A Look Back...

ROCKWELL HIMAT (HIGHLY MANEUVERABLE AIRCRAFT TECHNOLOGY)

AIR FORCE FLIGHT DYNAMICS LABORATORY

NASA USAF ROCKWELL HiMAT PROJECT TEAM

NASA

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HQ AFMC HISTORY OFFICE

ROCKWELL HiMAT

During the 1970's the name of the fighter game was maneuverability. Aircraft manufacturers needed to develop new concepts that would make their fighters more nimble than those currently in service. The legendary F-4 Phantom II had been a workhorse in Vietnam, yet it lacked maneuverability in a dogfight. Fly-by-wire control systems developed through the various Control Configured Vehicle (CCV) programs conducted by the Air Force Flight Dynamics Laboratory added flexibility to modern designs. In addition, the use of graphite-epoxy composites that are just as strong as their metallic counterparts, but less weight and more flexible, gave manufacturers the options required to create designs that could meet the new requirements set forth by the Air Force for added maneuverability.

Through the combination of relaxed static stability offered by fly-by-wire controls and construction with the use of graphic-epoxy composite materials, the designs coming off the drawing boards exceeded the known limits of pilots and crew. In order to test a new design to the proposed limits required the use of a unpiloted vehicle capable of supersonic flight and 8G+ sustained turns with superior maneuverability.

The Air Force Flight Dynamics Laboratory Vehicle Dynamics Division teamed with NASA to create requirements for such a vehicle. While submissions from Grumman, Douglas Aircraft, and Rockwell all showed great promise, the Air Force awarded the $17.3 million contract to Rockwell in August 1975 to build two, 44-percent scale, remotely-piloted vehicles under the Highly Maneuverable Aircraft Technology, or HiMAT, program. Rockwell chose the General Electric (GE) J85-21 jet engine with a digital control system replacing the standard hydromechanical engine control system to power the small test aircraft. To reduce complexity the HiMAT aircraft used skid landing gear in place of traditional wheels similar to the X-15.

Rockwell constructed the aircraft with a modular design giving the capability of changing the configuration. A proposed two-dimensional, thrust vectoring, engine exhaust nozzle had been test-fit in mockup form, but never built. The highly instrumented Remotely Piloted Research Vehicle's (RPRV) were air-launched from NASA's venerable NB-52B Mothership and flown remotely from a ground station with emergency backup controls in the aft seat of a TF-104G Starfighter chase aircraft. The advanced technologies incorporated into the new vehicles were a close-coupled canard planform, aeroelastic design with composite structures and relaxed static stability, with a secondary objective to evaluate the smaller RPRV design in comparison with a hypothetical full-scale vehicle.

An important feature of HiMAT was the flight test maneuver autopilot (FTMAP) system. The FTMAP linked with two ground-based computers that allowed preprogrammed maneuvers, such as a constant Mach windup turn, pushover/ pullups, and thrust-limited turns, that were implemented as an outer-loop command bypassing the pilot stick. The first HiMAT, RPRV 870, was devoted primarily to envelope expansion and design point demonstrations, while its sister ship, RPRV 871, was used for research data collection. An important goal of the program was the transonic maneuverability point of 8G sustained at Mach 0.9 and 25,000 ft. The supersonic endurance point goal was to sustain a 3G turn for 3.5 minutes at Mach 1.4 and 40,000 ft.

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The flight test program was carried out at NASA's Ames Research Center/Dryden Flight Research Facility (ADFRF) located at Edwards AFB, CA. From October 1981 to March 1994, Dryden Flight Research Center had been merged with Ames Research Center, becoming the Ames-Dryden Flight Research Facility, and currently named the NASA Armstrong Flight Research Center. During an unveiling ceremony at Rockwell's Los Angeles facility in March 1978, the company revealed the first HiMAT vehicle to a group of VIP's and media. Shortly after the official ceremony, Rockwell loaded the HiMAT on to a flatbed trailer and trucked the vehicle to ADFRF, arriving on March 10, 1978. The second airframe arrived just three months later on June 15.

The following week, on March 16, 1978, RPRV 870 performed the first fit check attached to the NB-52B Mothership. Utilizing a special adapter, HiMAT made use of the same NB-52B wing pylon that once dropped the X-15, Lifting Bodies and other test articles. Taken aloft for the first time on July 11, 1979 during a planned captive flight, this first HiMAT test had to be aborted due to telemetry and aircraft problems encountered during the mission. A second captive flight took place on July 20, with all test objectives met, the first free flight was scheduled for the following week.

The first free flight for HiMAT took place on July 27 with NASA test pilot Bill Dana flying HiMAT from the ground station With all objectives met, the small test vehicle performed a successful landing on Rogers dry lakebed at Edwards AFB. NASA engineers spent the next few months installing instrumentation into RPRV 870 prior to its second flight on December 21. Testing proceeded well until the fifth flight on July 8, 1980, when the decoder failed 5 minutes into the flight and control switched to backup pilot in the aft seat of the TF-104G. A glitch in the latest software update prevented landing skid deployment and HiMAT performed an emergency gear-up landing on the lakebed. With minimal damage, the team repaired the aircraft and it took to the air once more on October 10.

The second HiMAT, RPRV 871, joined the flight test program on June 25, 1981 making its first captive flight, and first free flight performed a month later on July 24. RPRV 870 performed the first 8G maneuver demo during its tenth flight on February 3, 1982, followed by the first supersonic flight to Mach 1.2 during the next flight on May 11, with NASA test pilot Steve Ishmael at the controls. During next flight on May 14, HiMAT flew to a maximum Mach number of 1.45.

Research flights continued throughout 1982 with ship 1 making its fourteenth, and final, flight on August 27, while ship 2 carried on until making its twelfth, and final, flight on January 12, 1983 with test pilot Einar Enevoldson in the remote cockpit station. The average flight time for each HiMAT flight was approximately 30 minutes. At the end of the test program, HiMAT 870 had made 14 flights with a total flight time of 11 hours and 35 minutes, while 871 made 12 flights for a total of 10 hours and 57 minutes.

ROCKWELL HiMAT

HiMAT's contributions appear to be mixed. The system's complexity was greater than predicted, flight operations more labor intensive, and the subscale size made it restrictive in many aspects. Yet, its accomplishments were impressive, sustained 8G turns at near supersonic speed, and supersonic endurance surpassed the design goals with aerodynamics as good, or better, than predicted. One HiMAT engineer stated that Dryden engineering section disliked seeing HiMAT on the flight schedule because it took virtually the entire pilot's office to fly a mission; 2 in the NB-52B, 1 in the RPRV ground station, 2 in the TF-104G safety chase and 1 more in a second chase aircraft as required, bringing about the joke of 'how many pilot's does it take to fly an unmanned aircraft'?

With the flight test portion completed, NASA placed the first aircraft in storage while the second participated in loads testing. Flexibility and strength of the composite wing structure tested to the point of failure provided data on future construction techniques of composite aircraft. After testing HiMAT 871, NASA technicians repaired the aircraft and placed it in storage with its sister ship. Eventually, HiMAT 870 found a place of honor in the Smithsonian Air & Space Museum in Washington DC. RPRV 871 eventually ended up on outdoor display at Ames Research Center at Moffett Field, CA. It remained there until 2009, when it returned to Dryden Flight Research Center, restored to its original colors, and placed on display outside of the center.

A number of contributions in fly-by-wire controls and design, manufacturing and use of advanced composites from the HiMAT program ended up in follow-on design programs such as the Advanced Design Composite Aircraft (ADCA), Advanced Fighter Technology Integration (AFTI), Rockwell's Tactical Interceptor, Ground Attack & Reconnaissance (TIGAR), as well as the Advanced Tactical Fighter program that became the Lockheed F-22 Raptor.

Additional Reading:

HiMAT Flight Program: Test Results and Program Assessment Overview, NASA Technical Memorandum 86725

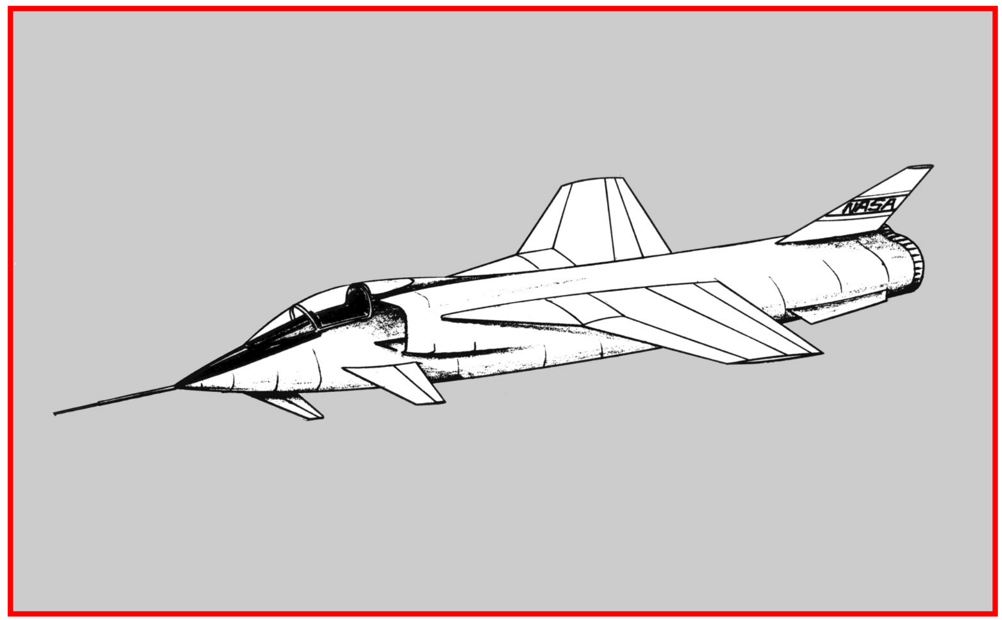
By Dwain A. Deets, V. Michael DeAngelis and David P. Lux

Turning Time Ahead, Boeing Frontiers, May 2007

By Erik Simonsen

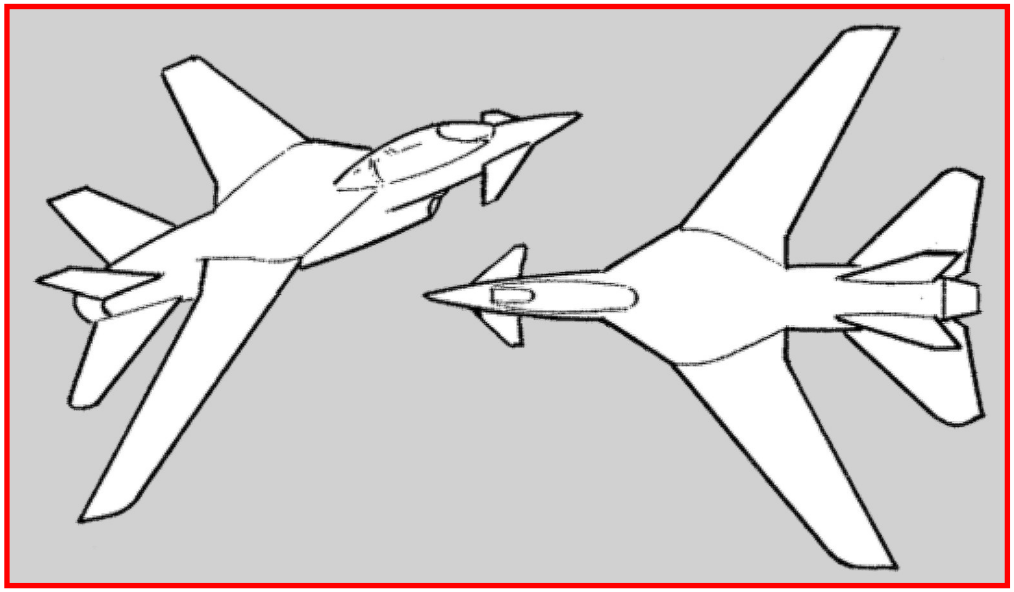
The Air Force Flight Dynamics Laboratory (AFFDL) modified a single F-4 Phantom II to test fly-by-wire control systems. This aircraft 62-12200, began service as a YRF-4c, later modified into the first YF-4E. The canards on the intakes were added in 1974 as part of the Control Configured Vehicle program. This aircraft is in the collection of the National Museum of the United States Air Force.

AFFDL continued their research into fly-by-wire controls by using the first YF-16 under the Control Configured Vehicle (CCV) program. CCV aircraft utilized independent or 'decoupled' flight surfaces making it possible to maneuver the aircraft in one plane without movement in another, such as turning without banking.

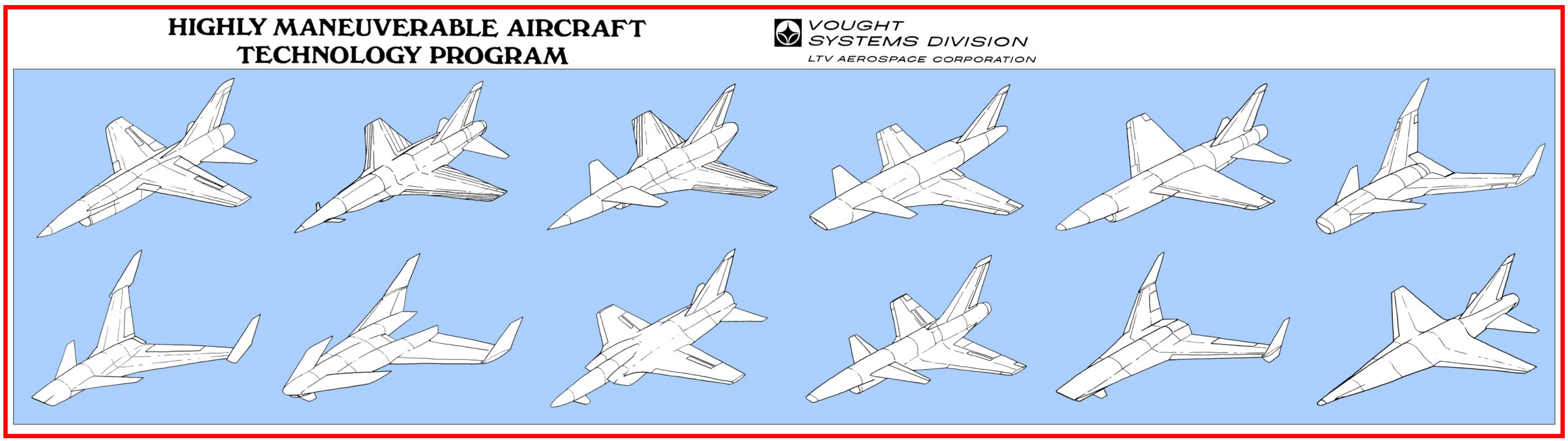


Ling Temco Vought (LTV) made numerous CCV aircraft proposals including a modified F-8 Crusader (above, left) as well as the clean sheet design above right. Neither of these vehicles moved beyond the concept stage.

