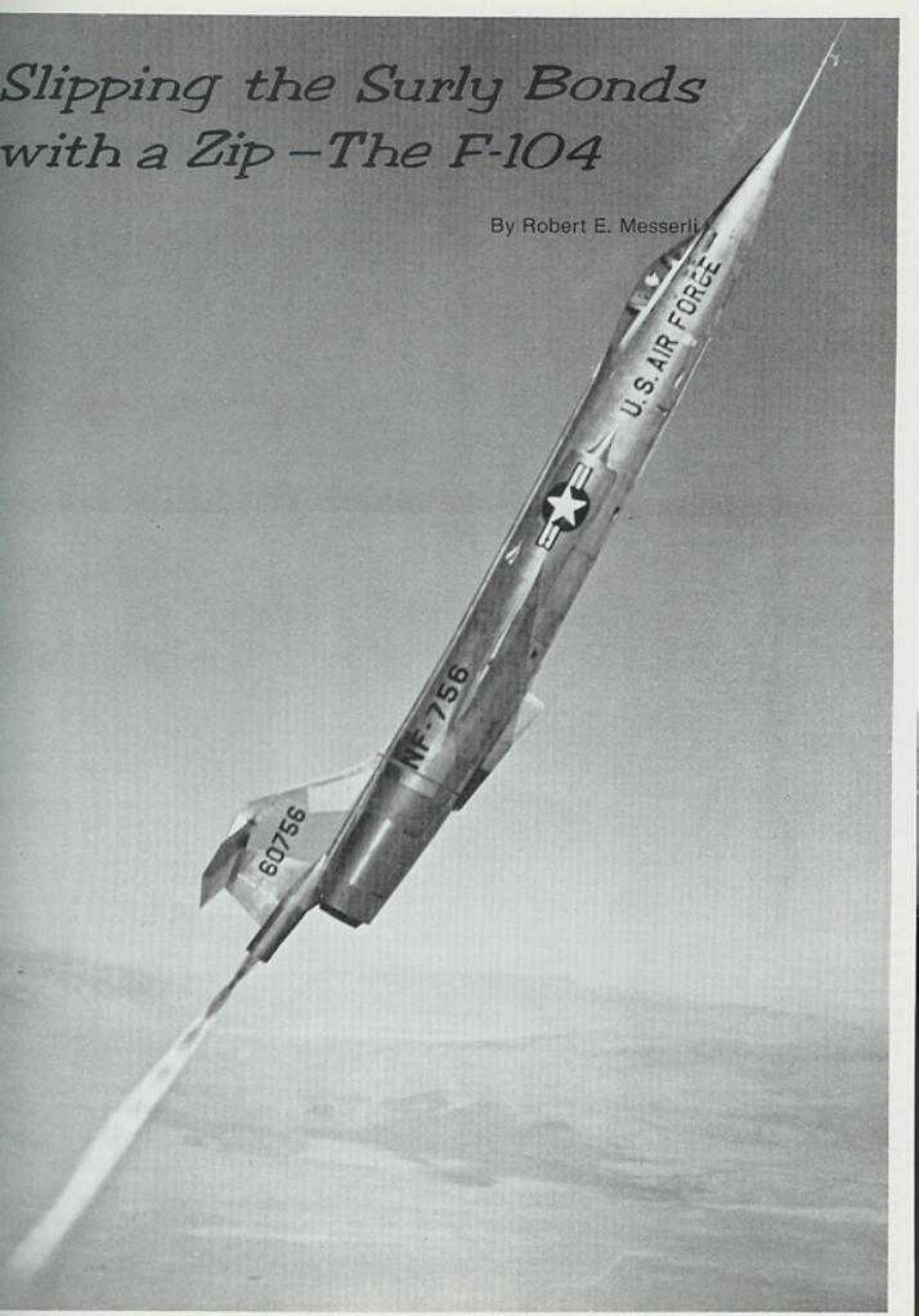
Slipping the Surly Bonds with a Zip – The F-104

By Robert E. Messerli



WHEN I first saw the F-104 Starfighter I knew in an instant why the press dubbed it "the missile with a man in it." With its sleek needle nose and long, slender fuselage it looked like it was doing Mach 2 just sitting still. Affectionately called the "Zipper" by those who flew it, the F-104 had razor-sharp leading edges and stubby wings which contributed to its lightning-quick appearance. It's horizontal stabilizer was set high on the tail fin and was shaped like a "T" for optimum stability from takeoff to plus Mach 2. This aft section, with the entire horizontal stabilizer moving as a "flying tail," was a unique feature. The success of the Starfighter's empennage proved to be one of the few times such a design performed satisfactorily.

