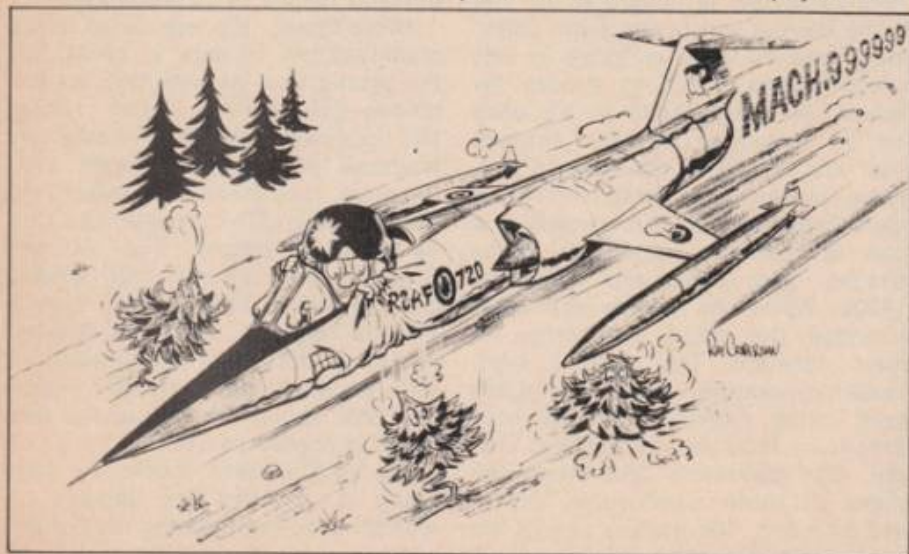
In this role a select group of high-spirited fighter pilots are suddenly given a license to steal, as it were. Not only are they allowed to fly below legal altitudes, they are ordered down to the trees. Talk about Cloud Nine!

Flight at very low heights can be among the most exhilarating of human experiences. Skimming tree-tops, getting right down into fields, seeing the startled faces of wingless earthlings, is a sensation little short of godliness. Double your speed and double your pleasure, it is a trip the likes of which cannot be chemically duplicated. Not without its price, though, for it is as dangerous as exciting. A split second's careless inattention can result in a brush with unyielding earth, disintegrating airplane and crew.

Very few vehicles fit more naturally into very high speed, very low level flying than the Starfighter. One of the more serious problems with this type of flying is turbulence. Its washboard effects can shatter a lightly loaded aircraft at speeds in excess of 400K. The thin-winged 104 eats up rough air with scarcely a burp.

On one of my early solo flights, having completed the mandatory exercises and having a goodly load of fuel remaining, I decided to experiment with my pointy-nosed pursuit ship. I wanted to see 600K on the ASI while close to the ground. Accordingly, I headed into the range area where anything goes. Getting comfortably close to the trees, I let 'er rip, at full military power.

It is impossible to describe the sensation of speed that is yours when charging over the landscape at over 1,000 feet per second. Directly below, if you dare look, is a simple blur. Objects half a mile from your path recede as rapidly as fence posts viewed from a racing automobile. Isolated trees appear on the horizon and pass under in seconds. They seem to duck at your approach. All, but all, your attention is riveted to the onrushing panorama ahead. The airplane seems to have a death wish, wanting to go lower and faster.



I knew this kiddy-car shouldn't go supersonic without AB. I sneaked a peak at the ASI and did a double-take. It read 640K and Mach .99999!

Unable to resist temptation, I slipped it into full Burner. The bird lurched ahead, oblivious to Sonic Number One. I let it run till it exceeded 700K. It is safe to assume that it was a little noisy below. Fearing that I might leave the range area I hauled it up into a "G" rotation. Through 10,000 feet and not yet vertical, my chariot was still stomping on Professor Mach's Unity. As we started to go inverted, I eased up on elevator pressure, barely keeping myself in my seat. When the horizon finally appeared, I rolled into level flight and throttled out of AB. I sat there, revelling in sensations, marvelling that I more or less was in control of this thing. I had started an Immelman from the deck, and rolled out at over thirty-five thousand feet!