ROCKWELL HiMAT

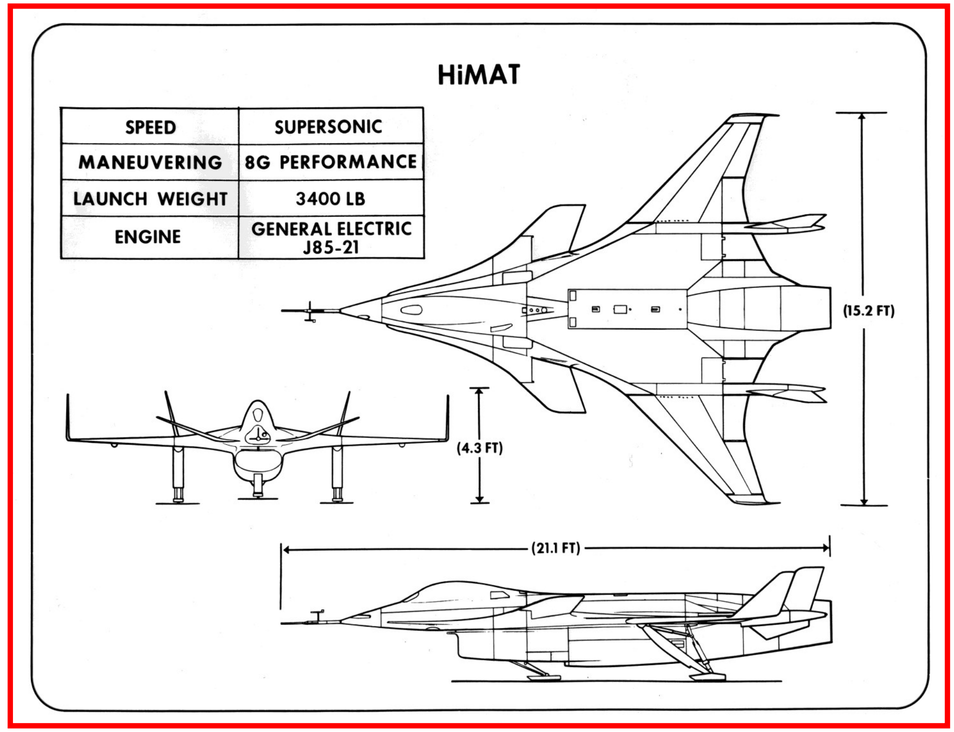


Grumman entered the HiMAT competition with an unmanned, variable geometry wing design known as the Model 636. While many companies submitted proposals, the competition narrowed to Grumman, Douglas Aircraft and Rockwell International. While Model 636 showed promise, the joint Air Force/NASA program office chose Rockwell's unmanned proposal in the end.

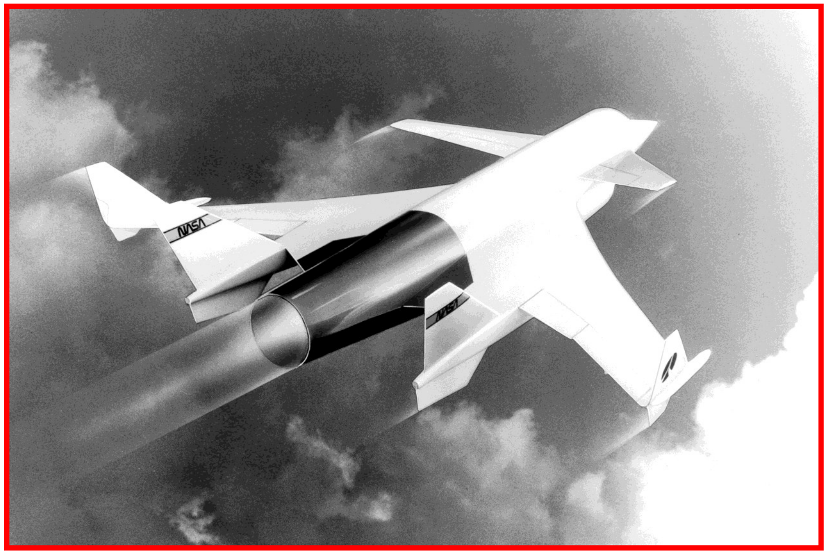


LTV submitted a variety of unmanned designs for the HiMAT competition. The designs varied from basic wing planforms to highly-swept wings, blended fuselage and swept canard surface proposals. Once again, none of these moved beyond the concept phase.

Rockwell International's winning proposal showed a futuristic-looking, unmanned vehicle capable of reaching all goals set for the program. Early designs had the canards as larger, curved surfaces as shown above right with the vehicle being launched from a wing pylon of a C-130 Hercules (right). The final layout looked closer to the illustration above with swept canards and launched from NASA's NB-52B mothership.

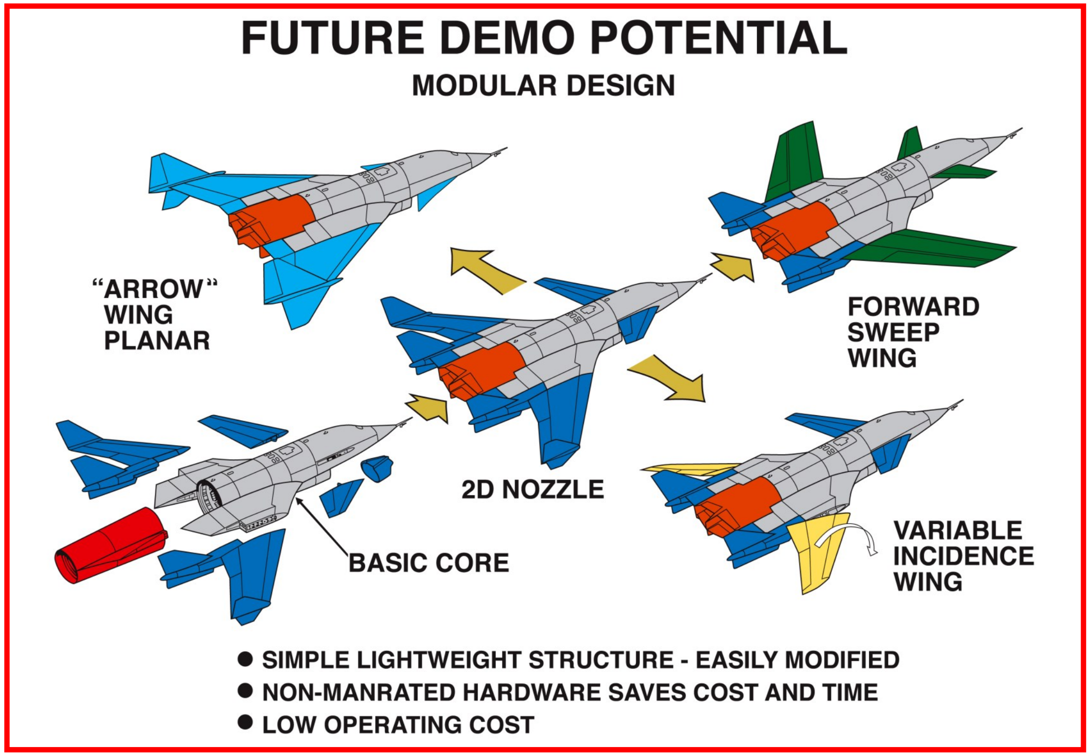


Rockwell International

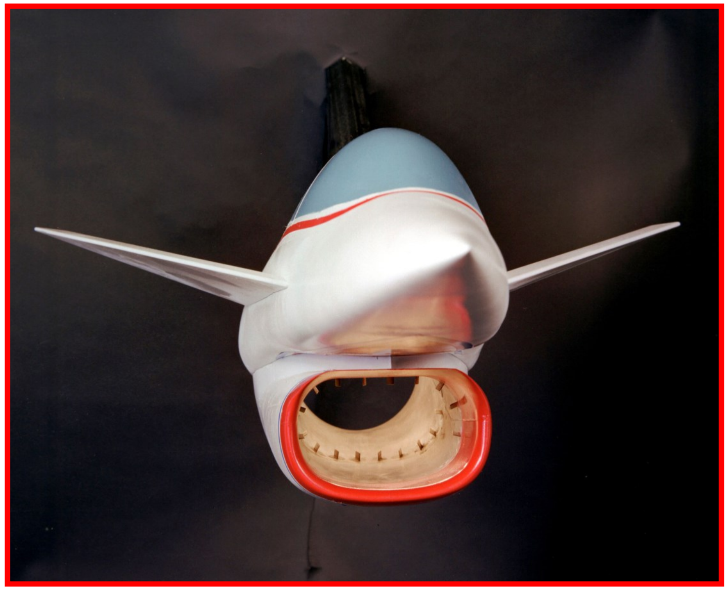


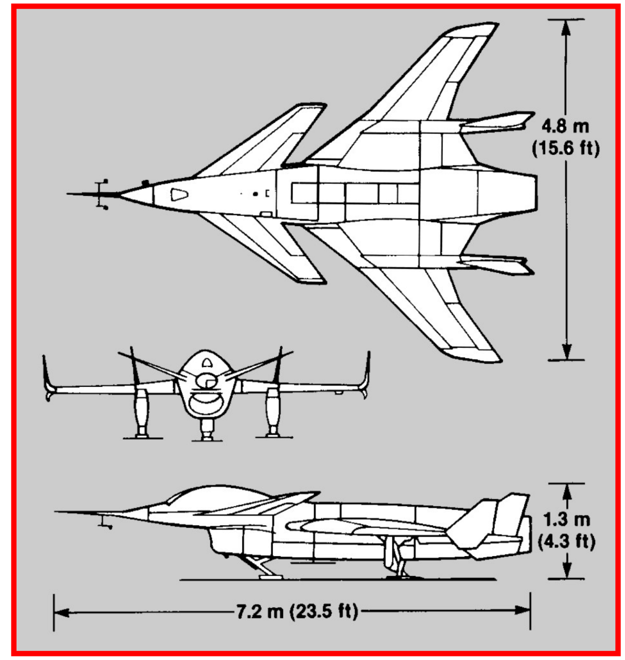
A refined artist concept from Rockwell, shows small pods on the outer wingtips that were not on the actual aircraft. Rockwell chose the General Electric (GE) J85 jet engine to power HiMAT.

NASA's Ames Research Center at Moffett Field, CA performed the majority of HiMAT wind tunnel testing with supplemental testing completed at NASA's Lewis Research Center (now Glenn Research Center), OH, Langley Research Center, VA and the Air Force's Arnold Engineering Development Center, TN.

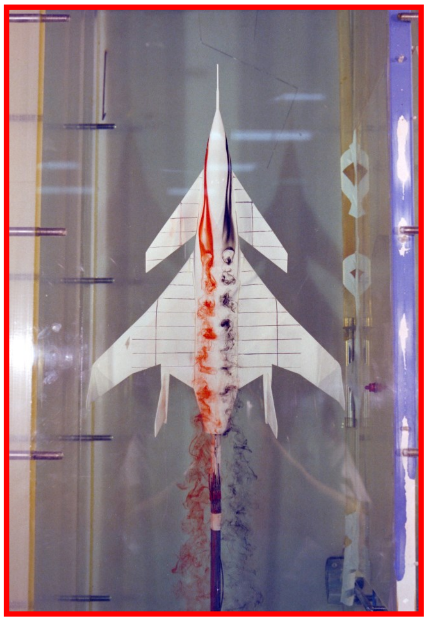


Rockwell designed HiMAT around a modular core in order for different design configuration testing shown at left. At least one HiMAT wind tunnel model received the square, 2D thrust vectoring nozzle modification. Rockwell constructed a full-scale 2D nozzle mockup that was test fit on the second HiMAT, yet no actual testing followed.

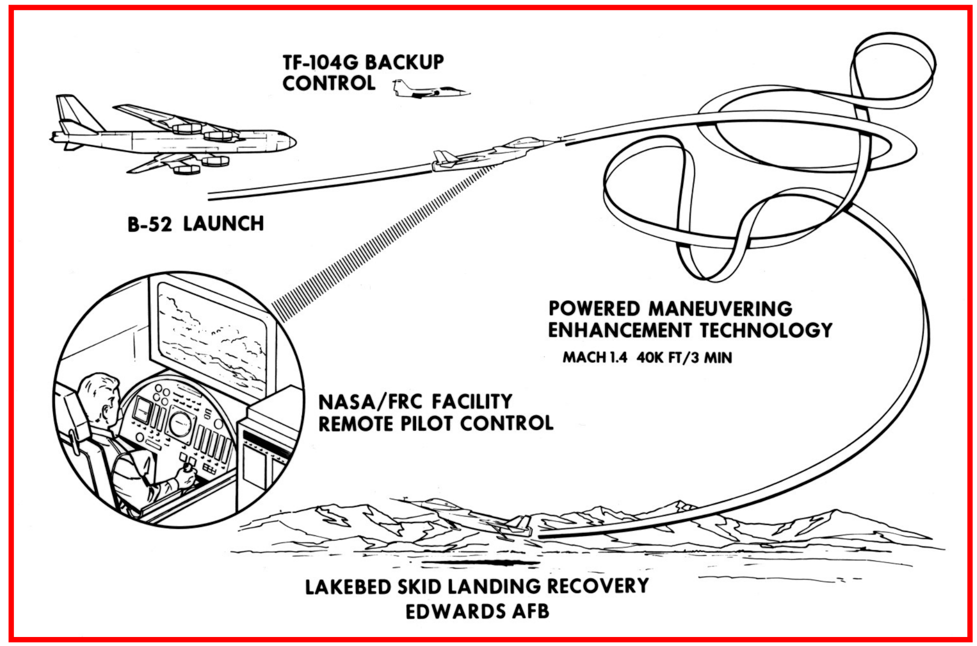




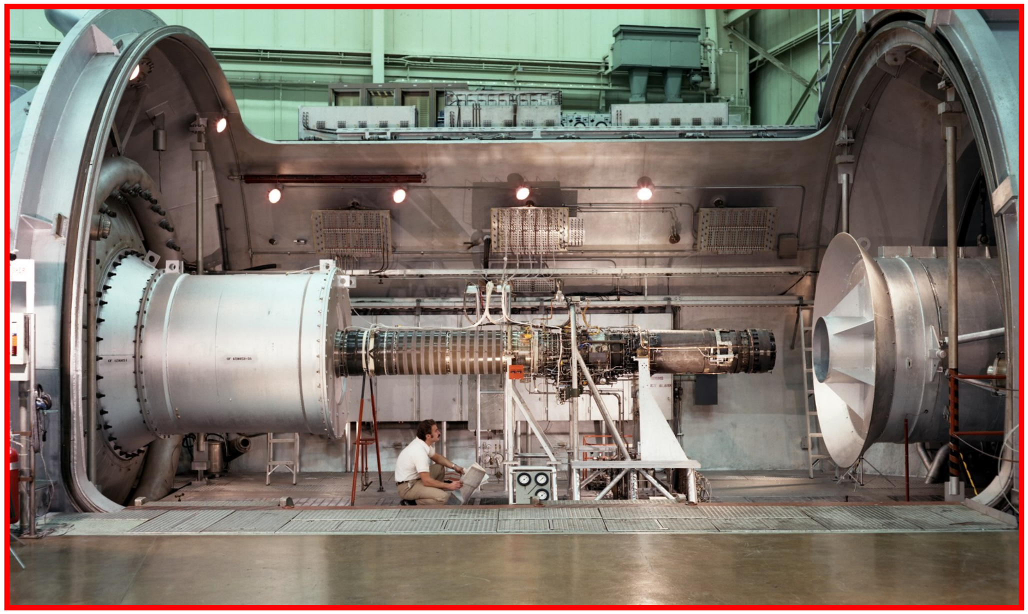
NASA's Lewis Research Center performed wind tunnel testing on a HiMAT inlet test model, as well as the J85-21 engine. Note the canard shape of this model.



NASA tested a 1/15th scale HiMAT model in the water tunnel at Ames/Dryden Flight Research Facility during May 1979. Inexpensive water tunnel models made use of colored dyes injected into the water flow to visualize airflow under different fight conditions.



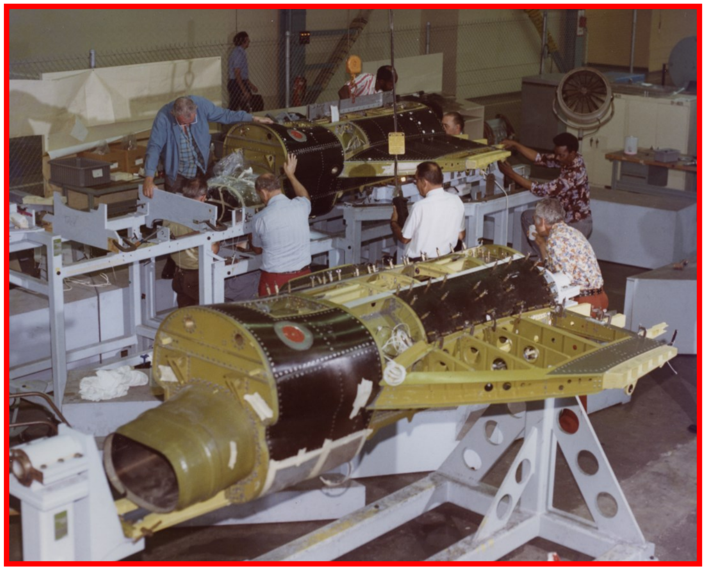
The illustration above shows the standard mission profile for a HiMAT test flight flown from a remote cockpit station. The small test vehicle measured just 23.5 feet (ft) in length and 15.6 ft wingspan as shown in the top illustration.