The innovative canopy design was an aviator's dream. Pilots were on top of the world while comfortably poised on the nose of the aircraft, enjoying virtually unlimited visiblity. It was akin to a motorist being seated on the hood of a car rather than confined behind the wheel. The excellent rear visibility was especially important to fighter pilots and had been unequaled until production of the F-15 and F-16.

The F-104 cockpit was entered via a metal stepladder placed alongside the canopy. From the top of the ladder, you stepped into the cockpit, placing the heels of your feet into the stirrup attachment. This fastened the spurs onto the end of a cable as you put foot pressure against the snap. The rest of the procedure consisted of a backpack-type parachute and conventional two-shoulder harnesses attached to the lap belt. Subsequent modifications to the West German F-104G aircraft have included the Martin-Baker seat, which did away with wearing the backpack-type parachute.

The very first models of the F-104A had downward ejection. The aircraft was designed that way because when using upward ejection the seat would not clear the high vertical tail during high-speed ejections in excess of 1.8 Mach. However, a modification was made to change all the aircraft to upward ejection because the success rate of downward ejection was not very good and the probability of ejecting above 1.8 Mach was considered unlikely.

The intricate and detailed design which had gone into the layout of the F-104 Starfighter's cockpit was evident immediately upon entry. The 360° cockpit visibility was previously unmatched. In addition, the simplified instrument panel was one of the best ever constructed. Every switch was within easy reach, annuciators were grouped together for high visibility, and gauges were easy to read and interpret. The simple instrumentation, with emphasis on such features as the gunsights,

Robert Messerli next to his F-104.

made this "manned missile" a fighter pilot's best friend.

Pilots were required to wear spurs on the heel of each flying boot. These spurs were fastened to the end of cables extending from the stirrups of the ejection seat. This maneuver proved to be a bit tricky during my first few attempts to get hooked up properly, but once I got the hang of it, I was not even aware of the attached cables. This design was to prevent knee and leg injuries during ejection. The cable would retract and pull your feet safely back within the stirrups prior to the ejection sequence. There was no doubt that when you stepped into the cockpit of the F-104 you strapped the aircraft to yourself and became part of this awesome machine.

Once strapped in, it was one of the easiest aircraft to start. The starting procedure consisted of connecting external electrical power and air pressure. The procedure was rapid and included the following steps:

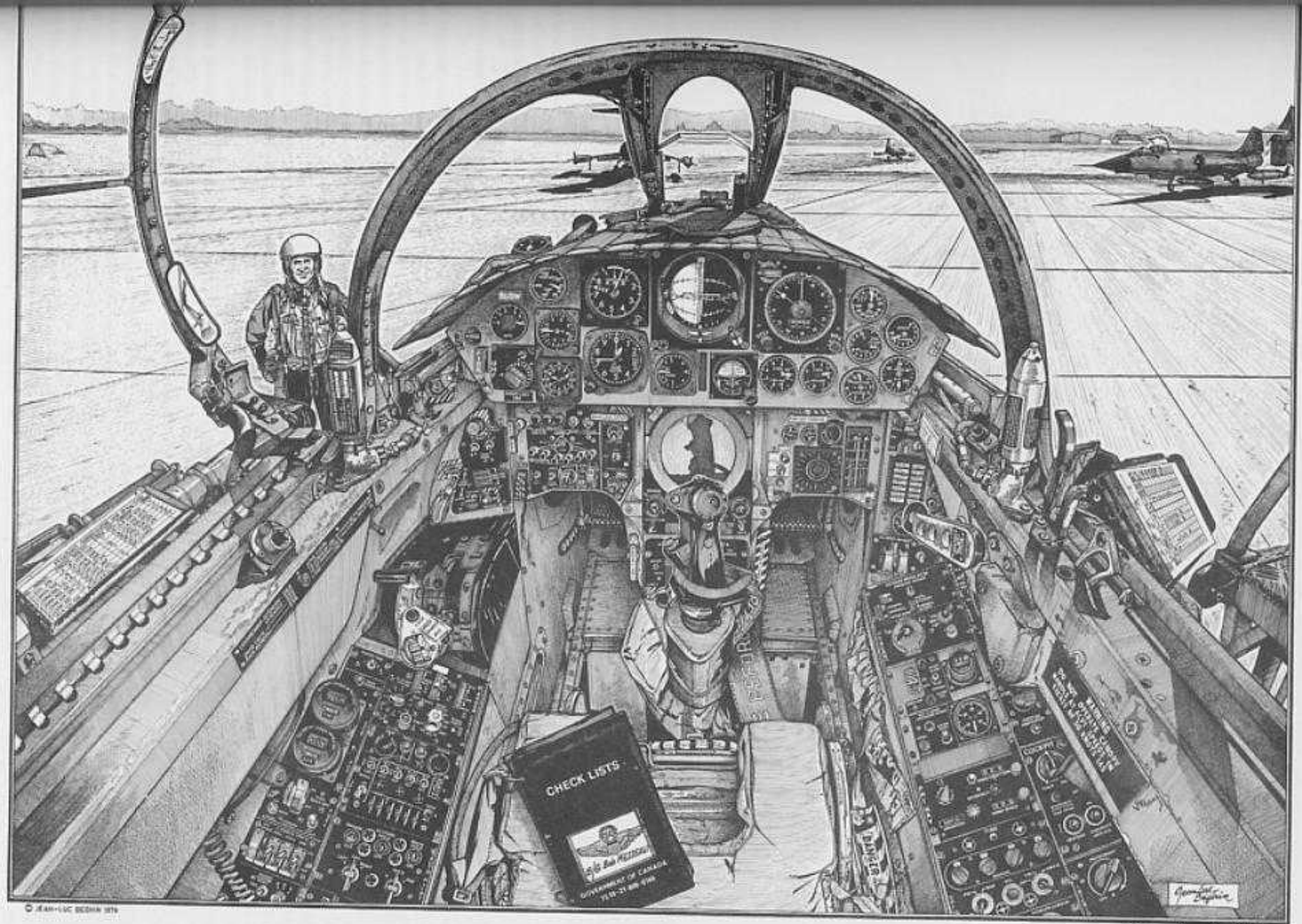
a. Start-Stop Switch — place to Start.
b. 10% rpm — throttle out of cutoff. (Fuel flow 400-800 lbs).
c. 14% rpm — ignition.
d. 40% rpm — Start-Stop Switch to Stop.
e. 67% rpm, Idle Power — disconnect external power.