We don't do such things every day. We fly our low-level cross countries at a sedate 450K, high level at Mach .9, or 540K, only rushing into target areas at up to 600K. High speed makes navigation easier. Beam winds have less effect, and time corrections can be effortless. Of course, if the navigator boo-boo's, that same speed can take him off his map in seconds. Navigation is really a simple procedure. Point your conveyance in the right direction, proceed at a given pace for a given period, and you're there, barring complications, that is. The measuring numbers don't matter, they could be furlongs per fortnight.

When I was checking out in the CF-104, only two roles were in vogue, Strike and Recce. Both are meticulously planned navigation missions, with a few uncomplicated bombing or shutter-clicking maneuvers thrown in. Challenging, certainly, but not totally satisfying since only a small portion of the steed's performance capability is utilized.

The low flying is great but there are other temptations. Very often we have ten or fifteen minutes of reserve fuel remaining after completing the prescribed training exercises of some solo missions. If the weather is right, this is play time. The Starfighter does all standard aerobatic maneuvers with comparative ease, but, if one gets careless, will invent one or two new ones.

The positive ailerons will roll it with the thought and a barely perceptible pressure on the stick. Vertical rolls are pure joy. Put 600K on the clock, light the Burner and pull

it straight up. With the stick partially over you will roll up out of sight, losing count everytime, and recover in the vicinity of 30 grand. One never does more than one maximum rate roll. Not only does partial aileron give sufficient rate of rotation, but with maximum rotation the center of gravity of the long fuselage divides itself into two centers, one each for nose and tail. These separate C/Gs are not equi-distant from the center of rotation, and will, therefore, begin a sort of spiral around each other, probably ending in some sort of rolling tumble. The final outcome of this maneuver has not been fully explored.

In the looping configuration the F-104 requires a bit more care and skill than airplanes with lower wing loadings. For example, the Canadian Armed Forces' basic jet trainer, the CL-41 Tutor, can be looped with idle power starting at 200K. With idle power there is no way a 104's nose could be raised past 45 degrees above the horizon without the airframe rebelling violently.

While the "missile" can be looped with or without afterburner, the military power loop is more of an exercise in critical attitude aircraft handling than an aerobatic maneuver. Starting with as much airspeed as you can muster short of Mach 1, you gingerly haul the nose up, drop takeoff flap as soon as the airspeed drops below 450K, and continue over the top about 12,000 feet higher than starting altitude. Here the speed is reading below anything you ever saw in level flight, but since you're holding almost zero "G," it's still flying. If that speed falls below 100K, the gyroscopic effect of your rotating turbine may alter your aircraft heading up to 90 degrees in an inverted, flat skidding turn. You don't argue with it, but let it do exactly as it will. A twitch of the stick here will bring on pitch-up (down?), but with the aid of gravity you can recover from this much more readily than the right side up variety. The back side of the mil power loop is normal, though not always in the intended direction.

With the burner lit it's a different airplane. The extra 5,800 lbs. of push allow you to haul it around at high "G" figures like other jets. Most common starting speed is 450K, though a sloppy and unround vertical 360 degrees of attitude change can be accomplished with entry speed as low as 375K. Loops inside 5,000 feet can be managed. You come out of burner on the back side of a loop, or the "G" loading required to avoid excessive buildup of

speed would be crushing. You do not, however, throttle below 100% rpm. The thrust that is converted to lift-vector by the fifteen, or more, degrees of angle of attack that is maintained throughout dive recovery, is very necessary for that recovery.

With practice, a very impressive airshow can be put together in the 104. It's exceptional acceleration from slow flight to very high speed can be utilized to good effect. There are a couple of no-no's, however. To my knowledge, no one has ever completed a double loop, or vertical figure eight, in a Starfighter. And, of course, any kind of stalled maneuver would end an airshow most impressively with a large cloud of black smoke.