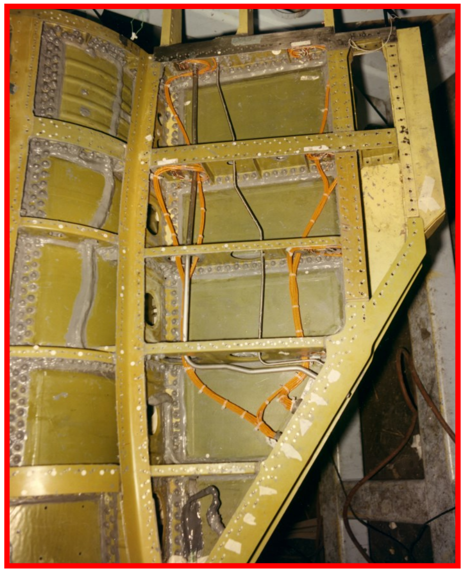


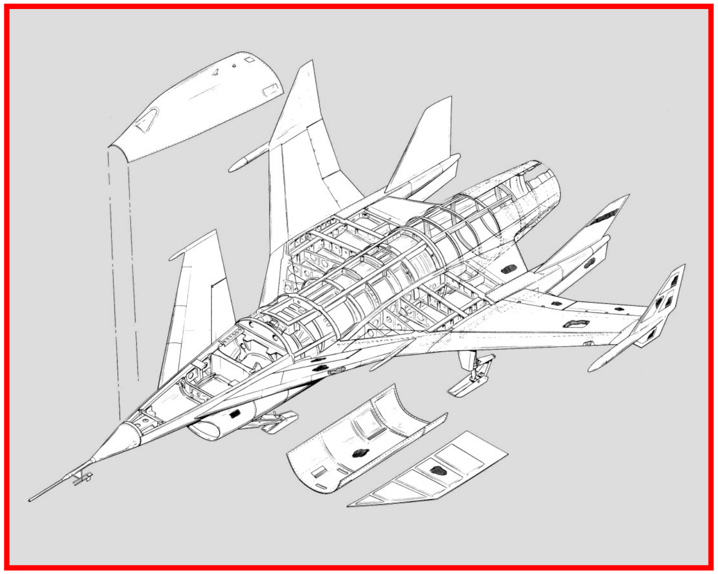
The GE J85-21 turbojet engine for HiMAT underwent extensive testing at the NASA Lewis Research Center in Cleveland, OH. The small engine weighed in at 684 pounds, yet produced 3,500 pounds thrust at military power and 5,000 pounds thrust in afterburner.

Rockwell constructed at least two full-scale mockups of HiMAT. One had clear windows enabling internal components to be viewed. Notable is the compact size of the internal structure .

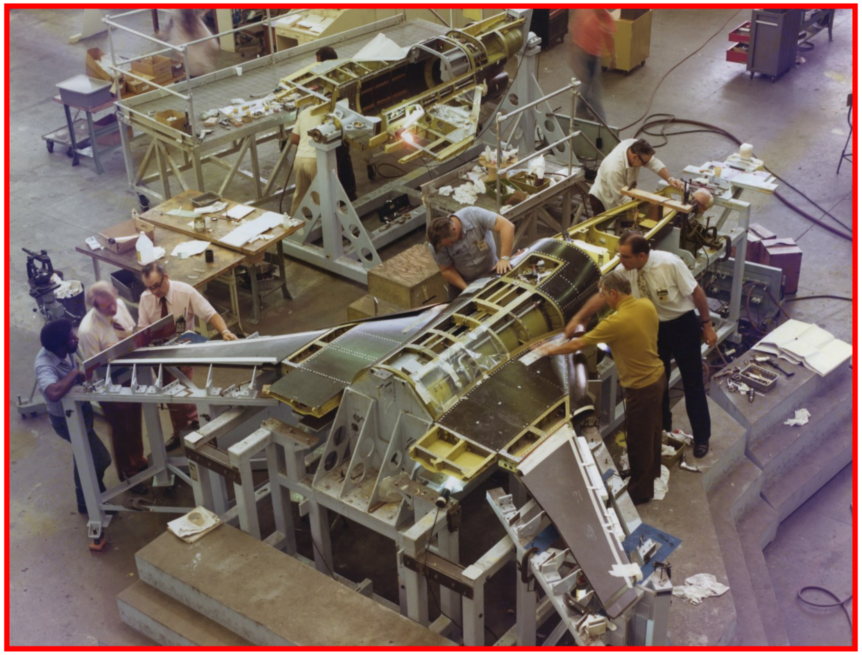
The second mockup, constructed from wood and fiberglass, gave an accurate representation of the actual vehicle. Crated at Rockwell and shipped to ADFRF, the mockup could be shown to visiting dignitaries. This mockup is currently stored at the Air Force Flight Test Center Museum at Edwards AFB, CA, awaiting restoration.



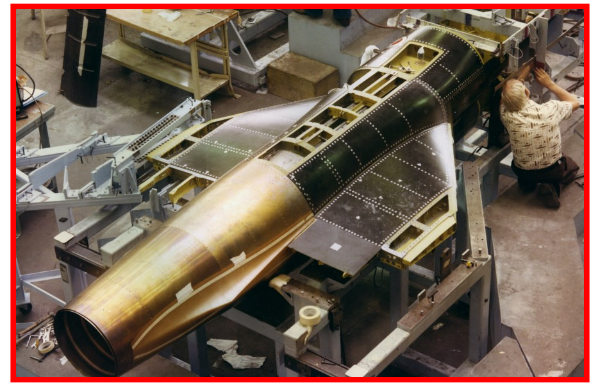




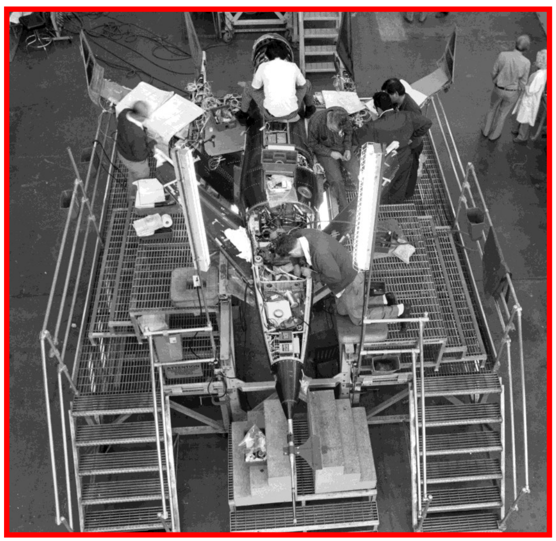
Constructed primarily of aluminum with a graphite composite outer shell, the two HiMAT vehicles went through the assembly process together (above, left). Orange flight test instrumentation wiring passed through various areas of the internal structure prior to the composite shell installation (above, center).

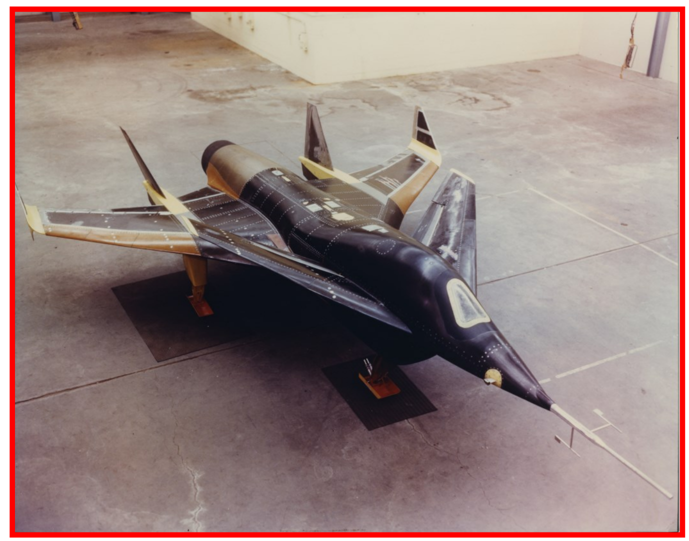


Since the Air Force contract stated only two test airframes be constructed, the HiMAT vehicles were essentially hand built at Rockwell's facility in Los Angeles, CA. Custom-built rotating fixtures allowed Rockwell technicians easier access to various components during the assembly process (above, left). HiMAT ship 2 followed behind the first by approximately one month (above, right).

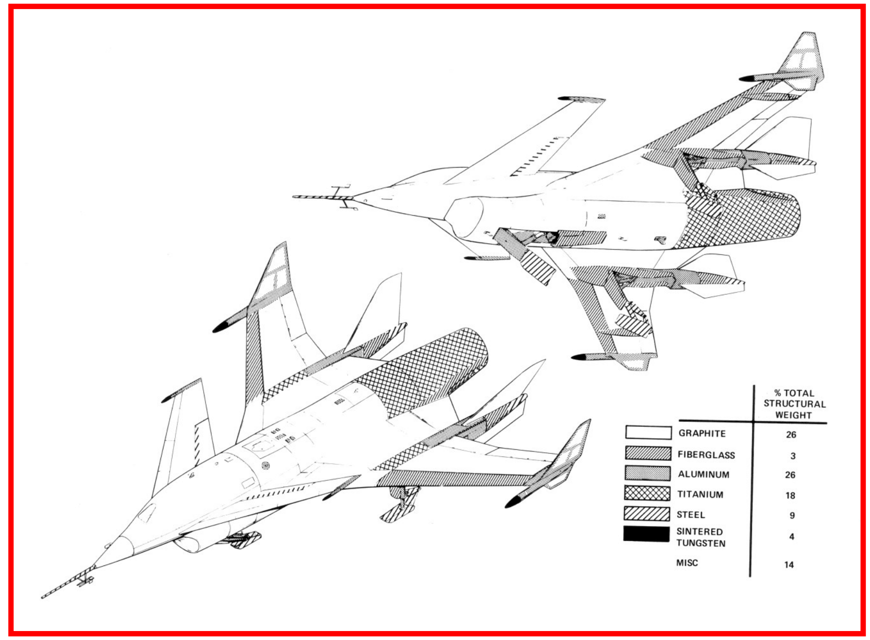


Assembly of the two HiMAT test aircraft began in late 1976 Rockwell's Los Angeles, CA facility and construction proceeded rapidly. By the end of 1977, the first HiMAT neared completion with the second not far behind. Assembly complete, the first test aircraft heads for the paint shop in February 1978 (bottom, right).



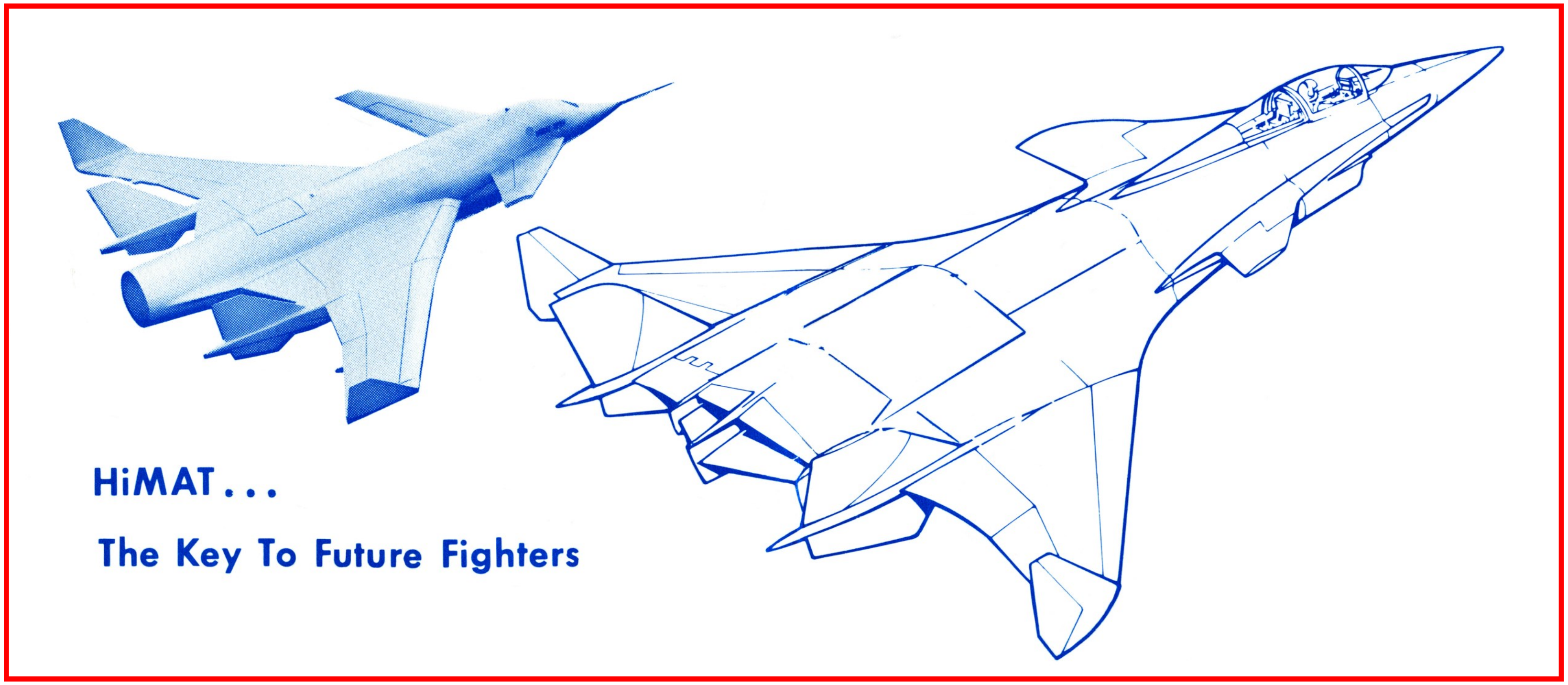


Rockwell debuted the new HiMAT aircraft during a small ceremony the first week of March, 1978 for selected dignitaries and media.



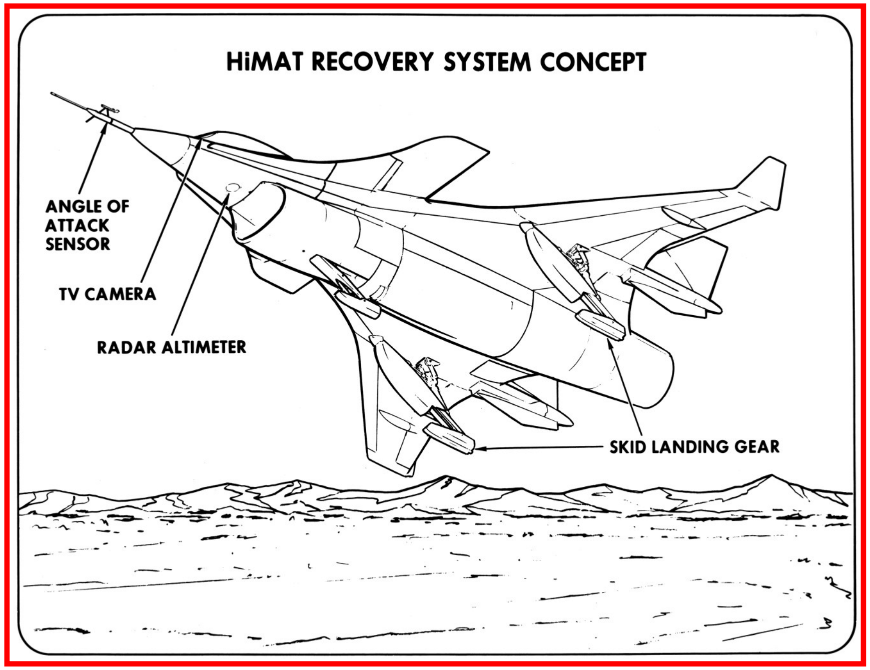
Graphic illustration showing the primary materials that went into the HiMAT vehicles. Graphite, aluminum and titanium make up the largest portions.

