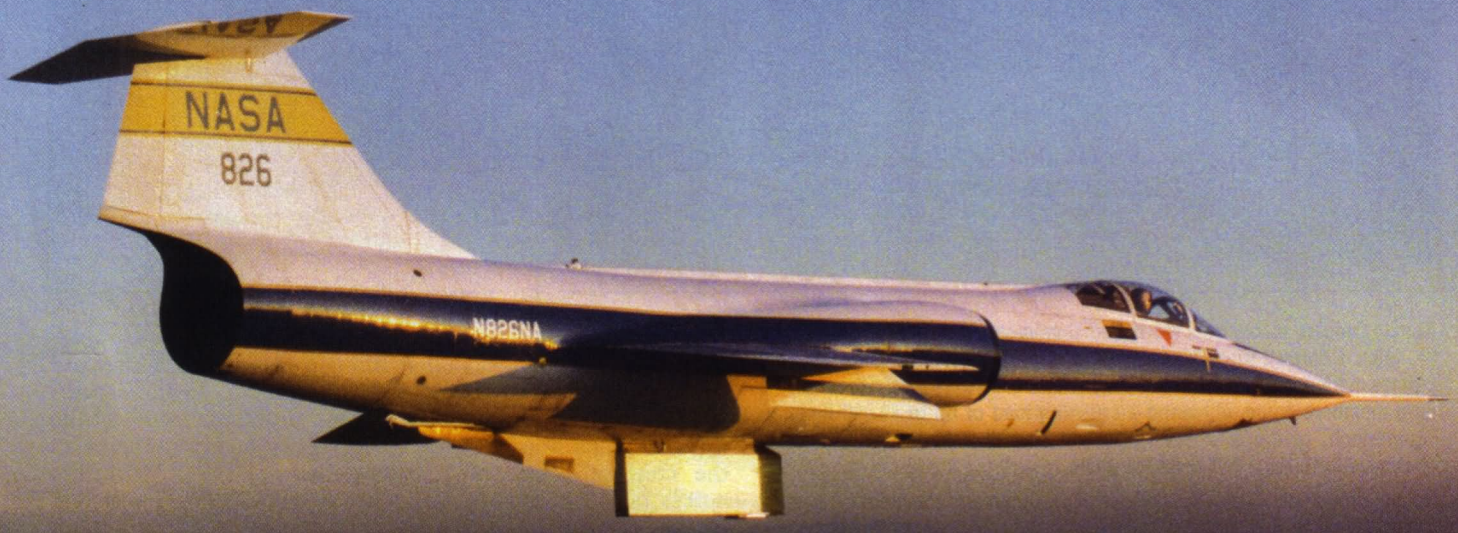
STARS OF NASA

The Lockheed F104s of NASAs Flight Research Center

By Roy Bryant

All images courtesy of NASA Dryden Flight Research Center



NASA Test Pilot Rogers Smith flies 'NASA 826' into another beautiful California Sunset.

It was one of those pristine days you read about in travel brochures. Temperatures were in the high 80s, with a slight breeze and deep blue sky accented by high, thin wisps of white clouds - truly a 'chamber of commerce' day in high desert the land of the X-planes. It was Monday, August 27, 1956 at the NACA (National Advisory Committee For Aeronautics – later to become NASA) High Speed Flight Station (HSFS) located at Edwards AFB. Employees watched as NACA's chief test pilot strapped into the cockpit of the facility's newest research aircraft, the seventh Lockheed F-104A built, S/N 55-2961. That first NACA flight lasted approximately 30 minutes and ushered in a legacy that would span portions of five decades, ending Feb. 3 1994. It was the legacy of the 'Starfighter'.

The F-104 aircraft series, fourth in the regal family of the Air Force's new-generation 'Century Series' aircraft, was designated as the 'Starfighter', continuing the proud tradition of galactic names for Lockheed's stable of aircraft. Furthermore, the sleek missile-like jet was a product of the Lockheed Burbank Skunk Works. First flown in February 1954, it was the first jet aircraft capable of sustained Mach 2.0 speed in level flight. Previously only rocket-powered planes had been flown at speeds this great and not for sustained periods of time. A single General Electric J-79 engine powered the F-104, which was developed for a primary Air Force mission. However, as history would show, it would become one of the most versatile research aircraft ever to grace the skies over the Mojave Desert.

Eleven of these aircraft saw duty in the NACA/NASA F-104 fleet, each providing valuable contributions to the Center's and Agency's overall mission and goals. The Department of Defense and aerospace industry in general also reaped significant benefits from the data acquired by these aircraft. Important benefits were realized early on in the F-104 program when the HSFS used F-104A #961 to investigate the 'roll coupling' phenomena believed to have been responsible for so many aircraft losses up

Above: NASA 812 is shown here in its delivery markings. This aircraft took over the PTV test missions after the loss of JF-104A #749. Now known as a Decelerator Payload, a handful of these flights were conducted in early 1965.

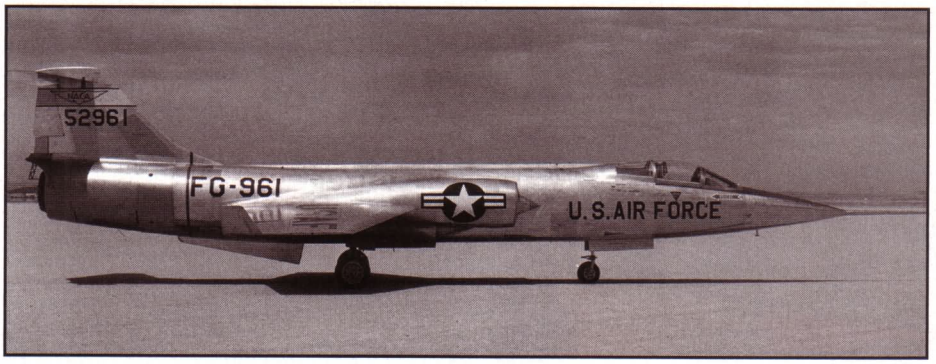
Below: NASA Test Pilot Joe Walker delivers the first of three F-104Ns that NASA purchased from Lockheed to the Flight Research Center on August 19, 1963. These three aircraft would perform the bulk of test and chase work done at the Center until the arrival of the more advanced F-104Gs twelve years later.

to that time. That investigation led to a mass of data turned over to the Air Force and manufacturers to be used on future designs. This particular aircraft was later outfitted with a Reaction Control System (RCS) to give the pilots experience in flying these systems. This was important because the North American X-15 was just coming into reality and would depend on this type of control system for use at high altitudes.