Some of us occasionally, and against orders, played at air combat. Some suspected shortcomings were confirmed and others discovered. Rearward visibility, one of the most important desirables in a fighter airplane, is lousy. This is a common failing in most modern fighter designs; collective density of brain apparently having taken possession of the creators of combat aircraft the world over. All were apparently convinced that their own particular Mach 2 brainchildren could never have equally speedy opponents sneak into 6 o'clock killing positions. Of course, all had eagerly subscribed to the theory that the death-knell to the old fashioned dogfight had long since sounded. Vietnam has brutally disproved that ever lingering, ever surfacing, bit of wishful thinking. It is interesting to note that the third generation of supersonic fighters, exemplified by the F-14 and F-15, are sporting all-round vision canopies, last seen in the F-86 Sabre.

We very quickly confirmed that the old Sabre-style rat racing, scissoring and buffeting right on the stall, or in gut wrenching turns sometimes right down to the deck, was not the 104's lifestyle. When both attacker and evader have to pay more attention to flying than fighting, then both have slipped out of their steeds' best performance envelope—fatal error in real combat against most other fighter designs. In any case, simulated combat between identical aircraft hardly ever proves anything beyond relative pilot abilities.

It was not until we had completed our training sojourn at Cold Lake and had been organized into a squadron at No. 4 Wing, RCAF, near Baden-Soellingen, Germany, that we had opportunity to try our "Wingless Wonders" against more conventional fighter hardware. Not immediately,

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CF-104

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nor with official approval, were we able to cast the glove of challenge roundabout. We had, after all, been formed as a Nuclear Strike Unit. Bombers! We carried neither guns nor rockets, nor the associated sighting equipment.

Officialdom had feared, when the F-104 had been selected for our Air Works as a Strike and Recce vehicle, that our pilots would turn and fight

if intercepted, forgetting the primary mission. It was considered more desirable, apparently, to keep the bombers defenseless, to risk losing weapon, aircraft, and pilot than to have the pilot jettison his nuke and return home, possibly with an enemy aircraft destroyed. This philosophy prevailed until 1971, when it became current philosophy that the capability of nuclear retaliation to nuclear attack was too heinous a characteristic for our image as a mod and liberal and progressive nation, and we opted out of nukes as of December 31, 1971. Since then the Canadian Forces have been re-rigging their CF-104's for conventional weaponry at five or six times what the original cost might have been.

Toothless though we were, we pretended armament, and took runs at anything military that intruded into our sky. These acts of sham belligerence usually took place on the way home from practice nuke delivery missions. The coincidence that these little hassles occurred at our airplanes' best fighting weight, i.e., with less than half a fuel load remaining, was as much plan as happenstance. Very few aircraft in the world are as weight-sensitive as the Starfighter.

Regardless of weight, however, there are damn few warplanes that cannot out-turn the 104. Only one comes immediately to mind and that is the F-101. Its wing loading is in the same ball park as the 104s. It also has the same pitch-up or super-stall characteristics. The F-105 is also in the same wing loading category, but with its low mounted tail-plane it can hang in there at low speed and full burner turns at angles of attack that would have kickers activated in both the F-104 and F-101. The F-4 and F-5 are both blessed with more wing per pound and therefore have shorter turning radii. Compared to our stub-winged "Missile," the Delta-Wingers, the F-102 and F-106, and the French Mirage III, can take square corners. Our only advantage over these being better acceleration and less airspeed loss at high "G" loadings at very high speeds, like supersonic.

It goes without saying that 104s don't get into turning contests with trans or subsonic fighters. When contending for a piece of sky against these, the name of the game is to indicate speeds of 600K or better at low altitudes and Mach One Plus when higher up. Some of these slower birds can display mongoose-like agility if they spot an attacker in time. If the jockey of a supersonic hot-rod allows himself to be lured into a ring-round-the-tail chase at

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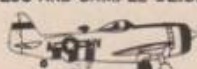
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anything below Mach .95 he very quickly finds himself leading the conga line.

Regardless of the calibre of opposition, the F-104's only real forte is speed. When Mach 2 is the base figure and combat is actually joined, a speed advantage of 100 to 200 knots can be easily neutralized by gun and missile. Positioning at time of contact counts for everything for the attacker, as evasive maneuverability does for the attackee. Positioning is a matter of luck, eyesight, and/or radar control or warning. Combat at Mach 2 would be decided in seconds, and contact lost.