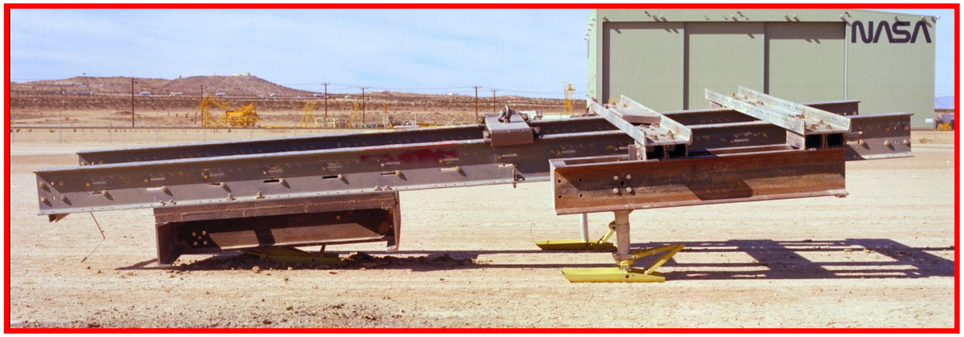
The first HiMAT test aircraft arrives via flatbed at NASA's Ames/Dryden Flight Research Facility on March 10,1978. NASA quickly painted over the Rockwell logo on the outer vertical stabilizers. Note another Rockwell product parked in the background, the Space Shuttle Enterprise atop the Boeing 747 Shuttle Carrier Aircraft prior to departing California for mated, vertical, ground vibration testing at Marshall Space Flight Center in Alabama.

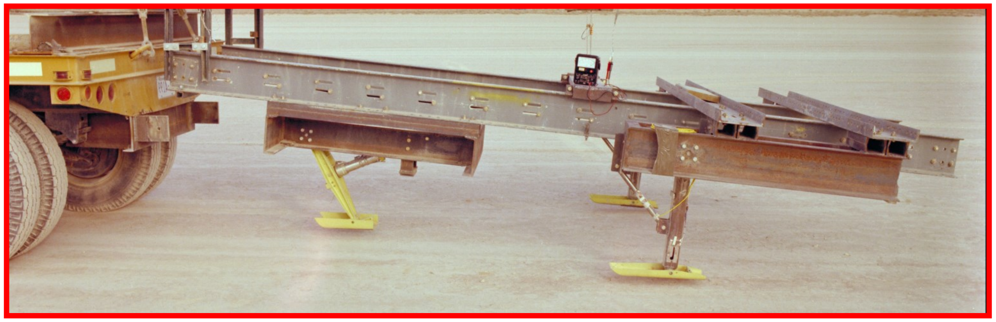


This illustration, taken from a Rockwell promotional HiMAT brochure, shows the subscale test vehicle next to a proposed, manned, fighter variant.

Two years prior to the arrival of the first HiMAT test aircraft, NASA test pilot William H. "Bill" Dana practiced perfecting remote landing techniques from the ground-based cockpit utilizing a camera and telemetry system installed in NASA's PA-30 Twin Commanche.



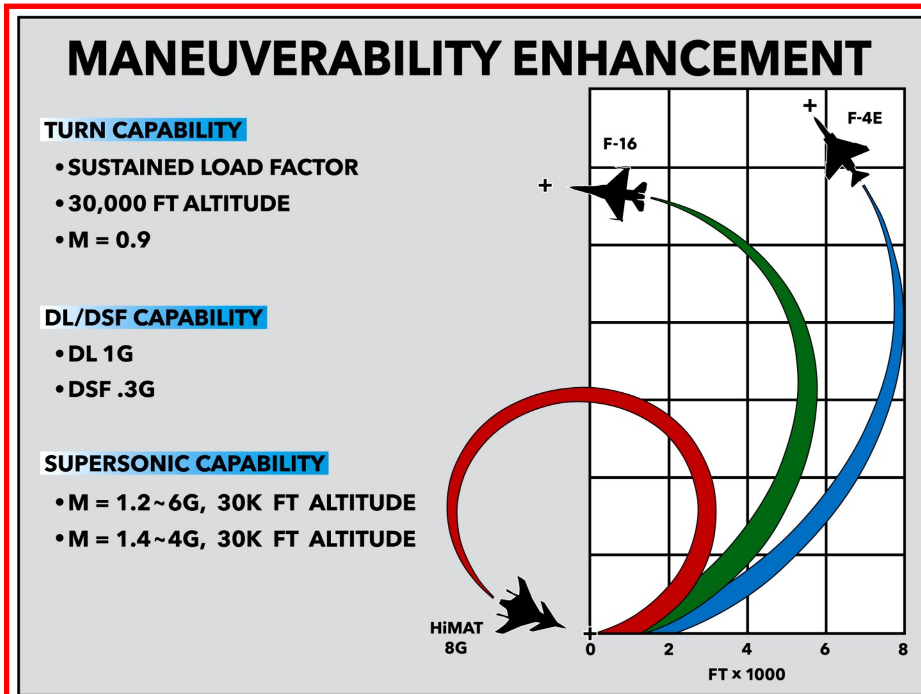




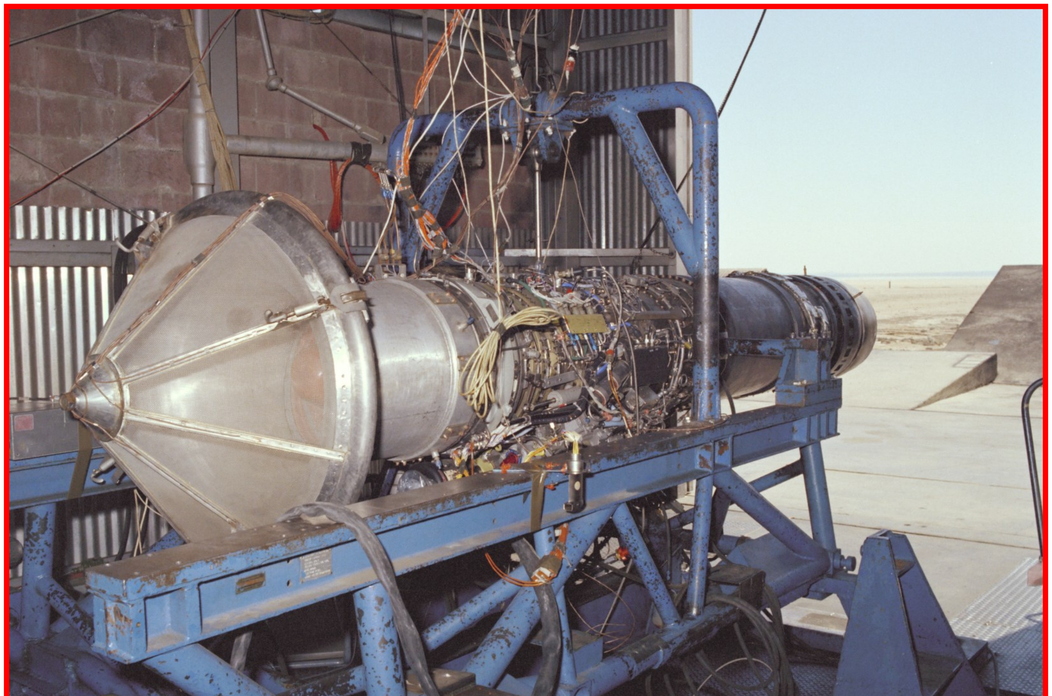
To save weight and complexity, HiMAT utilized skids in place of traditional, wheeled landing gear as shown in the illustration above, left. NASA constructed an I-beam test rig with the skid system attached to verify skid design, and the effects the skids have on the dry lakebed surface.

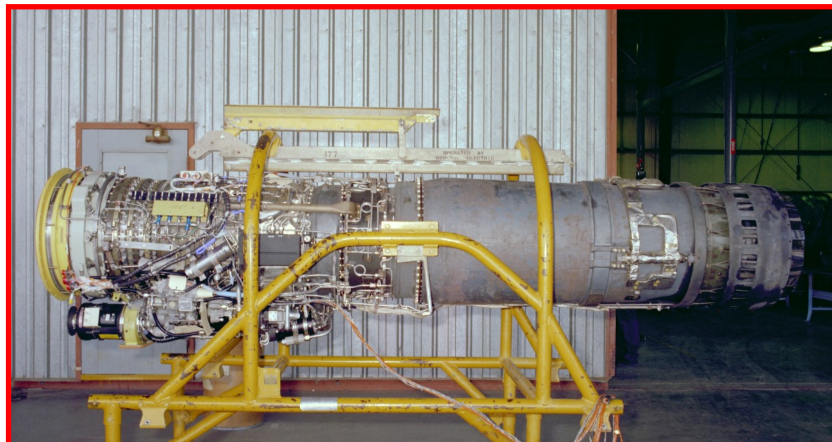
In order to use the NB-52B mothership, NASA technicians constructed a custom adapter that attached HiMAT to the X-15 pylon on the NB-52's right wing. This first mating occurred just a week after arrival of the first HiMAT vehicle on March 16, 1978. Control surfaces on the trailing edge of the wing and canard show up well in the photo above, right.

NASA's ADFRF took delivery of the second HiMAT test aircraft on June 15, 1978. Unlike the first vehicle, ship 2 remained unpainted during the ground testing that transpired over the next 36 months, prior to its first flight.



The illustration above compares the maneuverability and turning radius of HiMAT compared to fighter aircraft in service during the late 1970's.





The GE J85 turbojet engine (above and left) used in HiMAT also powered the Northrop T-38 & F-5 family of aircraft, as well as the Cessna A-37 Dragonfly. A compact design, the engine measured 112 inches in length and 20.8 inches in diameter at the inlet.

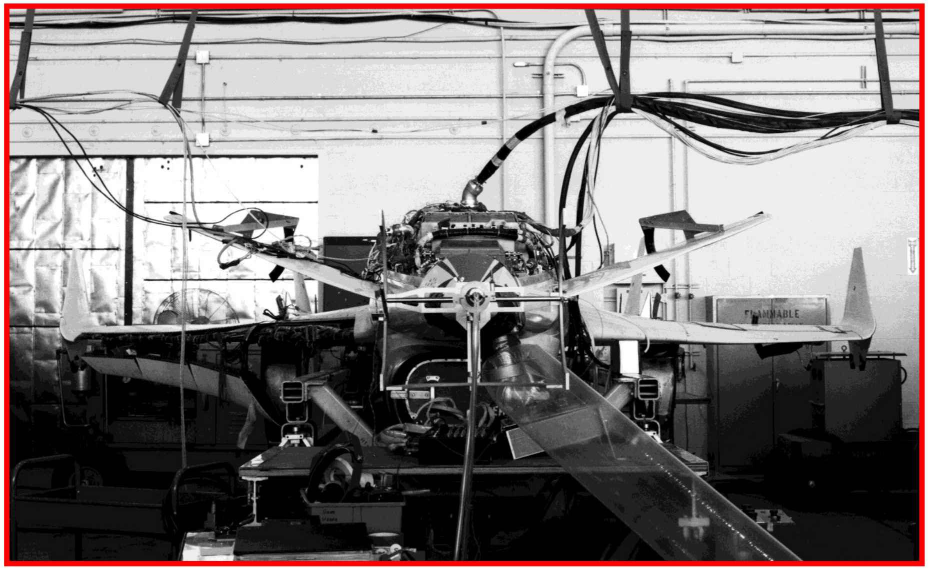
The second HiMAT, RPRV 871, began ground testing almost immediately upon arrival as shown above during moment of intertia testing on July 18, 1978.

HiMAT, RPRV 870, during weight and balance checks on August 7, 1978. Note the Rockwell logo on the vertical stabilizer is painted over.

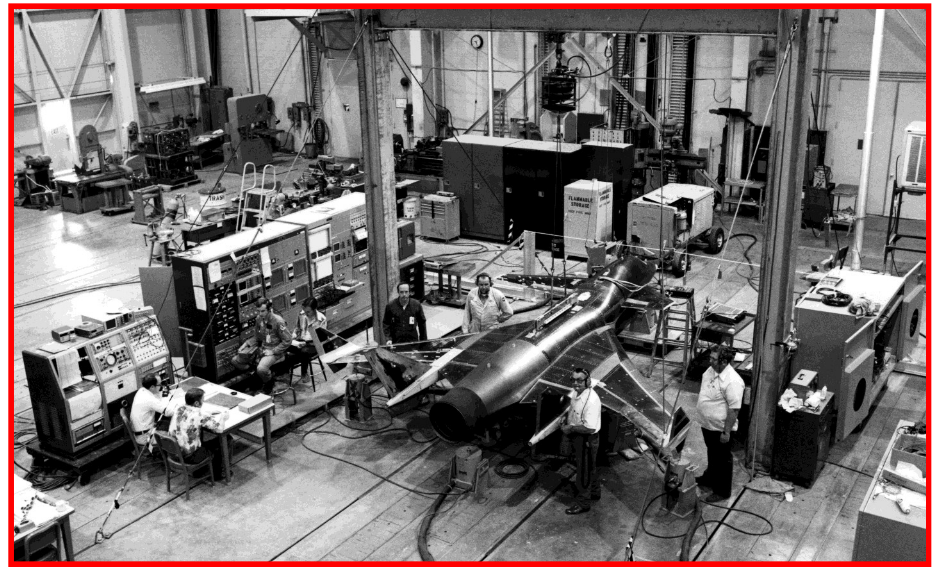
Ground testing of the GE J85-21 while installed in the first HiMAT vehicle, commenced on September 12, 1978. The large hoses attached to the vehicle in the photo above, right provided cold air to the avionics bay to prevent overheating in the hot desert sun. Note the signatures of HiMAT program personnel on the inside of the avionics bay cover above, left.

The two test vehicles, RPRV 870 above, left, and RPRV 871 above, right, were similar in most respects though each had specific mission functions assigned. The mission for the first HiMAT was primarily aerodynamic envelope expansion, while the second vehicle focused on research data collection.

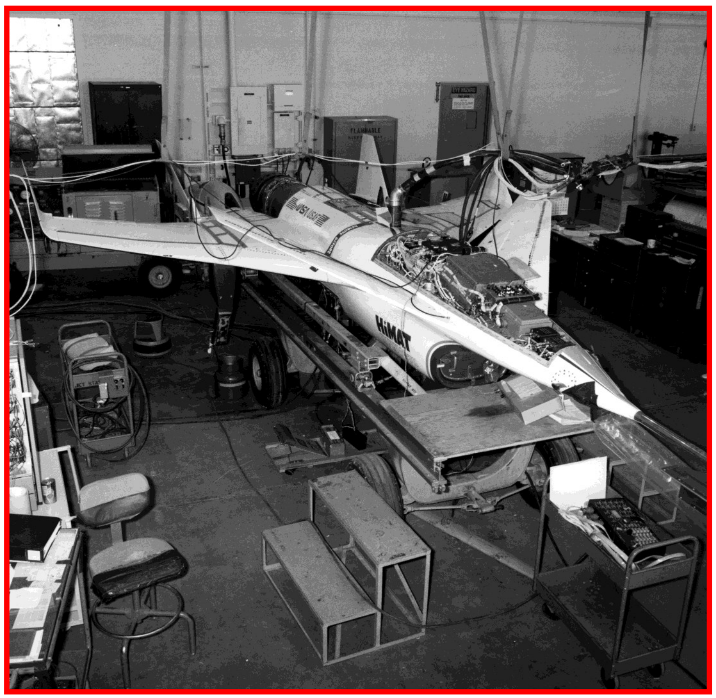
The landing skid system, engine inlet and instrumented pitot boom show up well in the view at left, as HiMAT RPRV 870 is lowered by crane onto Rogers Dry Lakebed at Edwards AFB, CA on September 18, 1978. The highly swept wing and multiple vertical control surfaces are highlighted in the rear quarter view above.

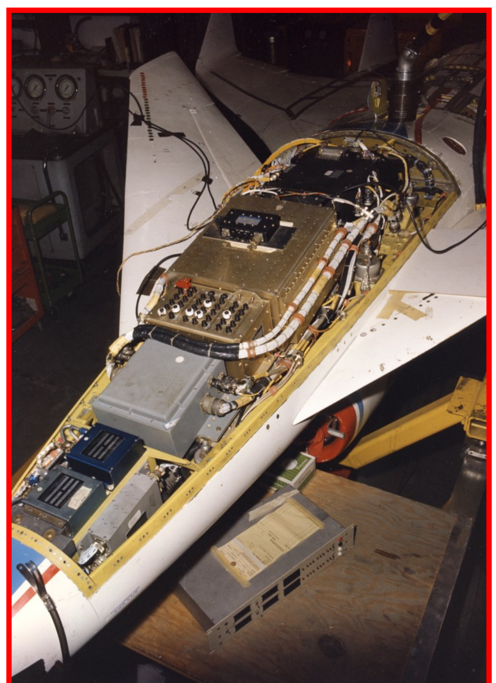


Looking like a patient on life support, RPRV 870 undergoes a series of systems tests in December 1978.