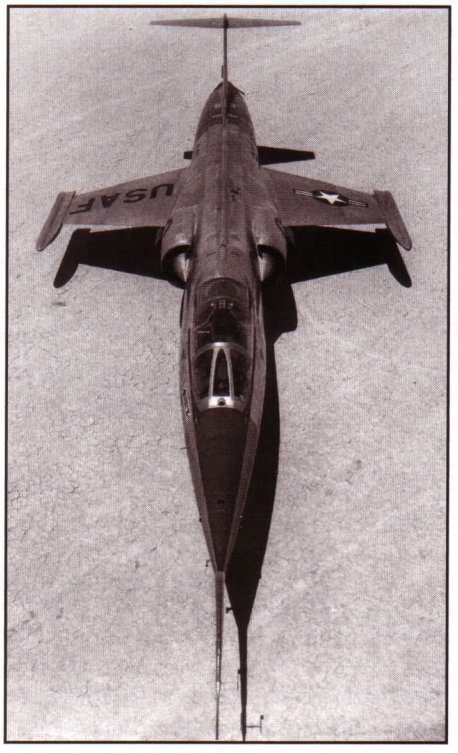
After completion of the RCS experiments this aircraft was given the serial number NASA 818 and continued to fly research and support missions for the next 15 years. NASA 818 made its last flight on November 18,1975 when it was flown to a place of honor by chief pilot Don Mallick to the Smithsonian Air and Space Museum in Washington D.C. It was a fitting honor bestowed on an airplane that made so many significant contributions during its 19 years of research flying. In October 1957, the Air Force lent the NACA a second Starfighter, F-104A S/N 56-1734. This aircraft was used in a major program to obtain boundary-layer-transition measurements in full-scale flight. To obtain the desired data, HSFS personnel installed pressure instrumentation and temperature gauges on the outside surface of the right wing. The leading edge flaps were deactivated and a fiberglass glove installed to maintain the original contour and smooth surface of the wing's planform.

A third Starfighter, S/N 56-0749, joined the fleet in April 1959. It was configured with a centerline launcher system to be used in an attempt to obtain precise air density at various altitudes by using a small rocket to deploy a balloon at extremely high altitudes. According to program pilot Milt Thompson, "We would then track the balloon with radar, measure its descent and from that, compute air density". He went on to describe this endeavor as "not very successful, but interesting". On Dec. 20 1962, a shadow was cast over the brightness of the NASA Starfighter program. Upon completion of a routine uprange weather check prior to an X-15 mission, Milt Thompson was practicing low lift/drag approaches in F-104A #749 when only one of the flaps extended-leaving him with an asymmetric flap configuration. After making every attempt to keep the aircraft in the air, the F-104 became uncontrollable and Thompson made a successful ejection at 20,000 ft.

A two-seat F-104 S/N 57-1303 was made available to the Agency in December 1959 and became the fourth member of NASA's proud Starfighter fleet. With the addition of this two-seater, another dimension was added to the Center's research capability: that of carrying instrumented individuals and/or experiments in the rear cockpit with a safety pilot flying the aircraft from the front cockpit. As a result, numerous and valuable bio-medical experiments were conducted, many of which were directly applicable to the space program and the aerospace medical research community. Now designated NASA 819 this Starfighter also played a vital role in establishing the Ground Command Guidance system used at the Flight Research Center. Two other areas in which this aircraft made important contributions were the development of the low lift/drag approach for landing patterns used by the X-15 and lifting bodies as well as the testing of a ballute system - a cross between a balloon and a parachute. Making its last flight on April 21, 1978 after completing some 1,731 flights, NASA 819 was eventually put on permanent display at McClellan AFB in Sacramento CA in June 1983.



Above: The first Starfighter used by the Flight Research center was F-104A S/N 55-2961. This aircraft was loaned to the NACA by the Air Force in 1956 and flew numerous research programs for both NACA and then NASA over the next 19 years. Note older-style NACA tail band that was replaced two years later when NACA became NASA.



Above: After the Bell X-1B was grounded in 1958 with fuel tank cracks, NASA engineer Jim Adkins proposed using an F-104 to continue testing Reaction Control Systems (RCS). F-104A #961 sits on the lakebed after having been modified for RCS testing. Now designated JF-104A, this aircraft made numerous zoom flights to give X-15 pilots some practical experience in using these systems.

Middle: The new RCS was tested on the ground to check reliability of reaction control modifications prior to committing the JF-104A to inflight testing.

Left: Stunning view of the JF-104's cockpit, showing the RCS control handle in the upper left corner of the instrument panel. The hydrogen peroxide thrusters were located in the aircraft's nosecone and wingtip pods.

STARS OF NASA

When You Wish Upon a Star

The first four Starfighters had all been acquired through loan agreements between NACA/NASA and the Air Force. In 1963, NASA purchased three 'personalized' F-104Ns from Lockheed. Initially given the serial numbers 011, 012 and 013, for commonality these were changed to 811, 812 and 813 in March 1965. These aircraft had been customized for NASA in that all tactical military systems such as armament and the fire control system, were not installed and internal compartments were specifically tailored for NASA test equipment. The first aircraft was delivered on August 19, 1963 and the pilots of the Flight Research Center used

Early morning ground testing of the new RCS on the JF-104A. Hydrogen peroxide was a very dangerous chemical, and had potentially disastrous results if not treated with care. A small explosion ripped a hole in the side of #961 when a cotton filter installed in a pressure line leading to the peroxide tank became clogged, but the airplane was quickly repaired and put back into service.

A rare shot of all three F-104Ns taken on October 24, 1963. Initially, the three aircraft were given tail numbers 011, 012, and 013 respectively, but these were later changed to 811, 812, and 813 in 1965. Leading the formation in ship 013 that day was Joe Walker, with Milt Thompson flying ship 012, and Bruce Peterson in 011.

STARS OF NASA

these aircraft to keep their flying skills finely tuned and to provide an extra set of eyes as safety chase for research missions. These three special aircraft were also used as airborne simulators for the X-15 and lifting body programs.

Sadly, on June 8, 1966 darkness once again was cast upon the legacy of the Starfighter. Upon completion of a safety chase flight in support of a North American XB-70 test mission, tragedy struck. The mission aircraft were aligned in tight formation for a photo shoot for the General Electric Company – maker of the engines for all five aircraft in the scene. After a grueling 45 minutes holding formation the decision was made to make one more racetrack pattern for the photographers in a Learjet. Suddenly, the right-hand wing tip of the XB-70 and the top of the left-hand horizontal stabilizer of the F-104 (NASA 813) made contact, flipping the '104 across the twin tails of the bomber. The tragic result was the loss of two pilots and two aircraft, NASA chief pilot Joe Walker in the F-104 and USAF Major Carl Cross in the number 2 XB-70 who was taking his initial orientation flight in the huge Mach 3 aircraft.

The two remaining F-104Ns (tail numbers 811 and 812) continued to perform their valuable roles for NASA during the next two decades, and continued to have illustrious careers with NASA well into the late 1980s. NASA 812 made its last flight on December 29, 1986 after completing 4,442 flights, this was followed nearly a year later with the last flight of NASA 811 on October 23,1987 at the end of its 4,370th flight for NASA. With their flying days behind them, NASA 811 was donated to Embry-Riddle College in Prescott, Arizona while NASA 812 was returned to Lockheed and modified to resemble an early XF-104. That ship is now on display at Lockheed's Plant 10 in Palmdale CA.