When a 104, or any other Mach 2 fighter, finds itself with speed or height advantage over a target that is flying subsonic, that advantage need never be lost regardless of the target's max performance. The target may save itself by evasive action, but its mission profile will be disrupted and that's the name of the game. Sure, airplanes like the Starfighter can snarl around the sky at up to 750K at tree top level, and up to 1,200K at high levels. They can do it and threaten everything in a given area, using an exotic technique to go up and down called "Energy Maneuvering." They can do it and be practically invulnerable to attack. But they can't do it for very long or very far from home. Supersonics mean After-Burners and that means fuel consumption of up to 48,000 lbs. per hour for the 104 at 750K at low level.

When not chained to a rigid flight profile supersonic flight can produce some pretty delightful kicks. In Canada, supersonic corridors are rigidly controlled and limited to unpopulated areas. In Germany, at that time, as long as we were at 30,000 feet or higher, the area didn't matter. In one of my early free romps after arriving at our base on the Rhine, I was lurking just above the contrail level at about 36,000 looking for a victim on whom to pounce. I spotted one, a little lower, about thirty miles away, the white condensation vapor trailing him for miles. I went full burner and went after him, sliding directly under his 'trail, in his blind area. The setup happened to be perfect, I was hitting Mach 1.95 just as I passed him. It is fortunate that I didn't have a proper gunsight with which to do a simulated firing pass, because I'd gone through him. It was a two-seat F-100D, cruising at a genteel Mach .9, that I steered to miss by thirty feet. I knew my bird's performance even though this was one of the first times I was playing at the top end of its envelope. But I

hadn't really thought about, let alone visualized, and overtake speed in the vicinity of 700 knots! I passed that F-100 when I was mentally a mile back! My mental jolt was at least as great as that of the guys in the 100. The shock wave of my passage must have had them thinking they'd been in a collision.

As I was recovering from my surprise, my instincts took me into a hard climbing turn to establish a perch from which to launch another pass. Naturally, my eyes were over shoulder to keep my victim in sight. I still had their 'trail when I arrived in the desired position, parallel to their heading and 4 o'clock high. The Stick Shaker rattled, and I glanced into the cockpit. Airspeed—about 280K, Mach—just over 1.0, altitude—nudging 66,000 feet! Je-sus!

I forgot my simulated hostility, rolled inverted, and gently pulled the nose down toward more hospitable climes. I returned to base resolved to do a lot of studying and thinking on this machine's max performance envelope. A flameout in those higher regions, engines can starve for air, would result in loss of pressurization and extreme danger to pilot, ME, since "Moon Suits" were not on issue. I recall horror stories way back in my intake of aviation lore that blood boils at altitudes in the sixties of thousands of feet, invariably with fatal consequence. You can do yourself injury by flying too high, as well as too low, in this airplane.

In the next three years that constituted my tour in Germany, I came to the inevitable conclusion that while the F-104 can be an effective combat aircraft if it has everything going for it—speed, altitude, and position—it is not an outstanding one. It can do its things only at very high speeds and associated high fuel consumption. The Starfighter does many things well, but nothing best. Each and every item in its bag of performance tricks can be matched or bettered by many other airplanes.

A spectacular feat of design and engineering it may be, but more in appearance than fact. Its two most outstanding features, the high tail and tiny wing, are more liabilities than assets. The high tail, because its position makes it ineffective at high angles of attack, prevents full utilization of what little wing area the airplane has. That wing, mounted on a research vehicle designed to log most of its flying time at over Mach 2, would make sense, on a working airplane such as the F-104 is

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meant to be, it doesn't. Even Lockheed has tacitly admitted this. Their proposed successor to the 104, the Lancer, was to have been given at least 50% more wing and a low mounted tailplane. Performance in acceleration and top speed would be greater using the same engine and landing speeds lower.

Supposedly designed with lessons learned from aerial warfare over Korea in mind, a very good argument could be made that the creators of the Starfighter ignored air combat lessons dating all the way back to World War I! All else being equal, to survive in a daylight environment where air superiority is in contention, a combat airplane MUST have either speed or maneuverability going for it; or rearward firing armament.