Ground Vibration Tests (GVT) are part of all new aircraft designs and both HiMAT aircraft endured this setup. Above, RPRV 871 during its GVT on November 15, 1978.



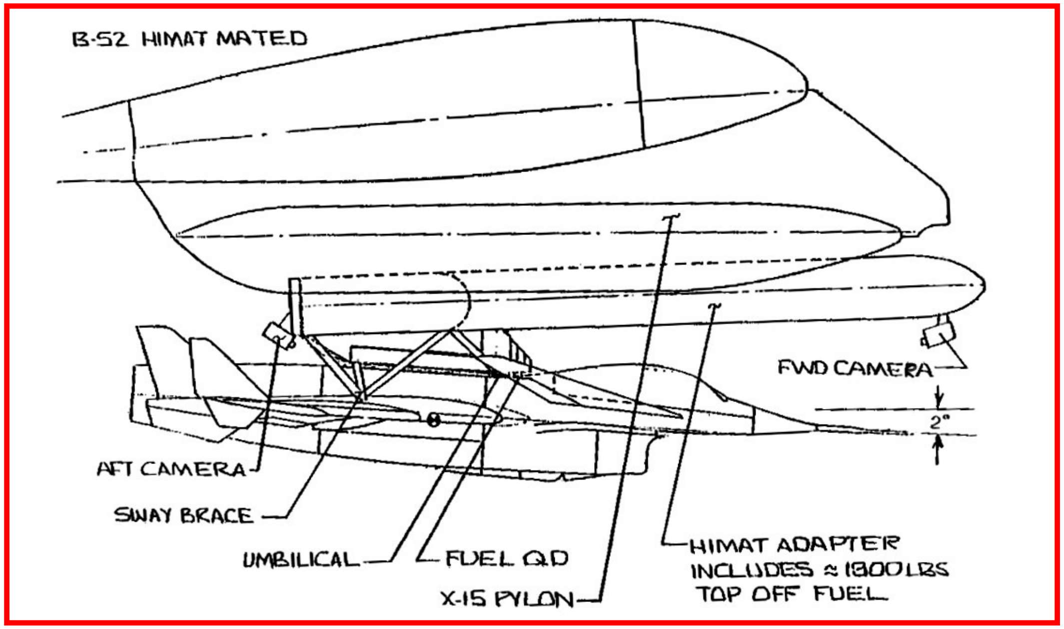


The condensed size of the avionics package used in HiMAT was due to the diminutive size of the HiMAT test aircraft. The compact nature added a degree of difficulty for the technicians that worked on the vehicle.

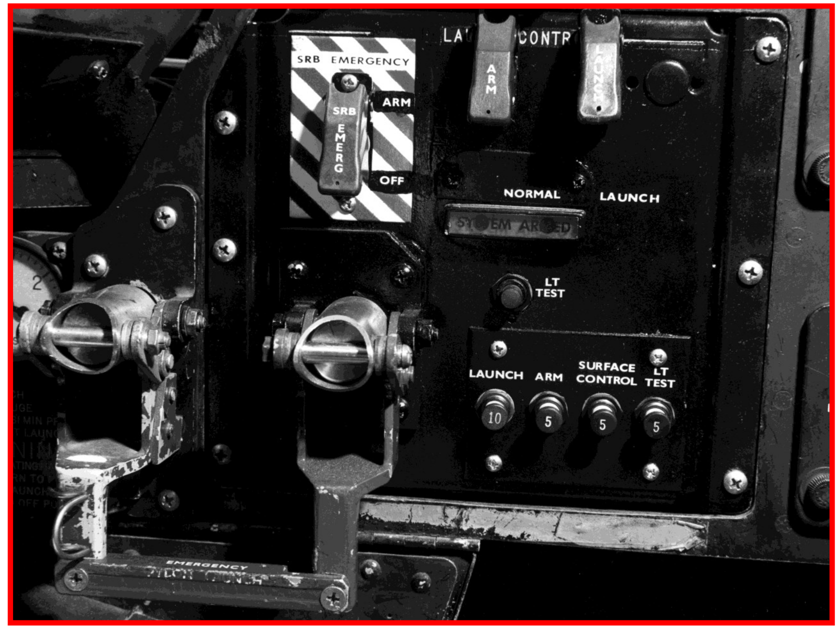
A NASA technician runs HiMAT RPRV 871 avionics system through a series of flight simulations through the use of ground based flight simulator setup attached directly to the onboard flight control computer. Note the red NASA Firebee II drone in the background.

The lack of a traditional wheeled landing gear system added complexity to the simplest tasks, such as moving the aircraft to different locations for testing. Moving the HiMAT aircraft relied on the use of flatbed trucks, forklifts and overhead cranes to get the test vehicles in correct position.

Foreign Object Debris (FOD) is a concern for all turbojet aircraft, especially those whose engine inlet sits close to the ground. NASA tested the possibility of damage to the engine during series of inlet tests in May 1979 by using Rice Krispies breakfast cereal placed in front of the inlet during an engine ran at various power levels.



The above illustration shows the placement of the HiMAT test vehicle, adapter and X-15 pylon on the wing of the NB-52B, Note the 2 degree nose down angle to assist in vehicle release.



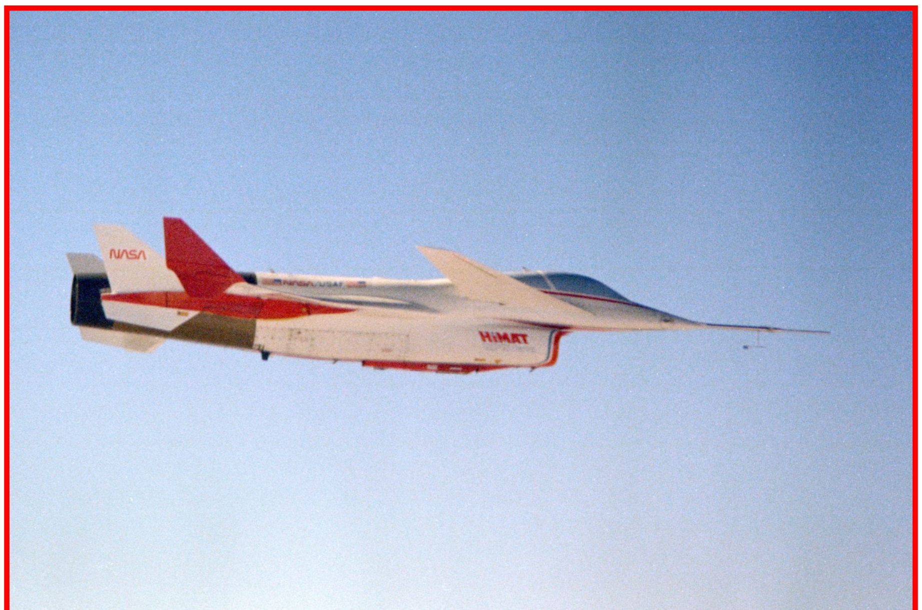
HiMAT made use of the same launch panel in the NB-52B used by other test programs such as the Solid Rocket Booster (SRB).

To facilitate the air-launch mission required by HiMAT, the aircraft required the use of a custom adapter mounted to the X-15 pylon of the NB-52B mothership. The adapter carried 135 gallons of JP-5 jet fuel to keep the vehicle topped off during the flight to altitude, as well as forward and aft cameras to film the separation.

After a year of ground testing and simulations, the first HiMAT is ready to begin flight testing. Towing HiMAT out to the NB-52B in July, 1979 (above, left) prior to the first captive test flight. A full moon hovers in the background as technicians finish final checks before starting engines on the NB-52B mothership (above, right).

With RPRV 870 all buttoned up and the mothership's engines running, the NB-52B prepares to taxi out to the runway at Edwards AFB, CA (left). Summer days at Edwards AFB often reach 110 degrees by midday, so many test mission begin in the early morning hours when temperatures are more manageable for both man and machine (above).

The small test aircraft is barely visible on the right wing of its NB-52B mothership. HiMAT completed two, planned, captive flights before taking to the air on its own.



HiMAT, RPRV 870 takes to the air for the first time on July 27, 1979, accomplishing 19 of the scheduled 22 test points, during the successful 22-minute first flight.

The NB-52B Stratofortress, 52-0008, began its career as a mothership in 1959 during the X-15 program. Affectionately known as 'Balls 8', it became the oldest flying operational bomber in the inventory until its retirement on December 17, 2004.

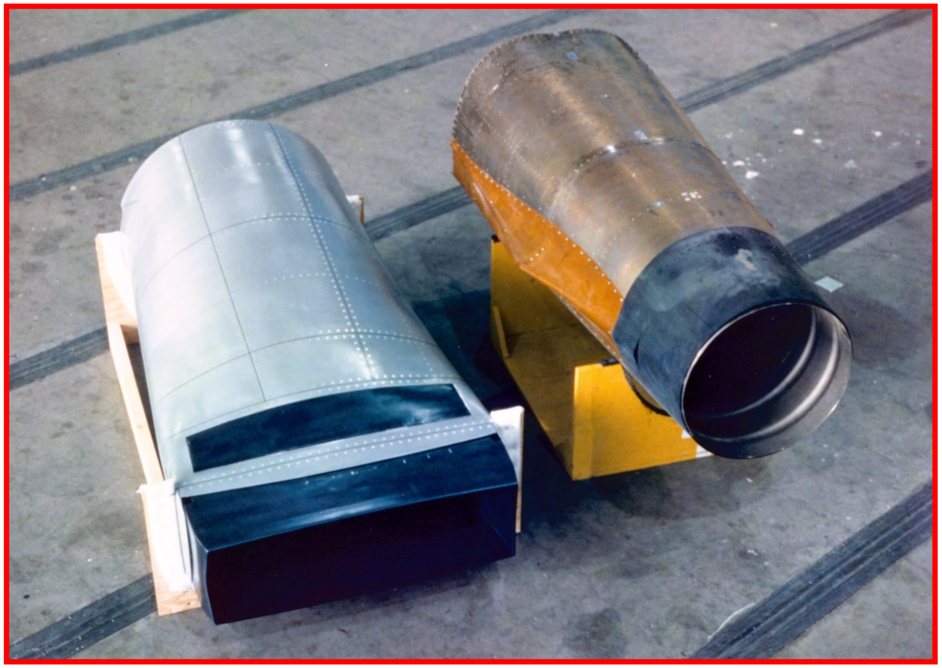
The laborious task of loading HiMAT onto its transport cart fell to the ground support crew that traveled to the landing site in vans shown in the background.

NB-52B flight crew after the second captive flight: L to R– Fitz Fulton (pilot), Bill McCarty (NB-52 crew chief), Ray Young (FTE) and Don Mallick (pilot).

Flight preparations for the second HiMAT flight began long before sunrise on December 21, 1979 (left).

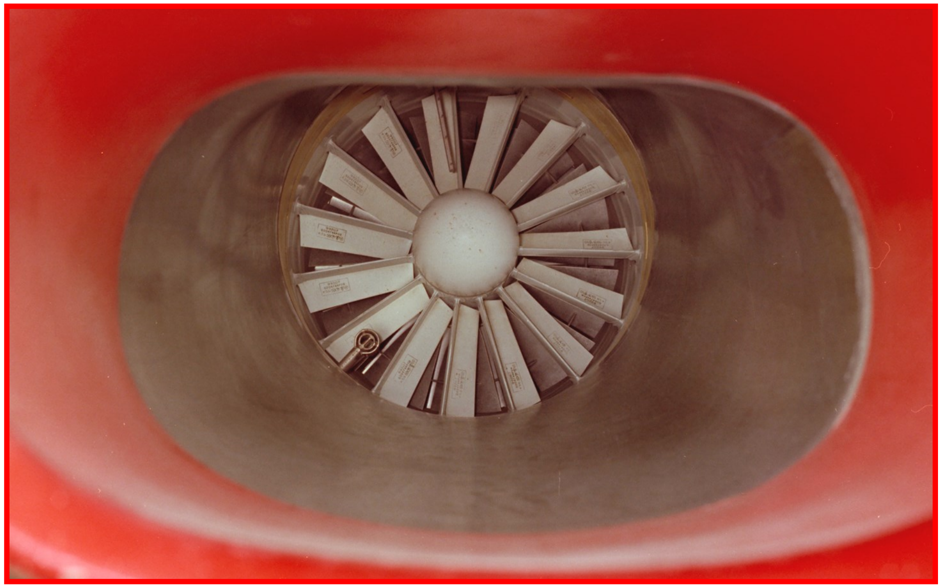
A single captive flight occurred between the first and second free flight. To check airflow disturbance around HiMAT, airflow tufts were added to the vehicle and filmed by cameras on board the NB-52 and safety chase F-104 (above and left). As delivered, RPRV 870 carried stars & bars and 'USAF' on the bottom of the wings (below, left). The 'USAF' was removed between flights 3 and 4. RPRV 871 carried no markings on the wings.

HiMAT 870 sits on the dry lakebed at the completion of flight 2 on December 21, 1979.

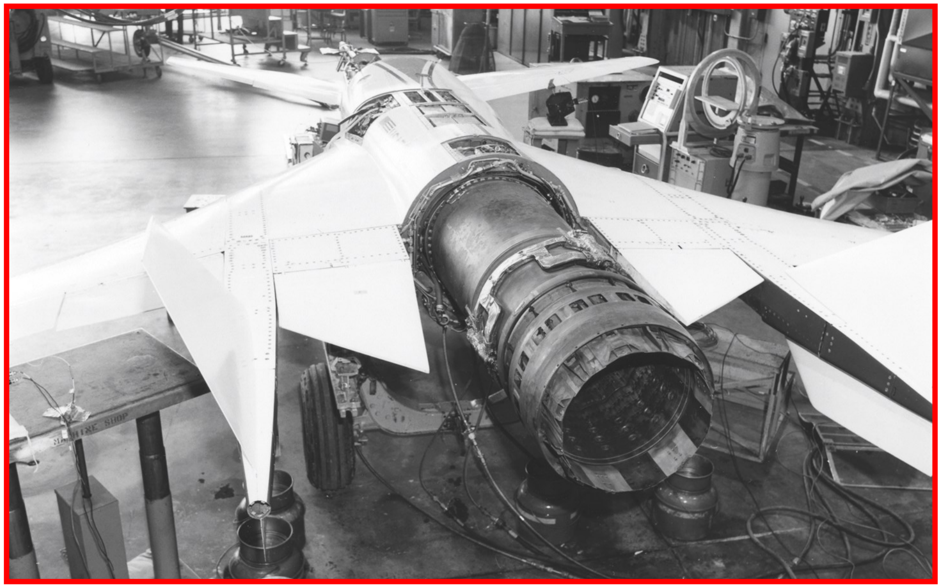


Rockwell constructed a non-functional, fiberglass mockup of a square, two-dimensional (2D), thrust vectoring nozzle for HiMAT and installed it on RPRV 871 in May 1980. The nozzle section could be adjusted up and down as needed, and included upper and lower thrust reversers as shown the photo at bottom, left. Rockwell never built a functional 2D nozzle, so this as close as HiMAT ever got to testing thrust vectoring.