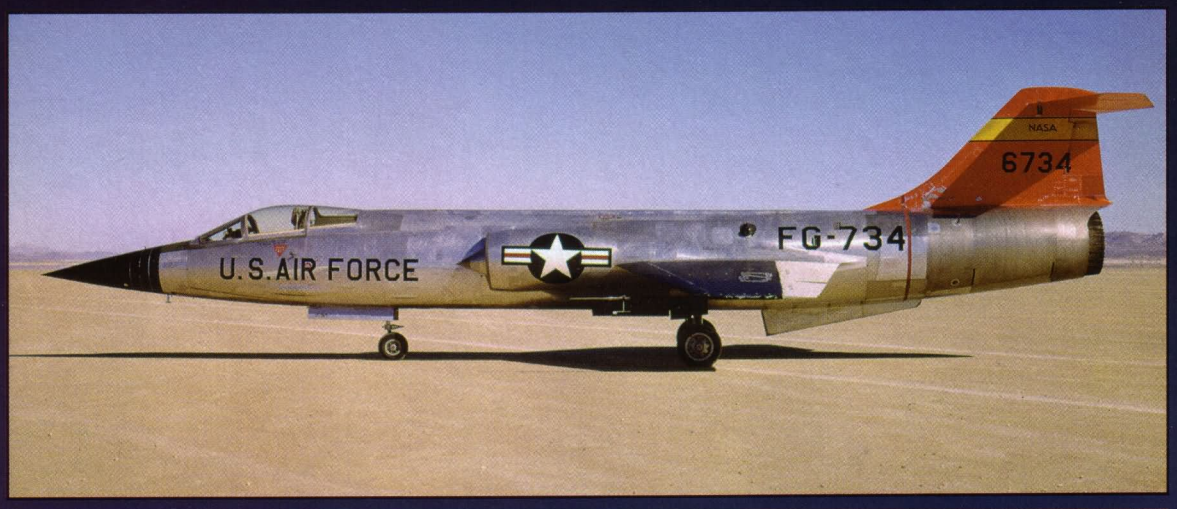
As a result of the quest to fill the vacancy left in the Starfighter fleet by the loss of 813, another F-104 SN 56-0790 was acquired on loan from the Air Force in December 1966. This aircraft had previously been used by Lockheed flight test as a chase aircraft for their Blackbird programs before being turned over to the Air Force. Given the NASA number of 820, this F-104 did not begin flying until April 1968 because it was due for major inspection which had to be completed first. During its nine-year flight test career with NASA, 820 served not only as a research aircraft but in the support role as well. On June 1, 1977 this particular Starfighter flew its final mission, and is now on permanent display in front of the Air Force Flight Test Center Museum at Edwards AFB.

Starfighters Uber Edwards

On a sunny July morning in 1975, the NASA Starfighter fleet took on an interna-

Right & Middle: Ship #734 poses for photos on the lakebed at Edwards on November 16, 1960. The new instrumented fiberglass nose carries internal microphones and thermocouples while both wings have been modified with fiberglass 'gloves' for taking boundary layer measurements. With the modifications to the aircraft's nosecone, the pitot boom was relocated to the left wingtip. Cameras were also installed above and below both wings. This aircraft was returned to the Air Force on January 10, 1961 and was eventually converted into a QF-104A target drone.

Below: After completion of RCS testing, Ship 961 went on to fly other programs including the testing of various experiments on an X-15 ventral fin configuration.



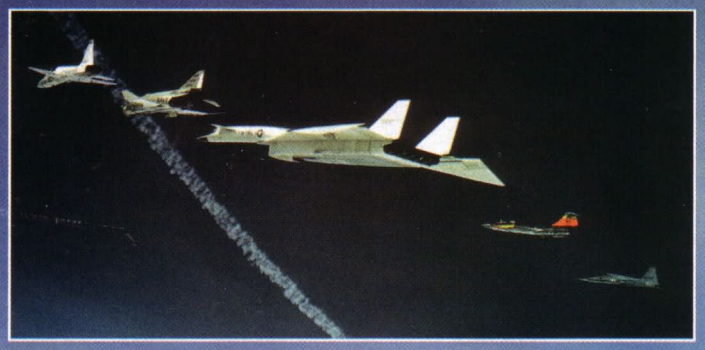
Above: Now sporting photo calibration markings and tufts on the upper wing surface, Ship 961 performs a test flight on December 9, 1965.

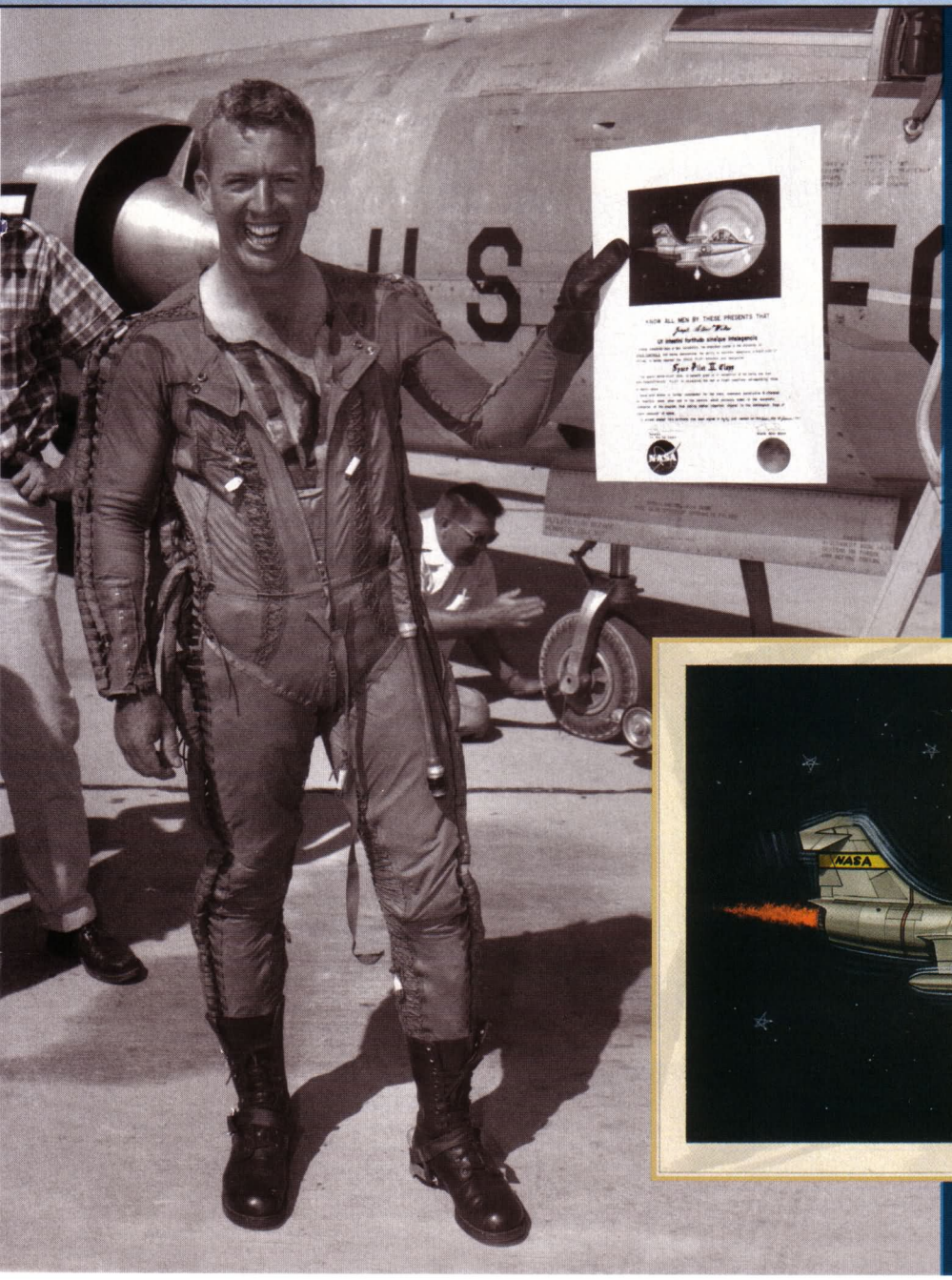
Modifications to the right wing began almost immediately upon acquisition from the Air Force. Ship #734 is shown here in April 1958 getting some final instrumentation installed prior to the beginning of flight testing. Note that the aircraft has yet to receive any NACA tail markings.