The entire procedure only took about one minute once electrics and air were connected. The pilot therefore could be taxiing in roughly 1½ minutes. The J-79 engine accelerated and responded to throttle movement immediately. Quick and simple pre-takeoff checks, coupled with rapid acceleration in rpm, made the aircraft ideal for scramble starts and takeoffs. Even the taxiing was expedited because of the pilot's position high on the nose of the aircraft. The great visibility, together with the short wing span and nose-wheel steering, made you feel as if you wore the aircraft. Consequently, you could taxi in and out of tight areas that no fighter has been able to do as well since.

During its time, takeoff in the Starfighter was an experience like no other. After taking the runway for engine run-up on a cold day, it was impossible to hold the aircraft using brakes without skidding. Lineup was especially critical because the instantaneous acceleration could place you 50 feet off centerline if you were not initially centered on the runway.

One of my most memorable moments in aviation was the initial takeoff in a clean Starfighter on a cold day at Wright-Patterson AFB. As I advanced the throttle to military power, the engine began its familiar howling sound. Its force was so strong that the aircraft appeared to crouch while the brakes were being held. Upon brake release, the plane suddenly shot down the runway. The early afterburner on the J-79 had four distinct stages. As each one was lit on takeoff roll, it felt as though I had selected an additional afterburner. With the slightest movement, I rotated the nose and my plane leaped from the runway — I was airborne!

These breathtaking accelerations were



Canadair CF-104 Starfighter (drawing courtesy of aerospace illustrator Jean-Luc Beghin).

very impressive and regularly left the pilot behind the aircraft on his initial sorties.

The subsequent climbout was no less spectacular than the takeoff roll. Within 20 seconds after brake release the aircraft was airborne at 186 to 210 knots depending upon load and ambient air temperatures and altitude. The ship passed through 350 knots indicated very rapidly thereafter and seconds later it had reached .9 Mach. At this speed you eased the stick back and began a constant Mach climb. The climb altitude was close to 45° and made you feel as if you were lying on your back with your feet pointed towards the sky. In looking aft, it was difficult to see the wings because they were positioned so far back on the fuselage. Looking off to the side, you could see the runway falling away and becoming a thin grey line, while inside the cockpit the VVI was pegged at 6,000 rpm. In this climb profile it was no surprise that the aircraft's performance was well ahead of the cockpit instrumentation, such as the vertical velocity indicator and lagging altimeter.