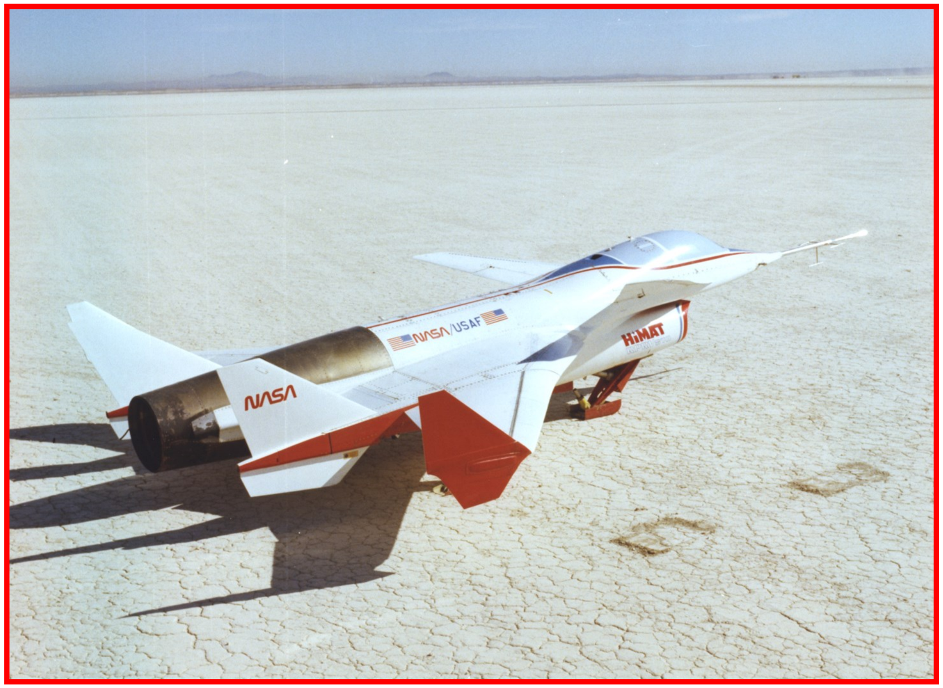
The only significant incident of the HiMAT flight test program occurred during flight H1-5-10 on July 8, 1980, when a telemetry decoder suffered a hard failure and control switched the backup control system (BCS) aboard the TF-104G safety chase aircraft. Though the BCS had activated during earlier flights, this time a software glitch kept the landing skids retracted and a gear up landing performed. Minimal damage occurred, and HiMAT was back in the air just two months later.



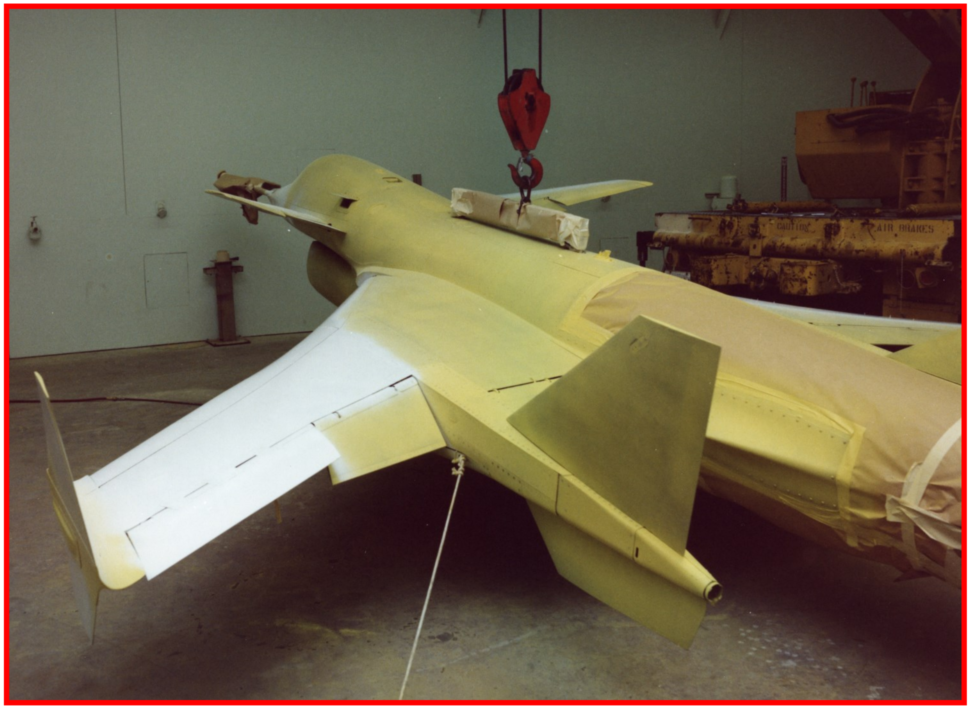
Looking down the inlet of HiMAT the GE J85 turbojet engine face is easily inspected by ground crew members.



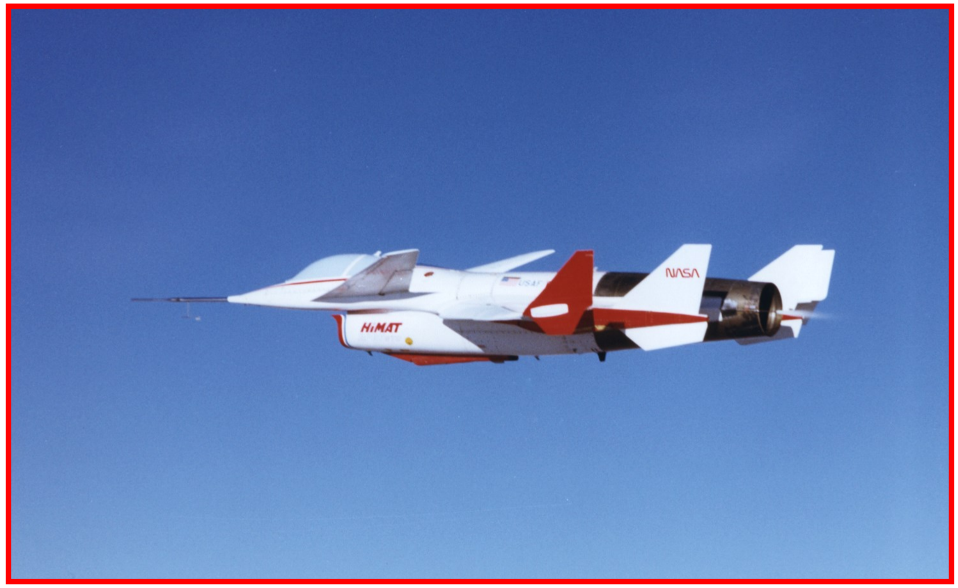
Maintenance access to the GE J85-21 turbojet on the HiMAT aircraft required the removal of the entire aft metal engine fairing.



Completely repaired, RPRV 870 sits on Rogers Dry Lake after flight H1-6-13 on October 28,1980. Two planned captive flight occurred on September 30 and October 10. All objectives were met during the second captive flight, though the main gear did not deploy when commanded during the first.



With most of the ground testing completed, it was time for ship 2 to join the flight test program. Prior to making its first captive flight, RPRV 871 received a basic black, red and white paint job in the NASA paint shop during November 1980. Prior to applying the white top coat, the aircraft received a zinc chromate primer (top, right) for corrosion prevention and better top coat adhesion.



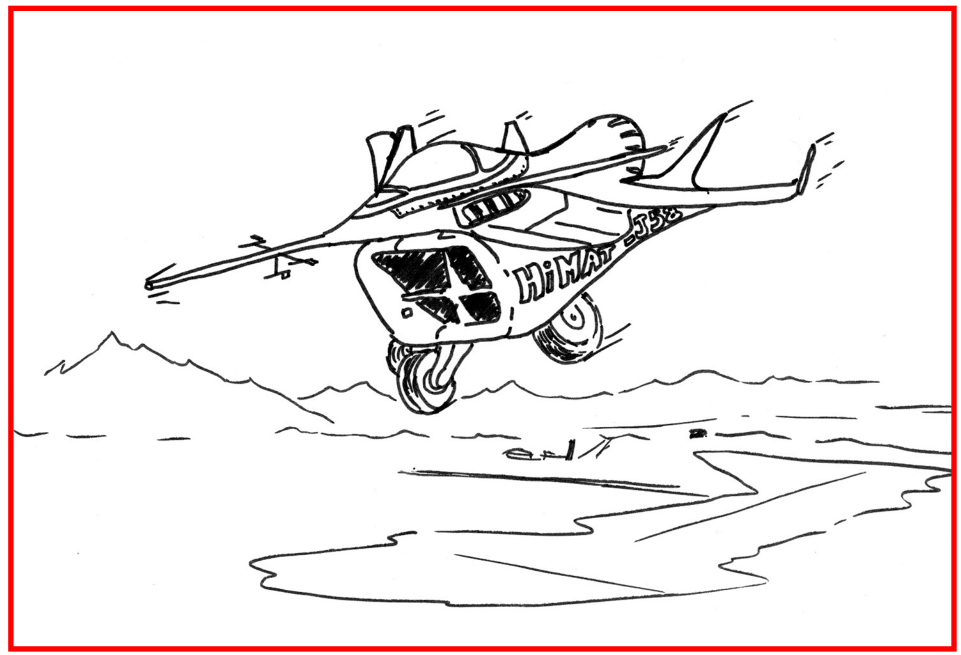
NASA allocated only a single chase mission to capture good inflight still photography of HiMAT during the 26-flight test program. The images shown here and the following page were taken during the 28-minute mission, H1-8-16, on December 18, 1980. Most chase missions gathered motion picture imagery for engineers to evaluate.


NASA
HiMAT

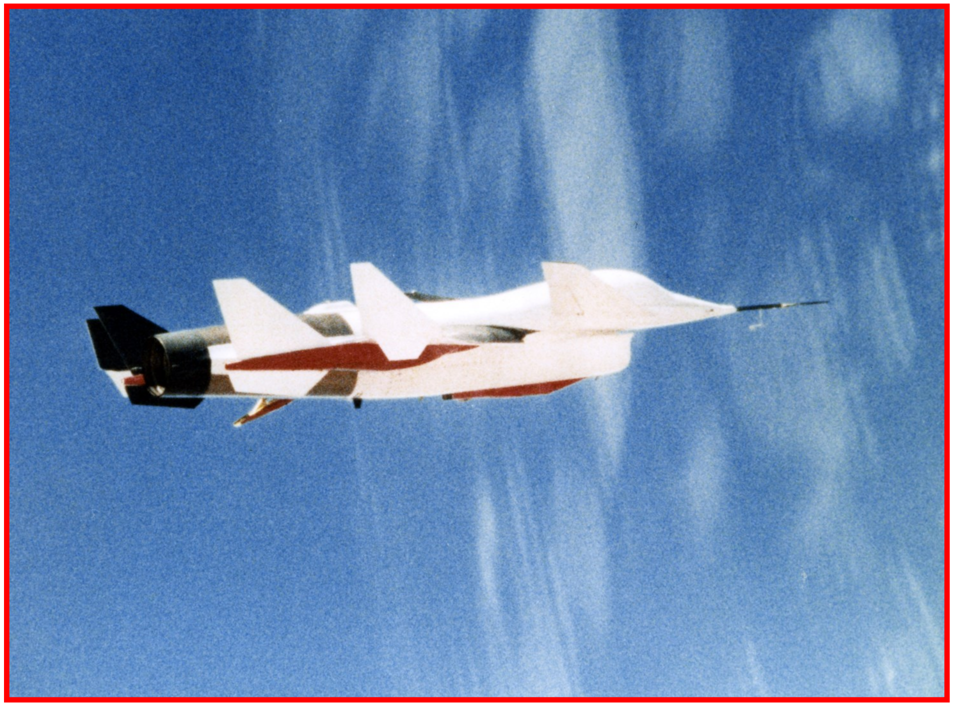
HiMAT ground crew pose with RPRV 871 after its successful 35-minute first free flight on July 24, 1981. Note the lack of markings on the aircraft.

The second HiMAT receives final systems checks to the avionics system prior to its first captive flight in June 1981.

All in good fun, NASA Flight Test Engineer (FTE) Ray Young, enjoys a video game of 'Space Invaders' from the pilot's seat of the HiMAT remote ground station.



Created by NASA engineer Wen Painter, this humorous look at HiMAT powered by a Pratt & Whitney J58 turbo-ramjet engine (used exclusively in the SR-71 Blackbird) shows the massive intake required to power the big engine.



The few inflight photos that exist of RPRV 871, show the aircraft devoid of markings during early flights. The two images above, taken during flight H2-3-5 on September 18, 1981, show the left landing skid deployed during the flight. This flight marked NASA test pilot Steve Ishmael's second HiMAT mission.

NASA test pilot Bill Dana was back in the remote cockpit for flight H2-4-6 on October 20, 1981. The successful 24-minute, 16-second mission to gather stability, control and air-speed data ended with another successful landing on the large dry lakebed at Edwards AFB, CA.

While ship 1 made the next four flights, ship 2 received all of its stenciling as well as mission markings on the forward fuselage.

Prior to taking over flight duties from RPRV 871, RPRV 870 undergoes weight and balance checks on December 10, 1981.

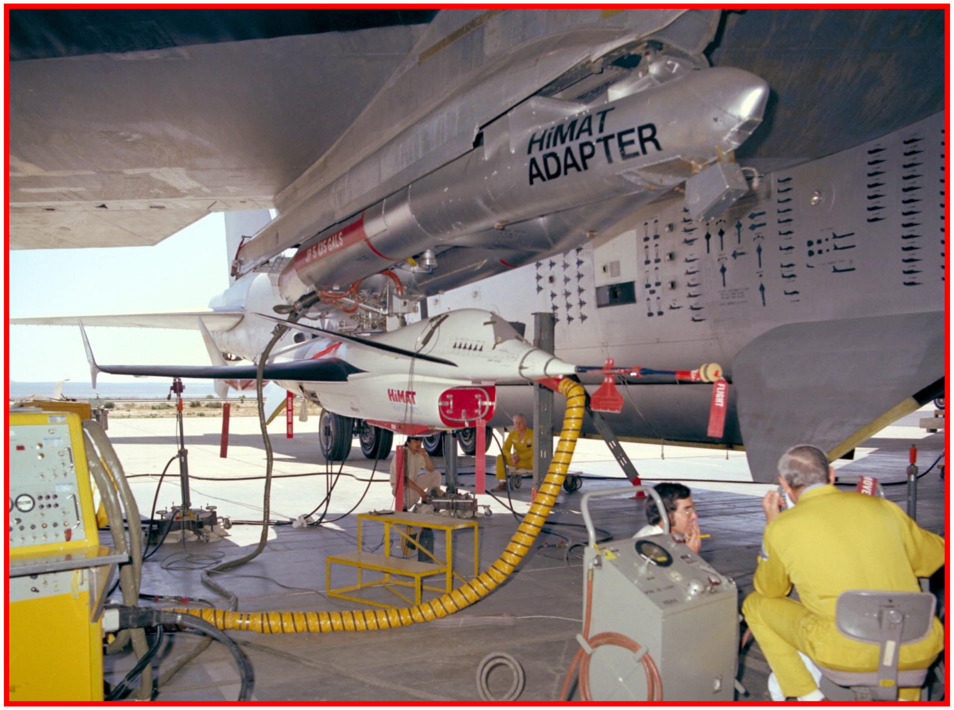
As shown in this series of black & white photos on this page and the following, mating HiMAT to the NB-52B mothership could be a tedious, time-consuming task. Little room to work made connecting the many instrumentation & electrical cables, safety latches and fuel connection more challenging.