STARS OF NASA

tional flavor with the arrival of three West German F-104G's (two had been built in West Germany and one in Holland). The 'new' F-104's, which were flown to the Flight Research Center from Jever Air Base in West Germany, were given the numbers 824, 825 and 826. With the arrival of these newer versions of the F-104, replacement parts became more readily available, making these aircraft easier to support and keep flying. Thus the NASA Starfighter legacy would continue well into the 1990s.

While 824 was used primarily as safety/photo chase support along with 811 and 812, the other two Starfighters, 825 and 826, would be left to perform in a pure flight research capacity. Early in its career 825 was used for a series of experiments that required an extended time of approximately one minute at or near zero 'g' (weightlessness), since the experiment could be flown in the rear cockpit. Towards the end of its flight test career 825 was modified with a periscopic-type Remote External Viewing Display (REVD) that allowed the pilot in the rear cockpit to fly the airplane with the canopy completely masked off. This system, being developed for the X-30 National Aero Space Plane program, was primarily to evaluate the pilot's capability to land the aircraft from various approach angles to





Above: The third and last F-104N delivered to the Flight Research Center was Ship #013 (later changed to 813 for commonality with the rest of NASA's aircraft fleet). Unfortunately, she had the shortest test career of the three original NASA F-104Ns delivered, having been lost in the infamous mid-air collision and crash of the North American XB-70 on June 8, 1966 (see inset) resulting in the tragic death of NASA's Chief Test Pilot, Joe Walker. This rare inflight portrait was taken on October 24, 1963.

Left: Joe Walker is shown here after making a zoom flight to 90,000 ft. proving the viability of the reaction control system on June 21, 1960. Upon landing he was given a certificate by lead engineer Jim Adkins which designated Walker as a "Space Pilot, 2nd Class". The lead caption reads "Ut Intesta Fortitudo Sine'que Intelegencia" which loosely translated means "More guts than good sense". Below is closeup of the novel artwork created by NASA artist Jerry Lyons.

Above: NASA 812, in its delivery color scheme, climbs into the beautiful blue skies above Edwards AFB.

Below: Two-seat TF-104G NASA 824 was used primarily for photo and safety chase missions. Now repainted in its new blue-and-white NASA color scheme, 824 is shown here providing chase for the NB-52 during a DAST captive test flight on September 14, 1979.

the runway without natural forward vision through a windshield.

During its career, NASA 826 flew a variety of different test programs including a series of tests on the Thermal Protection System (TPS) in support of the Space Shuttle Program. Shuttle tiles were attached to each flap and later to a Flight Test Fixture (FTF) mounted on the centerline of the Starfighter. These would help test the durability of the TPS in the rain as well as upon landing. Another experiment was installed in the radome of the aircraft to collect data for the evaluation of an Optical Air Data System (OADS). The OADS was a revolutionary system designed to be an unobtrusive augmentation or replacement for the conventional method of using external pressure probes to obtain air data parameters. One of the final test programs flown on 826 was a UCLA experiment. This ultimate collegiate science experiment was flown at night and was designed to gather data on boundary layers in the transonic and low supersonic regions. This was accomplished by spraying a mist ('smoke') into the boundary layer flow, illuminating it with a laser and video taping the action taking place.

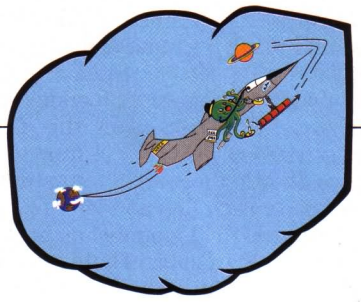
On October 1, 1985 change finally began to become a reality as Center pilot Ed Schneider in F-104 #824 shadowed a Navy F-18 Hornet as it made its way to its new home at the Dryden Flight Research Center. This was the first of several F-18s that would arrive at the center and eventually transition into the support role that had been so admirably performed by the Starfighters. As 824 touched down it would signify the end of a career that had

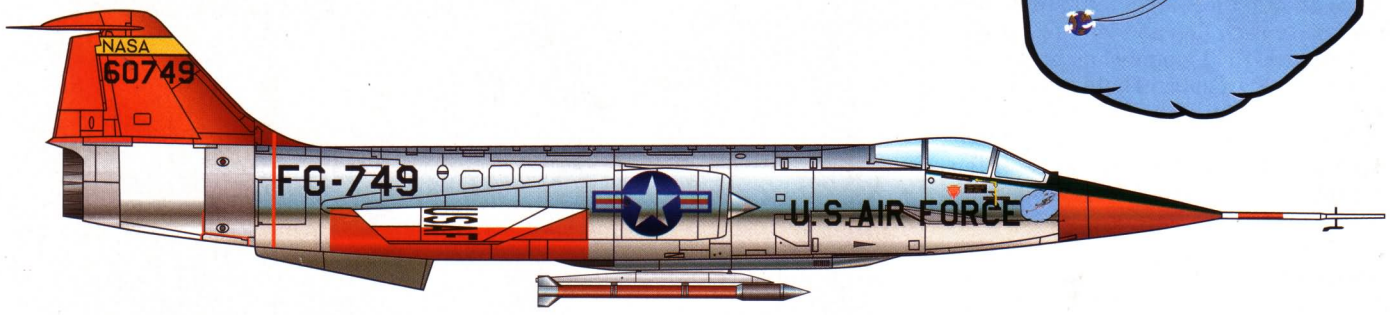
Above:The F-104's exotic flight characteristics lent themselves to steep, high-drag descents and low L/D approaches that mirrored the descent profiles of the Lifting Bodies being test flown in the late 1960s and early 1970s. Here, NASA 812 follows the Northrop M2-F2 to another safe landing on November 21, 1966. The Lifting Body's landing gear extended immediately before touchdown.