For the next few years 104 jockeys who find themselves in shooting wars will most likely encounter the MiG-21 as their major opposition. This bird was designed in the U.S.S.R. at roughly the same time and for the same purpose as the Lockheed brainchild. The 21 is several thousand pounds lighter than the American design, but has nearly twice the wing area and probably half the turning radius. Its engine has roughly 75% of the 104's thrust and

proportionately lower fuel consumption, but manages to push the MiG to a max speed of Mach 2.05.

The only known live ammo confrontations between these two fighters took place during the India/Pakistan war of 1971. The Indian Air Force MiG-21s were victorious over the Pakistani Air Force F-104s in every instance! At least according to the Indian Air Force. It is probably safe to assume that the pilots of those opposing air forces were roughly equal in skill and experience.

Not invincible, MiG-21s of the Arab Air Forces took a savage mauling from Israeli Mirage IIIs during the six day war of 1967. In this short scrap it is reasonably safe to assume that there was considerable disparity in pilot skills and strategy. I'd like to mention here that in our encounters with French Air Force Mirages we were humiliated more often than not, unless we had speed and/or height advantage and lots of it. The MiG-21's were not exceptionally successful against U.S.A.F. F-105s and F-4s over North Vietnam. Pilot skills were probably a factor there. It is probably noteworthy that while the F-104 is an American design, it never gained real acceptance in that air force.

The Lockheed F-104 Starfighter's

amazing success story in becoming the major combat airplane of ten-odd air forces cannot be attributed to its built-in or intrinsic qualities, for it is not really a very good machine, but to rather exceptional salesmanship. Perhaps gullibility of unqualified decision-makers in many lands was also a factor.

In Canada, the selection of the F-104 and its major role initially resulted in happy coincidence. The role was Nuclear Strike, not Reconnaissance, because that's a daylight game and the 104 is vulnerable to most modern fighters. The F-104G, or CF-104 as our version of that model is known, is probably one of the best Nuclear Delivery Systems in existence for its size, cost, and range. Of course, it should be used only at night or in weather in which enemy day fighters couldn't fly. The vagaries of governments have decreed that we are no longer that game.

The *Raison d'Etre* of nuclear bombers, ultimately, is deterrence. Isn't that a political and strategic sounding word? A potential peace-disturbing nation, or group of such, is given fair warning that if they misbehave too crudely some loud and hurtful objects may be dropped on their collective heads. Should

deterrence have failed prior to December 31, 1971, our 104 jockey's contribution to the chastisement of the ungodly would have been Nuclear Strike Combat Profile Missions.

The Nuke CPM is basically a simple mission. Its purpose is merely to place an assigned weapon within effective distance of an assigned target. When a nuke is the payload another very important requirement is added to our airborne retaliators' problems for the day. Nukes must be detonated within a very rigidly controlled time block. The desirability for accurate unloading is easy to understand. So is a desperate need for punctuality, if it is thought about twice.

Very often targets that merit nuke attention are located in relative proximity of each other. If a tight schedule was not strictly enforced, one of your buddies might just be too near your objective and be vaporized when your super flash bulb lights up. Worse, you might be exposed to an ally's war effort yourself. Worse still, in the opinions of cost-conscious planners in various headquarters, would be such misfortune befalling you before you were able to place your "payload," thereby lessening the overall megatonnage delivered, cost-effectively. After a fashion, the nuke CPM resembles a car rallye, but the incentive for accurate timing in navigation is somewhat greater.

Three years of sightseeing trips in the form of practice nuke CPMs over much of Western Europe and in hundreds of friendly combats, no one was shot down by live weaponry. After innumerable and totally confusing misadventures with some European Air Traffic Control organizations, I was posted back to Canada to CFB Cold Lake as an instructor on CF-104's.

European Air Traffic Control, patterned after North American and ICAO approved procedures, doesn't always turn out to expectation. Interpretation varies, I guess, but some French, Italian, and Greek controllers sometimes interpret air regulations in ways completely incomprehensible to outsiders. We were exposed to the first two five or six times annually on flights to Decimomanno, Sardinia, where we did our weapons training and to the third only occasionally on flights to Athens or Cyprus.