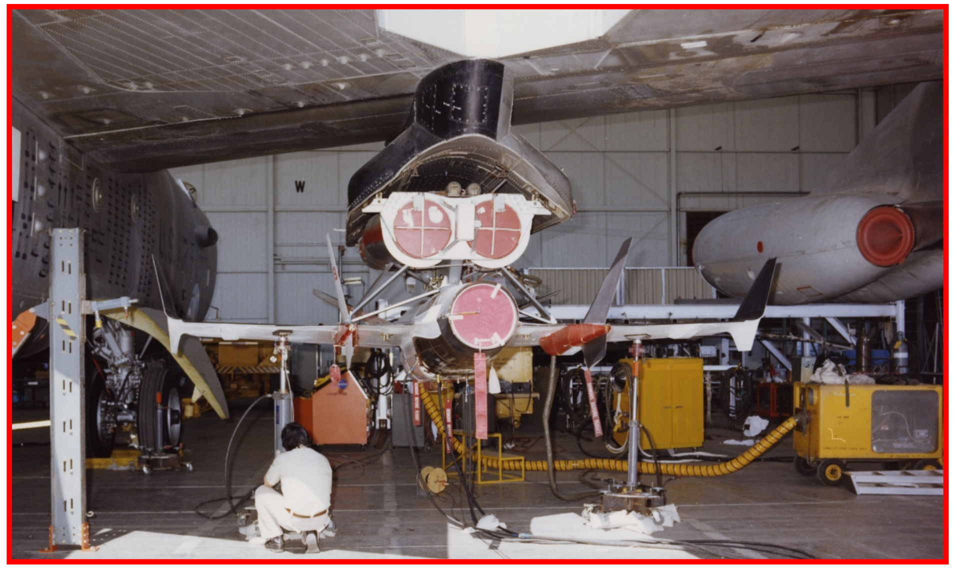

JP 5 135 GALS
NASA


JP 5 135 GALS
HiMAT
RPRV870

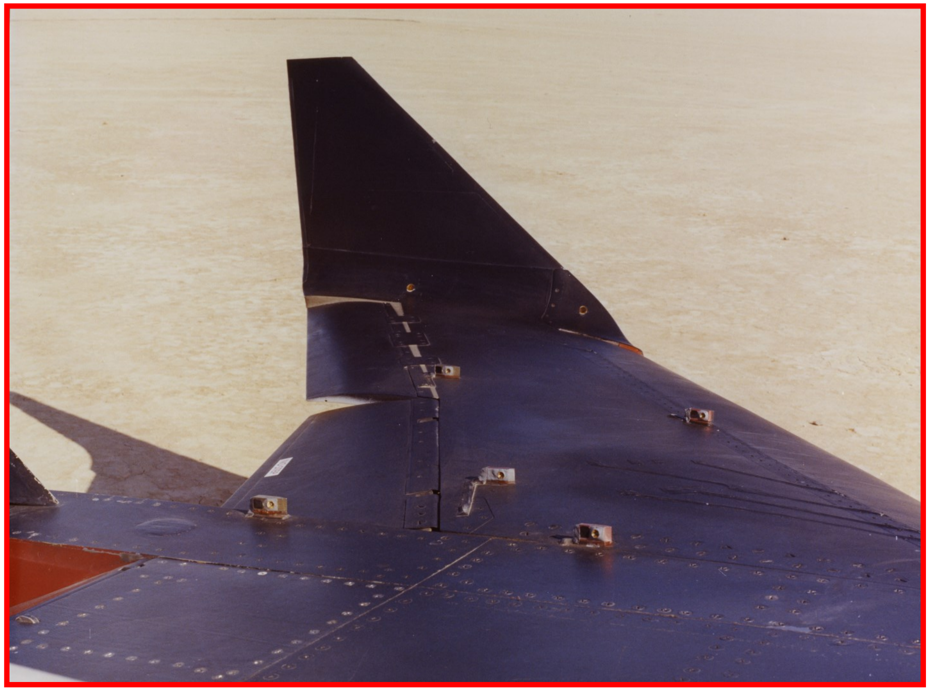

JP 5 135 GALS
USAF/NASA


HiMAT



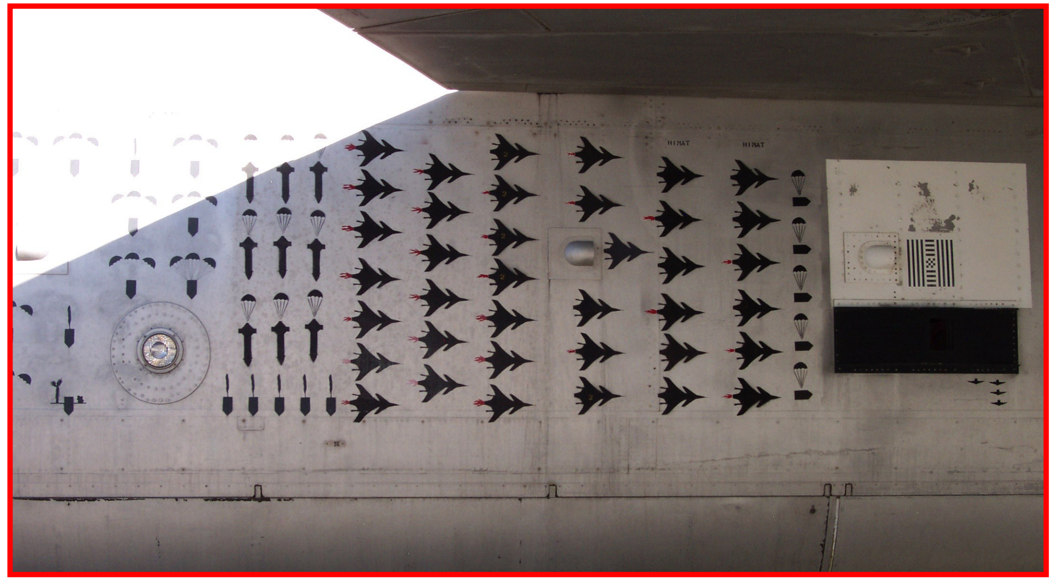


This series of photographs show HiMAT, RPRV 871, during NB-52B mating and calibration operations on April 22, 1982. In addition to new markings, ship 2 received new instrumentation on the upper wing and canard surfaces. All of this instrumentation required delicate calibration prior to its next flight.

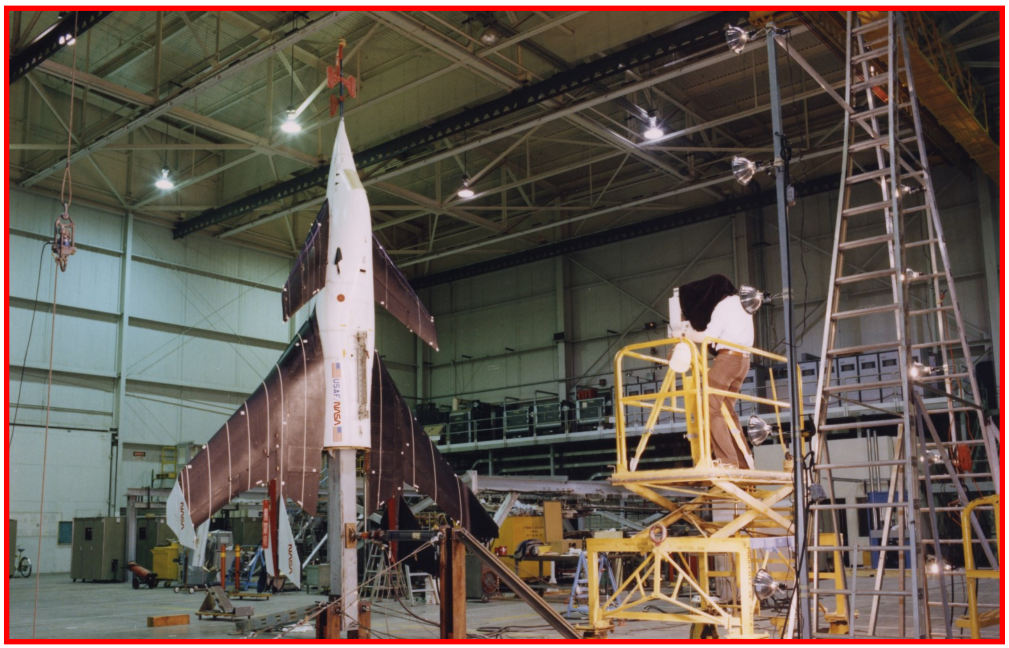


The most advanced instrumentation installed on RPRV 871 measured canard and wing deflections under different flight conditions. Targets consisted of light-emitting diodes (LEDs) mounted on the upper surfaces of the wing and canard, with receivers mounted on the fuselage. Targets activated sequentially, and the infrared light produced by the targets was sensed by the light-sensitive diode array of the receivers.

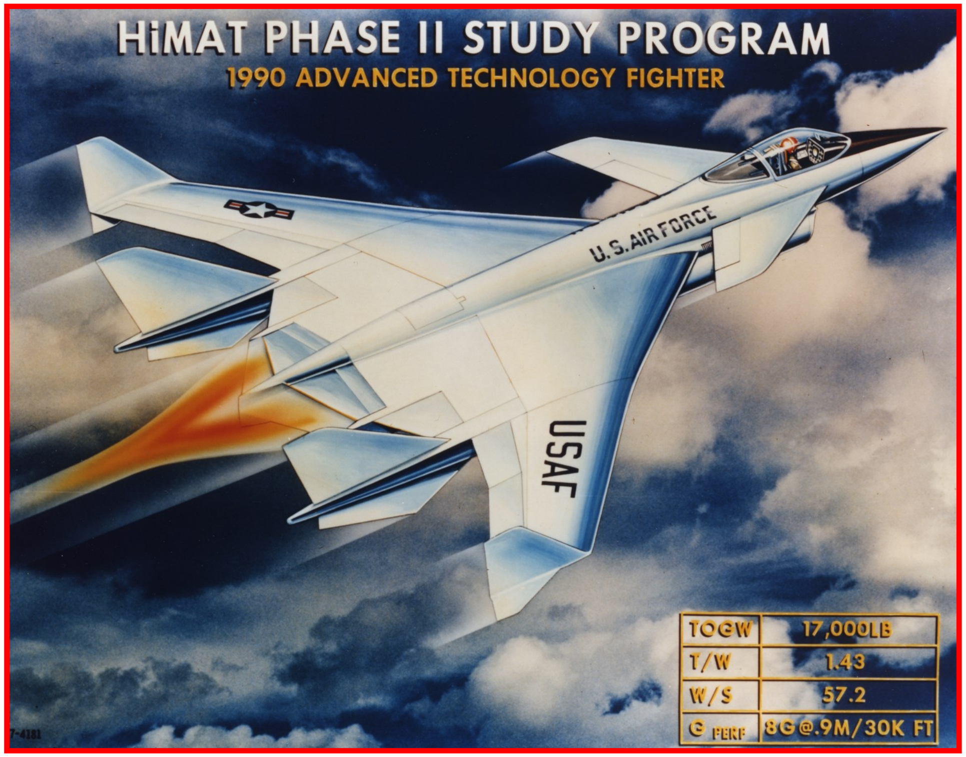
The flight program for HiMAT came to a close on January 12, 1983 after the twelfth, and final, flight of RPRV 871. The two vehicles flew 26 flights for a total flight time of 22 hours and 32 minutes (above and left).

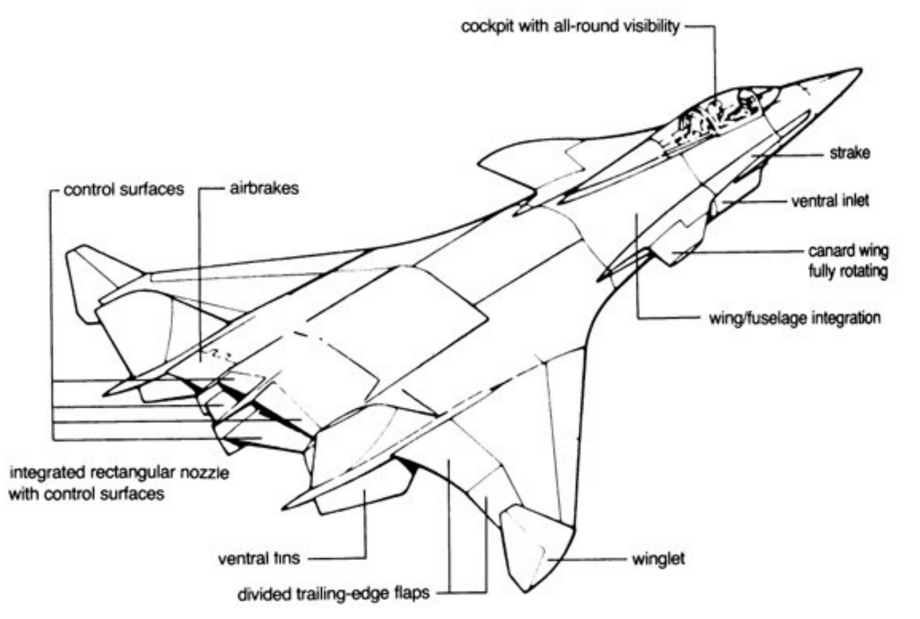


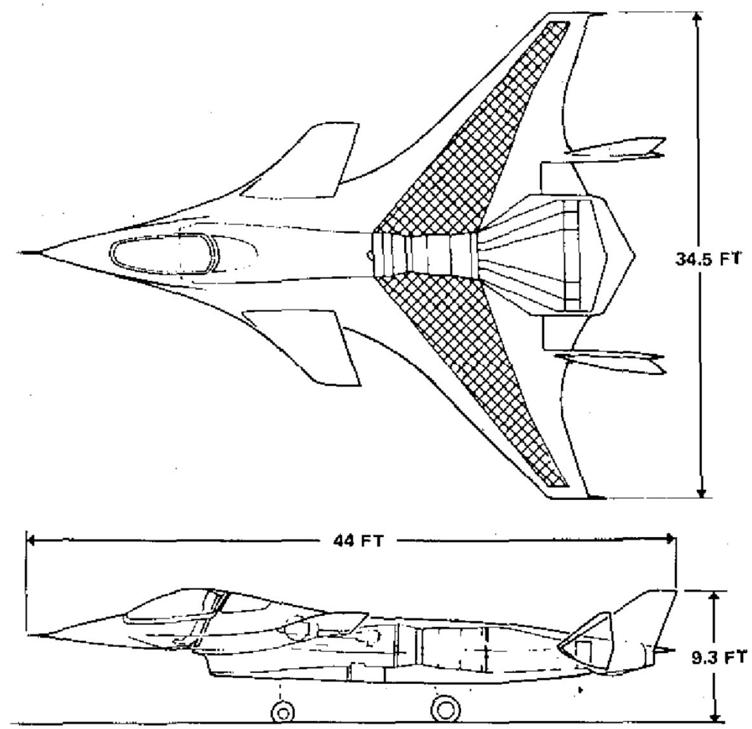
The HiMAT remote cockpit (left) with the video display contained just the basic information required for the pilot. HiMAT flight markings added to the NB-52B after each mission (above) . Red flames on each HiMAT stencil depicted powered free flights.



With the flight program over, the first HiMAT was placed in storage while the second was used for a series of composite aeroelasticity tests. These photos taken February 7, 1983, show RPRV 871 in the NASA ADFRF Loads Laboratory during photogrammetric measurement testing.