Below: NASA's F-104Ns provided safety chase for some very unique aircraft. Here NASA 811 follows the Martin X-24B towards touchdown on Rogers Dry Lake. Aside from the observational duties of the chase planes, their pilots would make altitude call outs to the Lifting Body pilots in the critical last few hundred feet of the approach, with touchdown speeds approaching 200 mph.

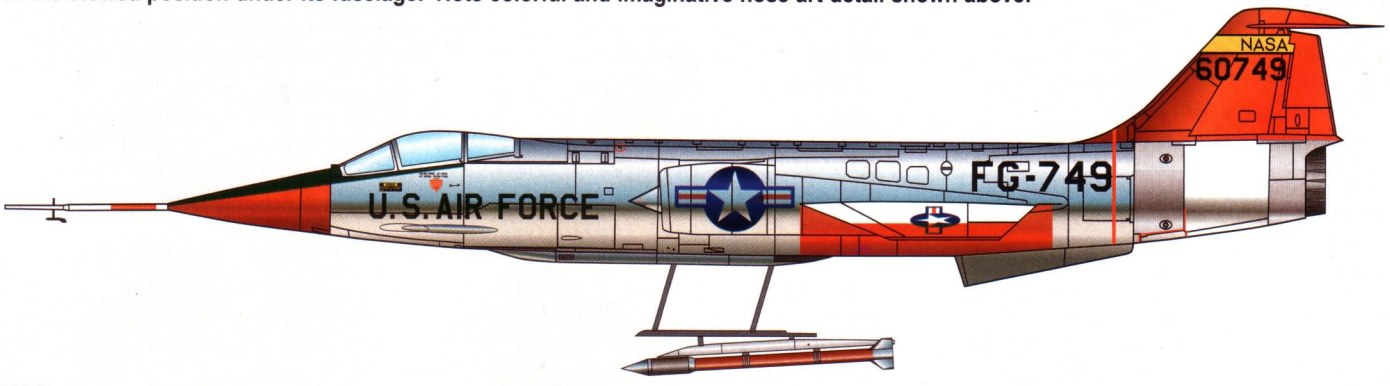
As the NASA F-8 Super Critical Wing testbed touches the surface of Rogers Dry Lake after another successful research mission, NASA 812 tucks in its gear and prepares to climb back into the pattern for a landing on the hard surface runway at Edward's Main Base. Lakebed landings were particularly hard on the F-104's high-pressure tires, and posed FOD danger to air intakes.

NASA 749

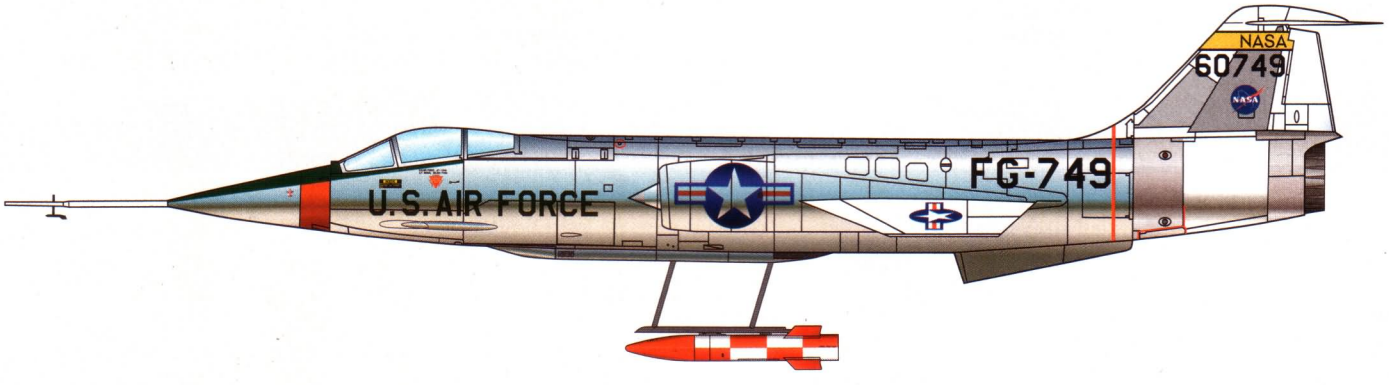




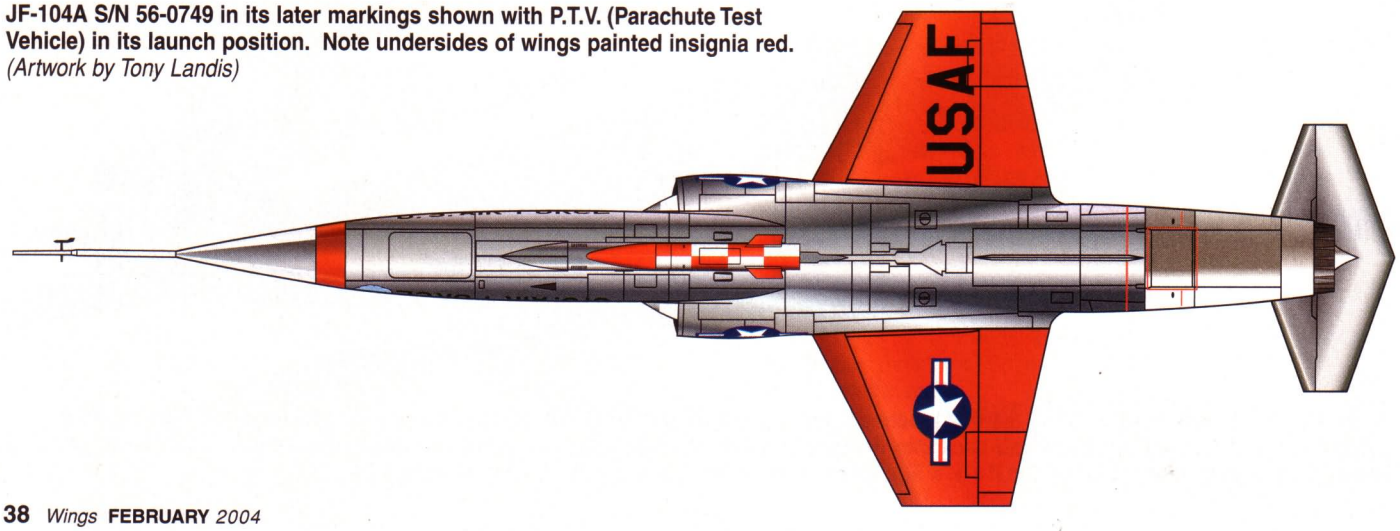
Since apparently no color photos of NASA 749 exist, the following digital illustrations of the JF-104A were produced to show the high-visibility markings during the early part of the test program. Here we see JF-104A S/N 56-0749 carrying the ALSOR Sounding Rocket in the stowed position under its fuselage. Note colorful and imaginative nose art detail shown above.