The Deci haul was in the vicinity of 700 miles and meant an IFR Flight Plan at altitudes between 30,000 and 35,000 feet. Two thirds of the flight was over France, the remainder over the Mediterranean and Sardinia under Italian tolerance. France control would usually assert its authority

soon after contact by giving us a change of cruising altitude, quite often to an unacceptable high or low level like 50,000 or 10,000 feet. When the new flight level was declared unacceptable, the reply from the controller would be: "Your flight plan is cancelled!" and silence. Only a MAYDAY call could evoke further conversation. The first time it happened you wondered whether you were expected to bail out, go home, or continue. After that first time it became the preferred way to travel, weather permitting.

After passing Corsica, ATC clearances were given reluctantly by the Italian agency, Rome Control. Response to radio calls was invariably slow in coming, but could sometimes be hastened if one said loudly and distinctly: "Roma Control, this is . . ." An exasperated voice was once heard to say: "Luigi, answer the Goddamn phone!" No answer, but a few days later a NOTAM came through to all NATO flying units which stated: "Rome Control is not to be addressed as Luigi . . ."

One improbable story persistently made the rounds for some time. A Canadian aircraft going into an Italian Air Force airdrome in bad weather asked for and was handed over to radar for a Ground Controlled Approach. The operator put him on course and advised him to commence descent on the glide path. Silence followed. Nearing minimums, the pilot called GCA. The reply: "Canadian Air Force . . . You on course, on glide path. Don't touch a nutting . . ."

Greek ATC was more predictable. They would reply only to aircraft over compulsory reporting points or destinations. At no other time would they condescend to communicate with mere pilots. In one way at least my return to Canada was a welcome change; ATC operates more or less as it is meant to.

On the theoretical night of the opening paragraphs I might be comfortably strapped into the front cockpit of a two-seat CF-104D. In back I have a trainee who has an Instrument Flying Hood covering his cockpit. The gauges are the only way he can keep his marbles right side up. The sounds I hear are the reassuring whine of the J-70 in the background accompanied by the whisper of air rushing over my transparent hood.

I am reasonably busy, monitoring our bird's speed and heading, checking our position on map and radar, checking our time, in seconds, over recognizable features on radar and visually if possible. And, most im-

portant, keeping an eagle eye on our altitude. At our speed, a couple of hundred feet can be lost in a heartbeat.

I hear some muttering too. I'm only monitoring the numbers I see in the cockpit. The trainee in back is flying the machine. He mumbles as he stays within one degree of heading, one or two knots of ground-speed, and twenty feet of altitude, making all height errors on the high side. Before airline drivers develop superior sneers, I want to point out that he is doing this less than 500 feet above ground and that the foregoing are less than half of his total task.

In his left hand he holds a strip map of his route. To this he attempts to match the indistinct, continuously changing forms on his radar scope which is his only link to the outside world. He eliminates all track error. He does not revise his Estimated Time of Arrival at his target; he revises his speed to meet that ETA on the second.

He has been assigned a Time-on-Target of a given second. His little flash-producing practice bomb is to detonate on that second, after falling several thousand feet. Two observers, positioned at scoring sites near the target with watches synchronized with Base Operations, will check time and accuracy when they see the flash.

He becomes a little busier later in the mission. Some 75 miles from his target he accelerates to roughly 1,000 feet per second and stabilizes at a new and lower height above ground. He locates a tiny, fuzzy blip on his scope and homes in on it, allowing pre-computed Kentucky windage for the drifting effects beam winds may have on his bomb. Having completed his Armament Check List he will depress the Timer Bomb Release button at exactly the right tenth of a second when his cursor touches the target on his scope. Precisely on signal he will fly the airplane into the correct delivery and escape maneuvers and recover safely. Having just survived seven or eight of the busiest minutes of his life, he can relax.

He has just completed the operational portion of a Night Radar Combat Profile Mission. He can relax as he turns to something more mundane, like recovery at base into simulated below IFR minima weather conditions. He may have lost a couple of pounds in honest sweat, but he hasn't given a thought to sound pollution or to the natives of the northern prairies who may have cursed our passage.