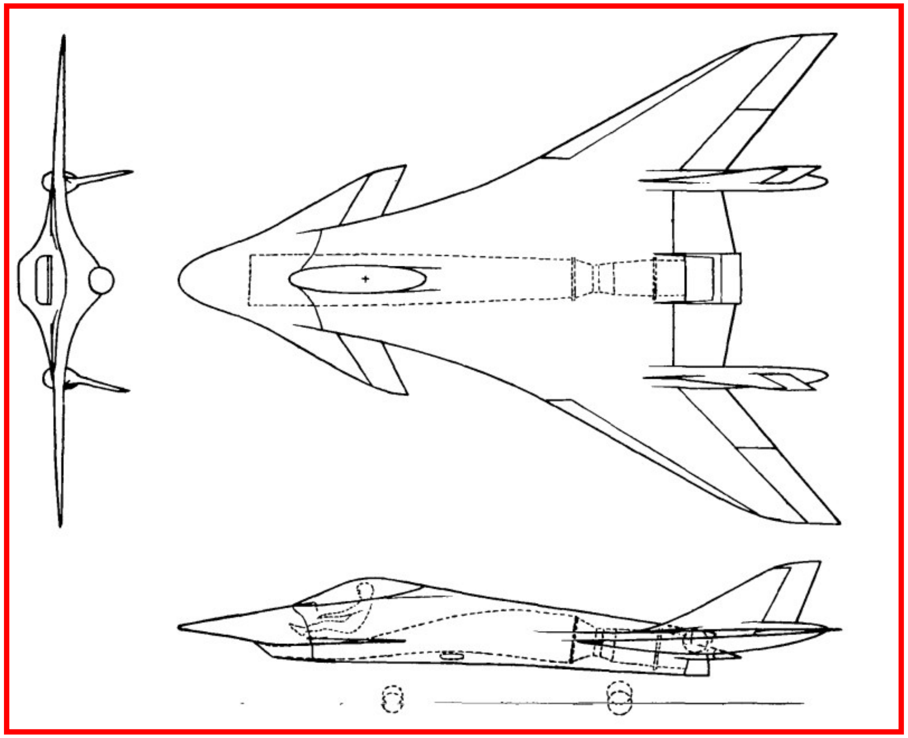


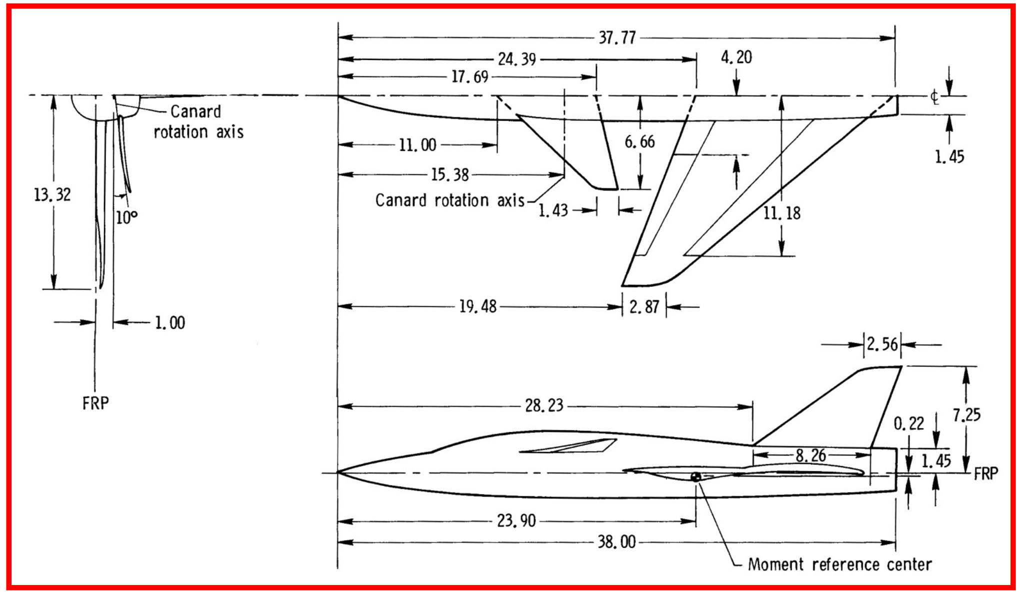
DESCRIPTION	
TOGW	17,064 LB
FUEL	3,941 LB
ENGINE	64.4 P&W74-20 (0.8 BPR)
WING	298 SQ FT 3.85 AR 45° LE SWEEP
T/W	1.43
W/S	57.2 LB/SQ FT

PERFORMANCE	
RADIUS	~ 300 NMI
SPEED	~ 1.6M AT ALT
SUSTAINED TURN	~ 8G AT 0.9M, 30,000 FT
$N_{Z_{MAX}}$	~ 12G

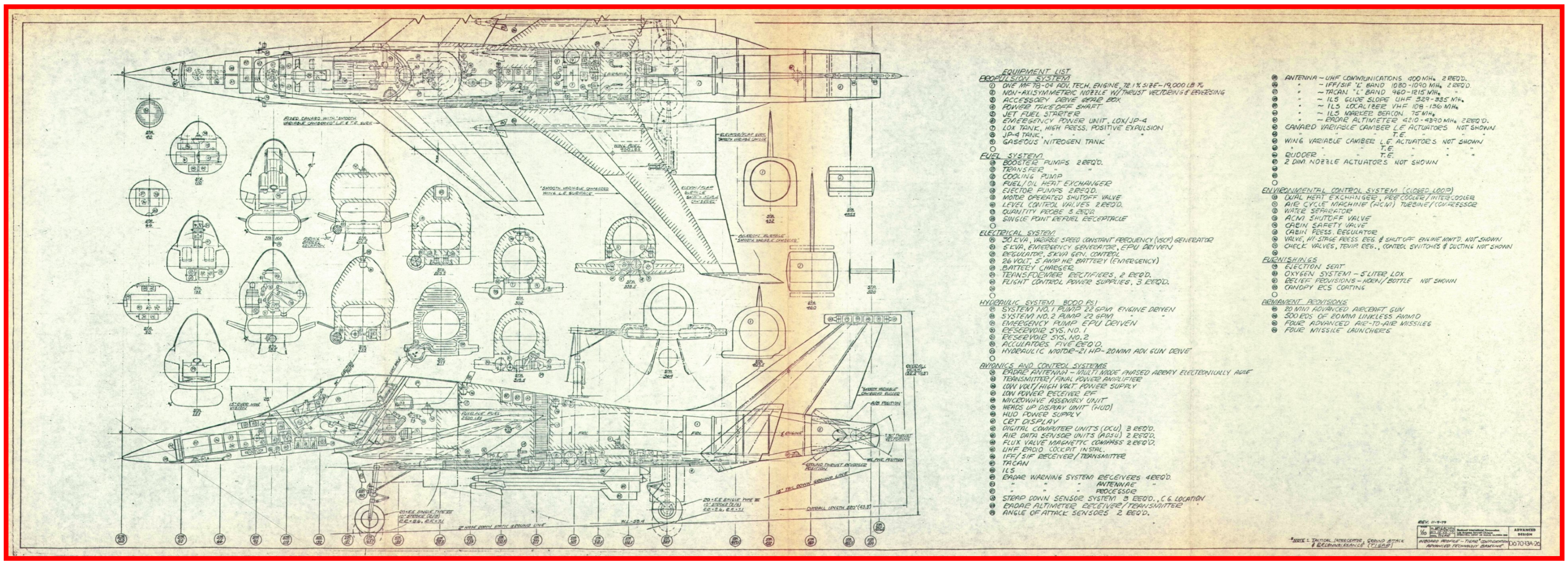
Fig. 1 - Advanced manned fighter basepoint

Rockwell International believed that the HiMAT test program could lead to a larger manned, fighter design utilizing an integrated two dimensional, thrust vectoring exhaust nozzle and spent many hours on future manned concepts.



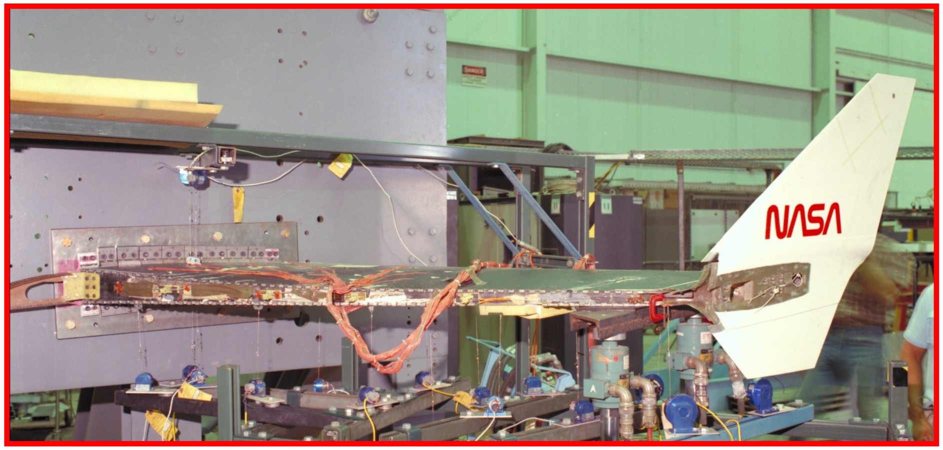


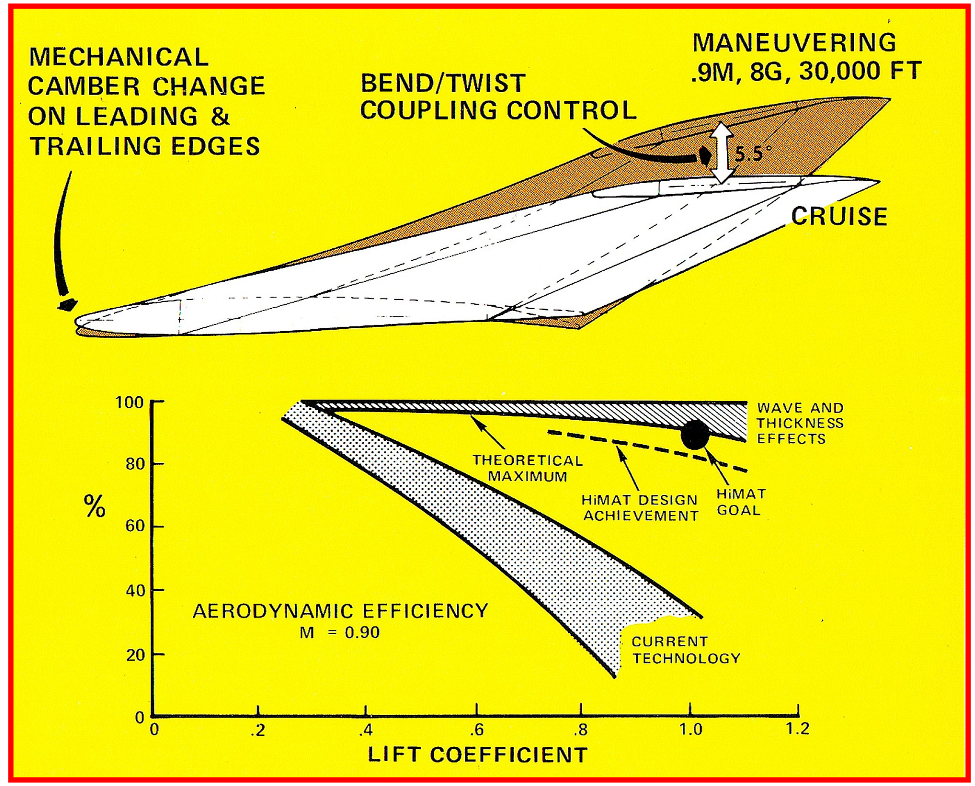
NASA used the data from the HiMAT program to propose the future of fighter design including the blended wing study at left and a forward swept wing design shown above, which would be tested in the Grumman X-29A.



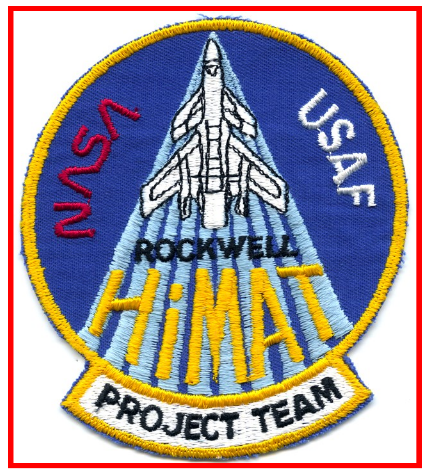
Rockwell International's Tactical Interceptor, Ground Attack & Reconnaissance (TIGAR) design from 1979 shows similarity to their HiMAT research vehicle.

ROCKWELL HiMAT





Predicted HiMAT composite wing bend and twist measurements during an 8G windup turn at 30,000 feet



Project Team patch for the HiMAT program.

Rockwell's aeroelastic design of the HiMAT wing structure was put to the test in the ADFRF Loads Laboratory when it was tested to failure in August 1985 (three photos at left).

After the end of the test program, the first HiMAT aircraft spent time on outdoor display at ADFRF sitting upon pedestals outside their cafeteria. In June 1984, the test vehicle was loaded abord a flatbed trailer and transported to its new east coast home at the Smithsonian Air & Space Museum in Washington D.C. where it resides to this day.

With testing completed, *HiMAT RPRV 871 was cosmetically repaired (top) in February 1987 and loaned the Ames Research Center, Moffett Field, CA and placed on outdoor static display (top, right). In 2009, Dryden Flight Research Center retrieved the aircraft, and as an April Fools joke, temporarily placed in in the parking space belonging to Center director Kevin Peterson (above). After refurbishment by the Dryden paint shop (middle, right), RPRV 871 received a place of honor in front of the NASA Center (right).*

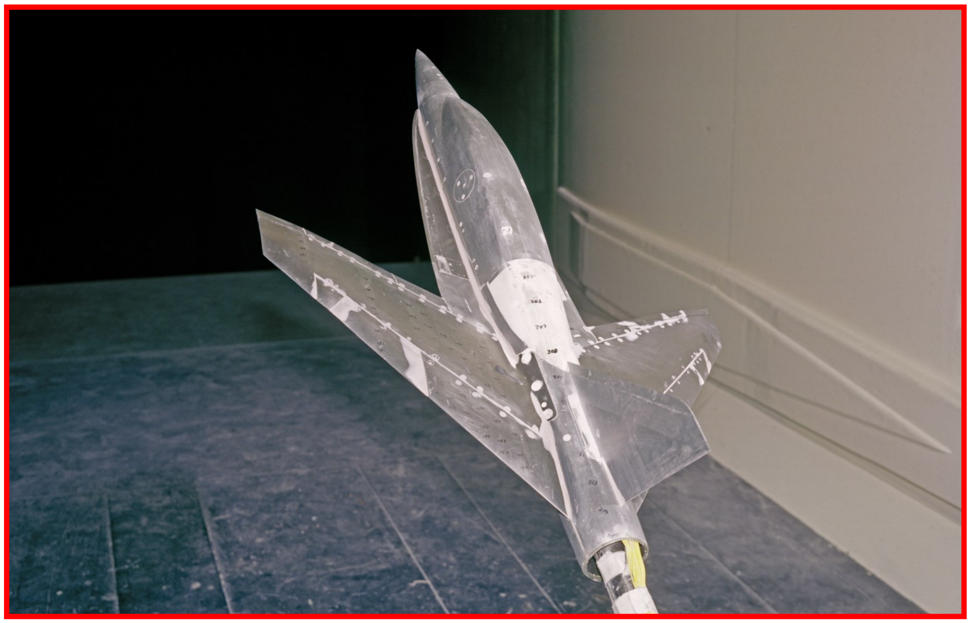
FLT. NO	FLIGHT DATE	PILOT			FLT. NO	FLIGHT DATE	PILOT
H1-X-1	11-Jul-79	Dana			H2-3-5	18-Sep-81	Ishmael
H1-X-2	20-Jul-79	Dana			H2-4-6	20-Oct-81	Dana
H1-1-3	27-Jul-79	Dana			H1-9-17	22-Dec-81	Ishmael
H1-C-4	20-Dec-79	Dana			H1-10-18	3-Feb-82	Dana
H1-2-5	21-Dec-79	Dana			H1-11-19	11-May-82	Ishmael
H1-3-6	15-Jan-80	Dana			H1-12-20	14-May-82	Dana
H1-C-7	30-May-80	Dana			H2-5-7	26-May-82	Ishmael
H1-C-8	24-Jun-80	Dana			H2-6-8	2-Jun-82	Dana
H1-4-9	25-Jun-80	Dana			H2-C-9	20-Jul-82	Ishmael
H1-5-10	8-Jul-80	Dana			H2-7-10	23-Jul-82	Ishmael
H1-C-11	30-Sep-80	Dana			H2-8-11	30-Jul-82	Dana
H1-C-12	10-Oct-80	Dana			H1-13-21	17-Aug-82	Dana
H1-6-13	28-Oct-80	Dana			H1-14-22	27-Aug-82	Ishmael
H1-C-14	26-Nov-80				H2-9-12	14-Sep-82	Dana
H1-7-15	3-Dec-80	Dana			H2-C-13	1-Oct-82	Ishmael
H1-8-16	18-Dec-80	Dana			H2-10-14	13-Oct-82	Enevoldson
H2-C-1	25-Jun-81				H2-C-15	24-Nov-82	Enevoldson
H2-C-2	21-Jul-81				H2-11-16	7-Jan-83	Enevoldson
H2-1-3	24-Jul-81	Dana			H2-C-17	11-Jan-83	Enevoldson
H2-2-4	30-Jul-81	Ishmael			H2-12-18	12-Jan-83	Enevoldson

H1- RPRV 870
H2- RPRV 871

Pilots: Bill Dana
Steve Ishmael
Einar Enevoldson

HiMAT program flight log.

Despite having not flown in five years, HiMAT, RPRV 871, joined the fleet of test aircraft in this family portrait at NASA DFRC on March 14, 1988.



After proving the design of composite, aeroelastic wings on HiMAT, NASA applied the concept to more futuristic designs, such as this forward swept wing model.

Composite artwork of HiMAT flying during a desert sunrise.

AFMC History & Heritage Program

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E-mail: *HQAFMC.HO@us.af.mil*