JF-104A S/N 56-0749 with the ALSOR in launch position on an extended articulating trapeze launch pylon similar in principal design to the system used in WWII on the Douglas SBD Dauntless dive bomber.



JF-104A S/N 56-0749 in its later markings shown with P.T.V. (Parachute Test Vehicle) in its launch position. Note undersides of wings painted insignia red.
(Artwork by Tony Landis)



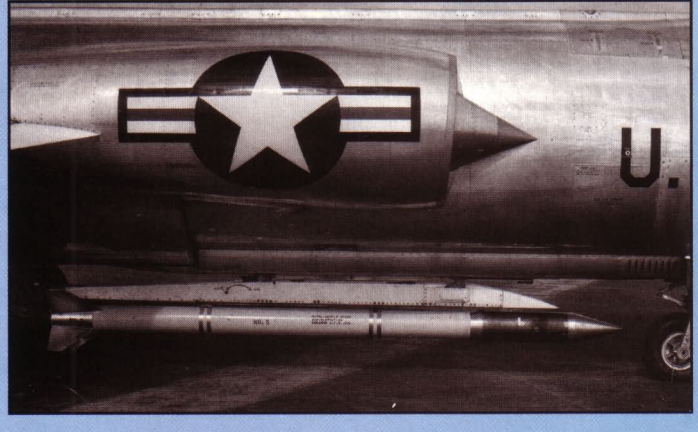
Towards the end of their NASA careers, F-104s provided chase for McDonnell Douglas F/A-18 Hornet test and evaluation missions flown from the Dryden Flight Research Center.

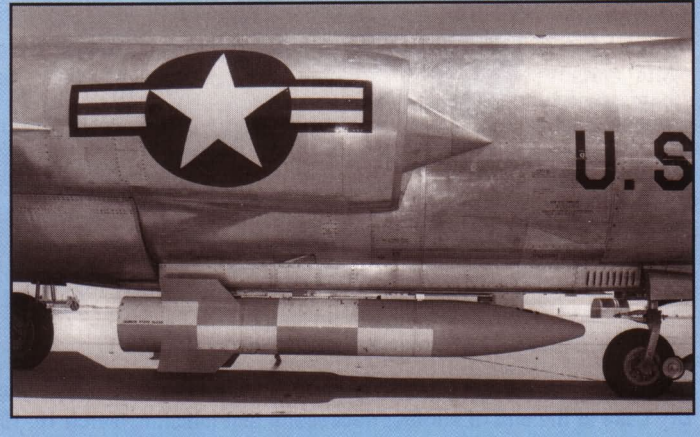
Above: The third Starfighter to join the NASA fleet was JF-104A '749'. This aircraft was equipped with an extendable centerline launch rail, and was used for a variety of test programs, the first of which was the ALSOR or Air Launched Sounding Rocket program.

Below Left: Close-up of the ALSOR missile mounted under JF-104A '749'. This rocket was used to launch either an eight or twelve-ft.-diameter balloon to extremely high altitudes in order to take accurate air density measurements.

Right: This photograph was taken from the frame of a 16mm movie film showing the ALSOR rocket being lowered into launch position below the JF-104A's fuselage.

Below Right: This Parachute Test Vehicle (PTV) was used for 'Project Scape' to test drogue chutes that were to be used in the escape capsules of Convair's Mach 2 B-58 Hustler.