Below are the Lockheed F-104 Starfighter "world time-to-climb records":

9,842 feet — (3,000 meters) — 41:85 seconds
19,684 feet — (6,000 meters) — 58:41 seconds
29,527 feet — (9,000 meters) — 1 minute 21:14 seconds
39,370 feet — (12,000 meters) — 1 minute 39:30 seconds
49,212 feet — (15,000 meters) — 2 minutes 11:1 seconds
65,616 feet — (20,000 meters) — 3 minutes 42:99 seconds
82,020 feet — (25,000 meters) — 4 minutes 26:03 seconds

Invariably, pilots would overshoot their level-off altitude until they became familiar with the F-104's tremendous climb speed and attained a feel for the aircraft which could not be substituted for by instrumentation. The Starfighter's level-flight capabilities continued to illustrate why the aircraft was a real performer in the air. Its in-flight acceleration was superior to any other aircraft. Deliveries began as early as 1957 and the aircraft, although not the smallest fighter in the inventory (the F-5 is smaller in length and weight), has the shortest wingspan ever introduced into the U.S. inventory. During the time (1957-) when the USAF utilized the Starfighter in an operational role, it could virtually dictate at will when to engage or disengage Air Combat Maneuvering (ACM) with any other aircraft.

ACCELERATING from .9 Mach to Mach 2 in the F-104 took less than three minutes; however, the transition from subsonic to supersonic speed was hardly noticeable. While slipping through the sound barrier, the Mach needle jumped slightly, providing the only indication that you were traveling beyond the speed of sound. Between .96 to 1.4 Mach the aircraft hesitated slightly, but then the engine went into "T-2 reset." This allowed the engine to overspeed and increased the thrust. The turbines whined at 104 percent rpm, and the sudden increase in performance again reminded you that the Starfighter was truly a supersonic bird. The F-104 was the first operational jet aircraft to exceed Mach 2 in level flight. It also proved it could maneuver and fight at that speed. Throttle movement was unlimited, speed brakes could be extended, and all flight maneuvers could be attempted while flying within the supersonic speed range. When flying at this high speed, retarding the throttles out of afterburner was like applying brakes; as you felt the sudden deceleration, you again were reminded of just how fast your aircraft was traveling.

The breathtaking takeoff in a Starfighter.

I have always felt that the F-104 was an honest airplane — if attention was paid to its operational limitations and warning systems. However, it was a terribly unforgiving aircraft for the ham-fisted jock who refused to handle and treat it gently, for those pilots who attempted to muscle the controls and were not smooth and deliberate with the aircraft. It was possible to pitch-up the aircraft if you ignored the angle of attack/airspeed relationships and built-in stick shaker. But even if you ignored these indications, it had a stick kicker built into the system which automatically positioned the horizontal stabilizer just below neutral to recover before pitch-up occurred. But the kicker *could* be rendered ineffective if the pitch rate inputs were fast enough to allow the controls to pass through safe transient ranges too quickly. When these warning indications did occur the pilot needed only to release the pressure on the stick and fly out of the dangerous condition. The F-104 needed to be controlled in the vertical plane allowing for high-energy maneuvering. This resulted in maximum use of the aircraft's acceleration and power.

Another innovation designed for the F-104 was the boundary-layer control system which provided greater lift. High-velocity compressed air was piped from the engine into the wing, where it was ejected from a slotted tube over the upper surface of the trailing edge wing flap. These streams of air smoothed out the airflow over the wing flap and allowed pilots to land at lower airspeeds of 160-165 knots instead of hurling themselves towards the ground in excess of 200 knots.

Initially, formation flying was quite difficult for a pilot because of the short wings. While rocketing through the air at supersonic speeds, pilots were unable to detect the initial banking by the leader until he had already established a bank into or away from them. Night-formation flying was especially challenging; however, a modification of adding special wing-tip lights and formation-strip lighting alleviated this problem. Once pilots were no longer re-

Climbing out after a successful strafing run.

quired to play catchup with their leader, F-104 flights became the most illustrative examples of close-formation flying.

The "Zipper" also had the distinction of being an extremely stable platform for weapons delivery. Again the Starfighter's phenomenal acceleration contributed to the aircraft's combat capability by providing the instantaneous overtake required for launching missiles so that they had an airspeed advantage needed for overtaking. Guns firing 4,400 rounds per minute earned this aircraft an awesome reputation. Other aircraft went to great lengths to avoid any air-to-air confrontation with the Zipper. When not armed with missiles, it often carried 2.75" RXs or Napalm on the pylons. This reduced some of the clean configuration capabilities; however, a Zip with any weapon was the meanest thing of its day.