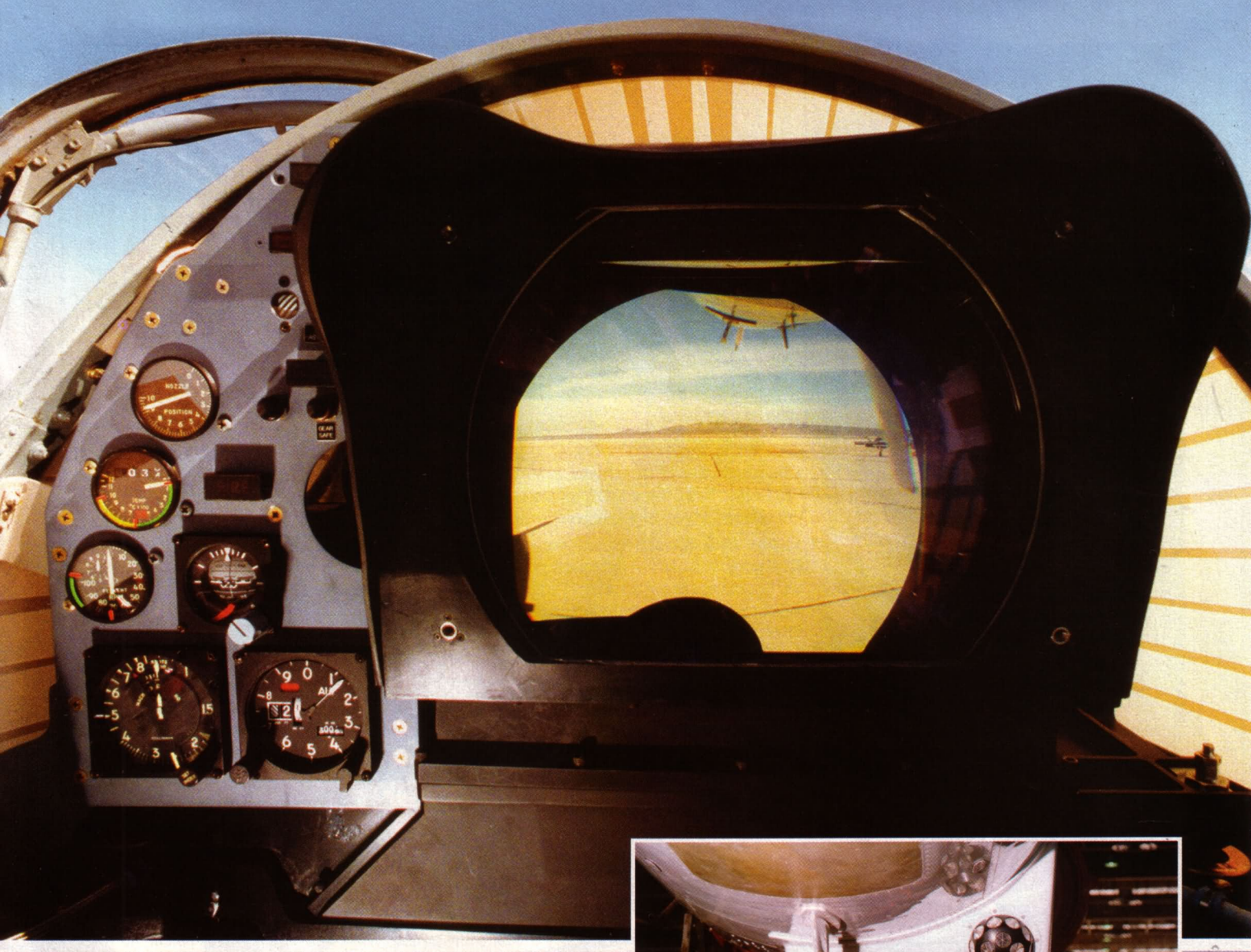


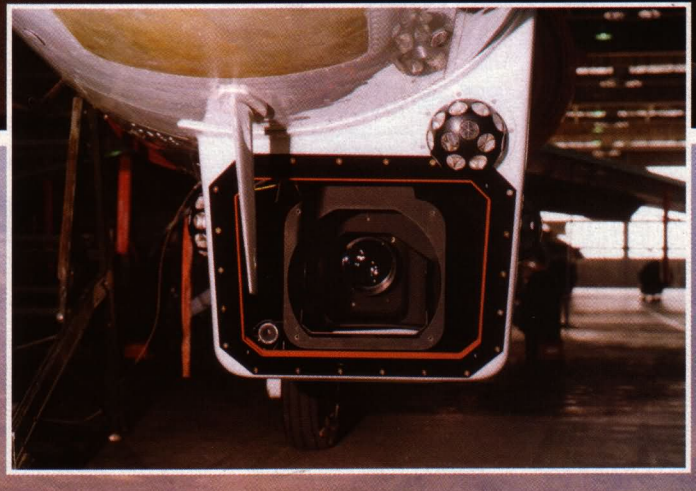


Above: During the mid-1980s, a specially-built Flight Test Fixture (FTF) was mounted on the fuselage centerline of NASA 826 and was used to conduct moisture impact studies on various Space Shuttle Thermal Protection System (TPS) tile and blanket materials.

Right: Nicely demonstrating that even test pilots have a good sense of humor, NASA's Rogers Smith dons a classic yellow slicker and rain hat prior to launching on one of the Space Shuttle TPS moisture impact research flights in October 1985.

Below: With NASA test pilot Ed Schneider at the controls, NASA 826 banks over Rogers Dry Lake at the end of another successful test mission, March 16, 1992.

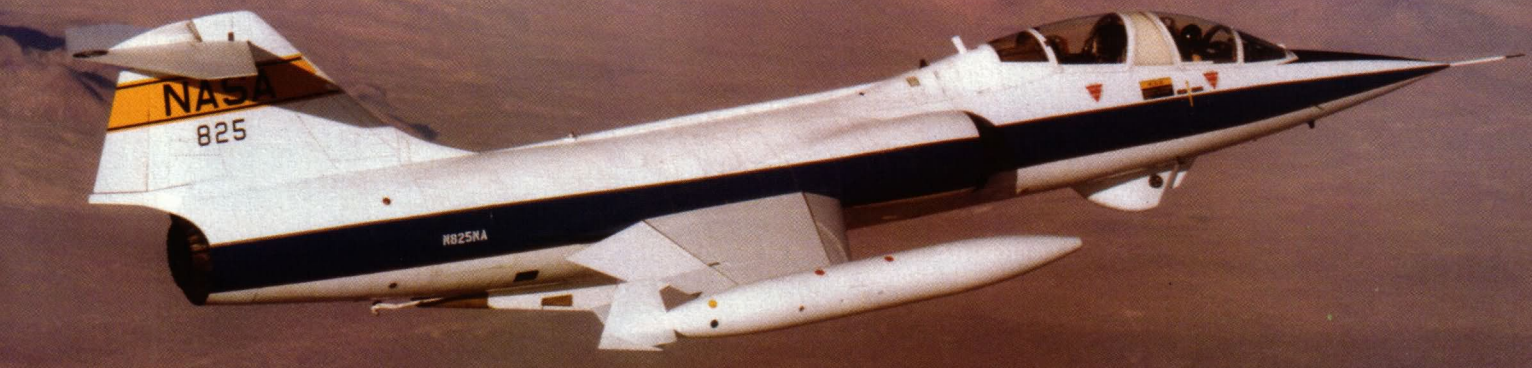


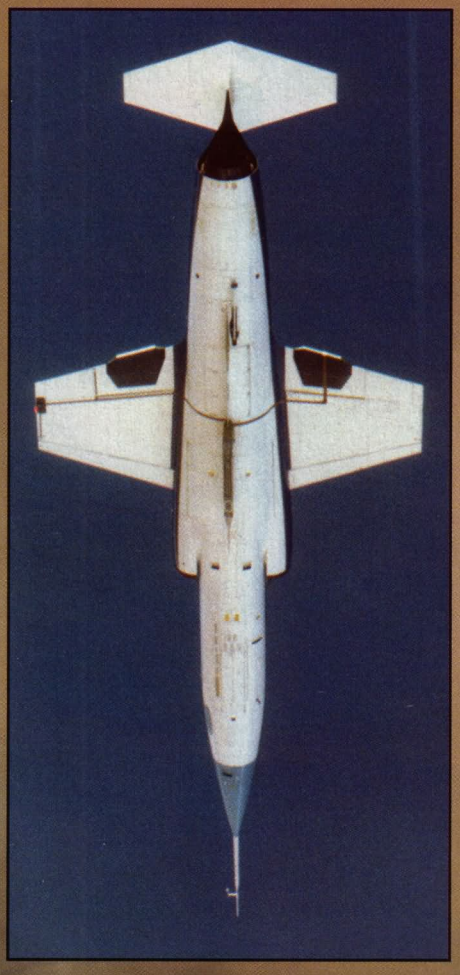


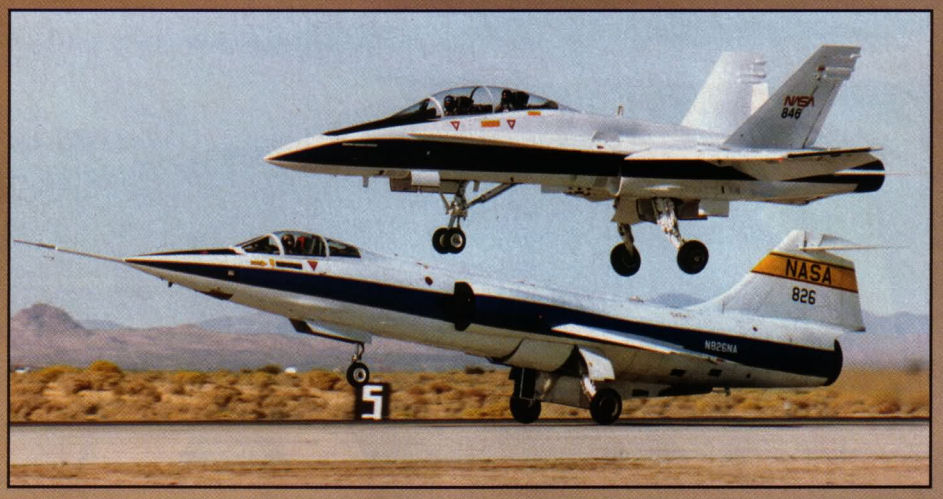
Above: Towards the end of its career, NASA 825 was modified with a Remote External Viewing Display (REVD) that allowed the pilot in the back seat to fly and land the aircraft with the canopy completely masked off. This was to simulate in an airborne aircraft the characteristics of the periscopic device as it was planned to be used in cockpit of the X-30 National AeroSpace Plane. In this photo, we get the pilot's-eye view looking through the REVD.

Right: Close-up view of the REVD lens mounted below the TF-104G's forward fuselage.

Below: Inflight shot of NASA 825 showing the REVD lense fairing below the rear cockpit.





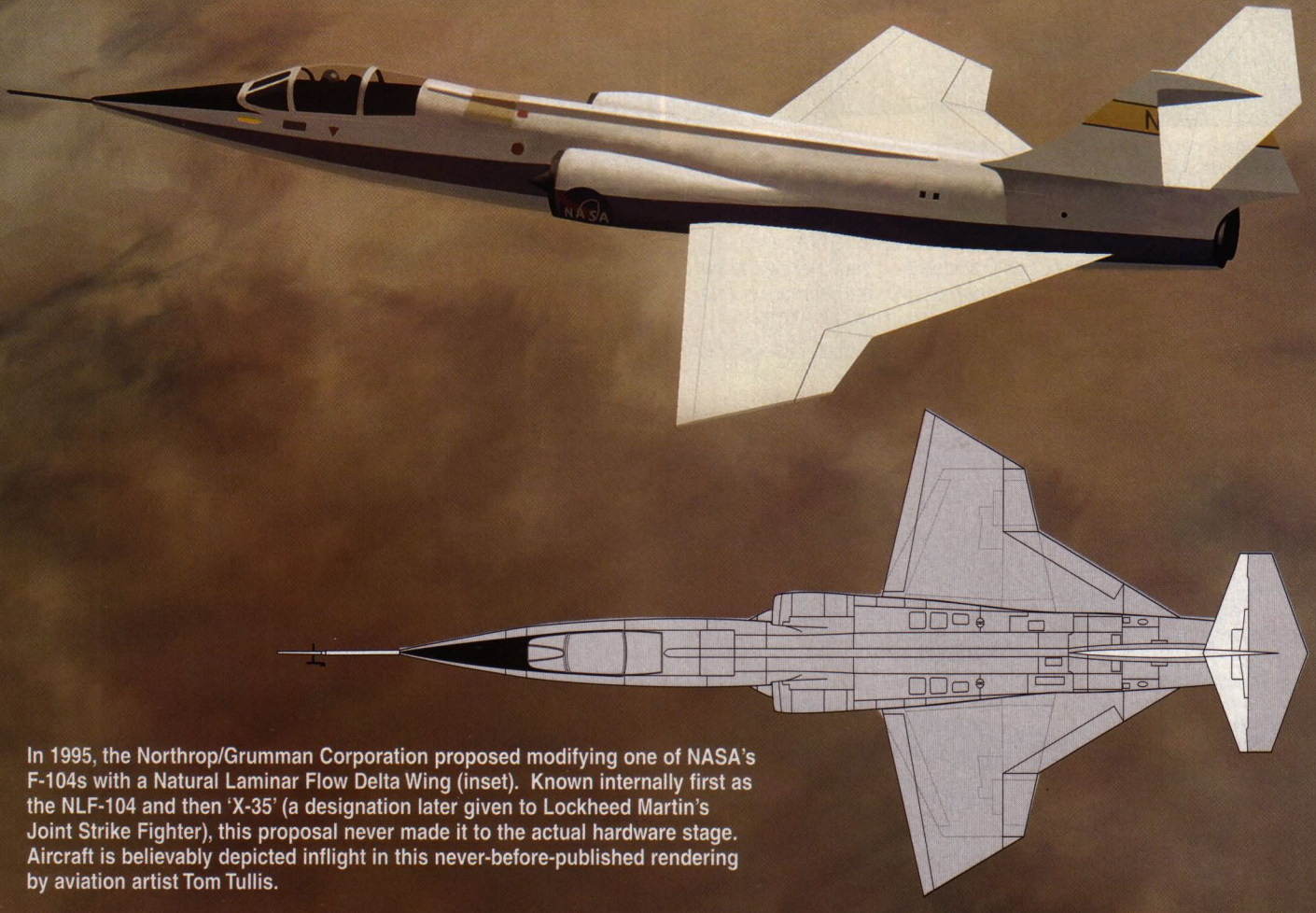


Left: While the two TF-104Gs were off flying other research and support missions, the sole single-seat F-104G was being used to support the Space Shuttle program. Thermal Protection Tiles were attached to the undersides of the flaps on NASA 826 in order to test their durability in flight as well as on landing.

Above: In a classic role reversal, NASA 846, a McDonnell Douglas F-18B flown by Tom McMurtry with NASA photographer Jim Ross in the back seat provides photo chase for Ed Schneider in NASA 826. This formation is known in chaseplane parlance as an 'inflight pickup', with the photo ship tucked in tight just as the subject aircraft lifts of the runway. Photo was taken November 3, 1993. *(Christian Ledet photo.)*

Opposite Top: 'Changing of the Guard' – NASA 826 leads a three-ship flight over the Sierra Mountains with an F-18B (NASA 841) and T-38 (NASA 821). This was the one and only time these three aircraft were ever flown in formation.

Opposite Bottom: 'End of the Line' – Landing gear tucking into the wells, F-104G 826 flown by Tom McMurtry takes off for the last time from Edwards' Runway 22. A bittersweet experience for NASA personnel witnessing the event, this was the final flight of a NASA F-104, February 3, 1994.



In 1995, the Northrop/Grumman Corporation proposed modifying one of NASA's F-104s with a Natural Laminar Flow Delta Wing (inset). Known internally first as the NLF-104 and then 'X-35' (a designation later given to Lockheed Martin's Joint Strike Fighter), this proposal never made it to the actual hardware stage. Aircraft is believably depicted inflight in this never-before-published rendering by aviation artist Tom Tullis.

STARS OF NASA

spanned just over a decade. Now the aircraft would be turned over to Cal Poly San Luis Obispo, CA where it was to be put on display.

Swan Song for the Starfighter

The luster of the Starfighters legacy began to shine once more on a rainy Thursday, February 3 1994, as the clouds cleared just in time for Flight Operations Director Tom McMurtry to take Starfighter 826 to the air to pay a final tribute to the NASA Dryden employees. Tom was airborne at 10:03 am for a 29-minute flight that featured a sonic boom plus both low and high-speed fly-bys over the Center. When Tom landed the F-104 on this final mission, it brought to a close a portion of history that began nearly four decades earlier at a facility called the NACA High Speed Flight Station in California's Mojave Desert.

The list of NACA/NASA pilots that flew these airplanes over the years reads like a whose who of well-known flight test pilots. They include Gemini, Apollo and Shuttle astronauts as well as XB-70, SR-71, X-15 and Lifting Body pilots and many honors, awards, and accolades have been bestowed in recognition of the accomplishments of these great pilots. However, a very special tribute goes to the mechanics and technicians who maintained these aircraft and their data acquisition systems over the long duration of time the aircraft flew. For a machine that endured significant teething problems in its early development, the performance record of the Lockheed F-104s used in NASA service was nothing less than outstanding.