Firing the weapons only can be described as effortless. The Lockheed designers built the entire aircraft with simplicity as their major objective. One only had to set a couple of distinctive switches, set the sights, and fire. And once engaged in combat, few aircraft could escape the wrath of the F-104. The simplicity and ease of interpretation allowed the pilot to concentrate on maneuvering for position in order to destroy his target.

Highly sophisticated radar for its day also aided the pilot in his quest for air superiority. The air-to-air radar was both accurate and reliable, but the real advantage of the Zipper's low-level system capability was the contour mapping and terrain avoidance. Today's terrain-following radar is the direct result of the F-104 system's success. This system was greatly advanced for its time and provided the pilot the capability to navigate the aircraft for strikes into enemy territory.

I cannot talk about bailing out as I have never ejected nor have I witnessed anyone ejecting from an F-104 aircraft.

On a normal training mission, endurance for a clean aircraft is about 1.5 hours. Tip tanks increased the endurance to approximately 2.5 hours.

BACK in the pattern, the F-104 was like a graceful falcon gliding in for an effortless landing. Rolling into the pitch, with flaps in the takeoff position, sets up a 4 G turn onto downwind. Once rolled level on downwind, it was immediately ready for gear down and full landing flaps. Within seconds it was time to roll into a smooth, final turn and begin the descent to the runway. At this point it was a power-on approach all the way, in order to keep the boundary layer control activated for the extra lift required while flying at slower airspeeds.

Simulated flameout patterns provided an extra measure of excitement. Hi-Key was set up at 10,000 feet over the runway, yet within moments you were starting the flare with a horrendous sink rate. With a 240 knot touchdown speed and the distinct feeling of literally falling out of the sky, it is no wonder that flameout procedures were only utilized for precautionary patterns.

The F-104 provided an extremely stable platform for instrument approaches. Paired with aircraft response, this made approaches relatively simple once the pilot became familiar with the accelerated sequence of events. Even the air traffic controllers had to be reminded of the F-

Close wing-tip formation.

104's high approach speeds. If not, they would be back at the final approach fix while the pilot was already in the flare! Of course, any good landing in any aircraft was always a challenge, and as the tires squeaked at touchdown and the drag chute burst open, pilots experienced the ultimate satisfaction of having slipped the surly bonds with a Zip.

The success of the F-104 was highlighted by the overwhelming foreign demand for this aircraft. Several versions were built and with the introduction of the F-104G, the aircraft was heralded as one of the greatest achievements in American aviation. Contracts were signed with West Germany, Canada, the Netherlands, Japan, Belgium, Norway, Denmark, Greece, Turkey, Spain, Nationalist China, and Pakistan. Furthermore, the largest international aircraft production resulted from factories such as Lockheed, Messerschmitt, Fiat, Dornier, Heinkel, Siebel, Fokker, Aviolanda, Mittsubishi, Sabca, and Calac. The use of special modifications for astronaut testing and short (zero length) launch testing along with the outstanding production record attested to the 104's reliability and safety. In all, over 2,500 Starfighters have been produced, and over 15 countries have utilized this aircraft.

Some impressive records established by the Zip include:

World Altitude Record
91,249 feet
Maj. H. C. Johnson, USAF
7 May 1958

World Speed Record
1404.9 mph
Capt. W. W. Irwin, USAF
17 May 1958

USAF Time-to-Intercept Record
TARGET: 35,000 feet
172 miles from base
Time-to-Intercept: 8 minutes, 59.9 seconds
Capt. M. Schaff, USAF
Capt. B. Jones, USAF
10 Dec. 1958

An F-104 armed with Sparrows.

Breaking ground from a touch-and-go.

The F-104 in the "Zelf" configuration for a zero length takeoff.

World Altitude Record
First aircraft to exceed 100,000 feet
103, 395.5 feet
Added World Time-to-Climb Mark
98,424 feet (30,000 meters) in 15 minutes
Capt. Joe B. Jordan, USAF
14 Dec. 1959

The F-104 became the only aircraft ever to hold world records for speed, altitude, and time-to-climb, simultaneously.

The Starfighter was also always the first aircraft to deploy during any crisis. In September 1958, it was sent to Taiwan in defense of the Republic of China and was unofficially credited with being a major factor in preservation of peace at Quemoy. Later in 1961, several squadrons deployed to Europe in response to the Berlin crisis. Again, in the Cuban missile crisis, it was the F-104 that was called on first to be ready to defend our country. Even after the decision had been made to phase out the aircraft, squadrons were sent to Vietnam and Thailand from 1965-1967. Clearly the Zip was our "Ace in the Hole" and in its heyday, wherever the Zips flew, there was nothing that could compete.

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