~ Historical Overview ~

Between 1946 and 1961, the Air Force and the Atomic Energy Commission spent a billion dollars in an effort to develop nuclear-powered airplanes. Although no aircraft ever flew, using nuclear power for propulsion, a converted B-36 bomber, shown above, did carry an operating three-megawatt air-cooled reactor aloft to identify and assess problems associated with the concept.

This aircraft made forty-seven flights over Texas and New Mexico between July 1955 and March 1957. Designated as the NB-36H, it carried the reactor in its aft bomb bay. Its nose section included shielding to protect the crew from radiation.

In parallel, at several sites in the United States, developmental work on a practical nuclear propulsion system for aircraft moved forward. By 1961, these efforts were well advanced, including the design, manufacture and test of two nuclear-powered aircraft engines and support facilities for a nuclear-powered bomber. At its height, over 7,000 people were involved in this program.

But also by 1961, manned bombers had been largely replaced by faster and relatively invulnerable ICBM's. This, plus the growing realization of the possible drastic consequences of such an aircraft being shot down or crashing resulted in the cancellation of development of nuclear-powered aircraft. As the following pages reflect, it was a unique program, from ambitious start to aborted finish.

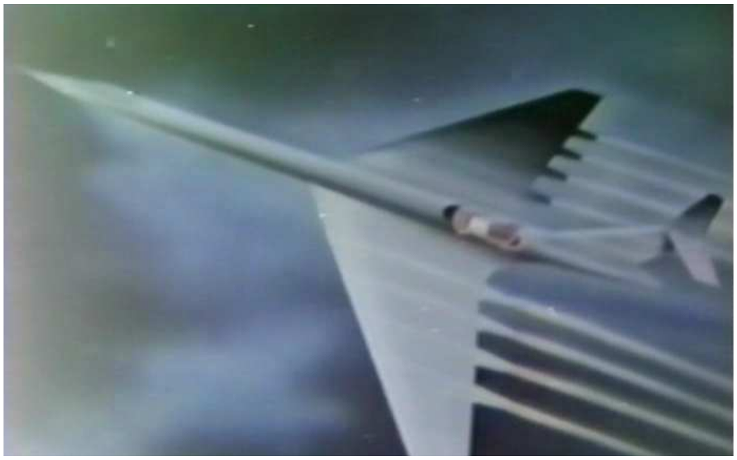
~ The Dream…and the Dreamers ~

It was just the year after World War II ended, and in parallel with the development of naval nuclear propulsion that air power advocates began to consider that nuclear-powered aircraft might be feasible. They were intrigued with the possibility that a nuclear-powered bomber could stay aloft for weeks at a time and fly missions anywhere on earth without resorting to aerial refueling.

Preliminary calculations quickly made it evident that no existing aircraft was large enough to carry a reactor capable of providing sufficient power to sustain flight, plus shielding for the flight crew and ground personnel, and an ordinance payload. An important additional consideration was the need to minimize or preclude the release of radioactive material in case of an aircraft crash.

But the war years had seen larger and larger aircraft created and successfully sent into battle. In fact, by the summer of 1946, a new bomber (i.e., the B-36), bigger than the biggest bombers deployed during World War II, had already been designed and test-flown.

The feasibility of creating an even larger aircraft capable of sustained flight using nuclear power was not questioned. Or, if it was, any such concerns were pushed aside or ignored by the military hierarchy. Initial flight parameters for a nuclear-propelled bomber were specified: capable to fly at least 12,000 miles at 450 miles per hour and deliver the multi-ton atomic weapons of the 1940’s.



In 1949, only two years after being created as a separate branch of the armed forces, the Air Force convinced the Atomic Energy Commission to help fund development of an airborne reactor. The agency’s Oak Ridge Lab was selected to take the lead in this ambitious, albeit audacious and ultimately unsuccessful effort, which became known as the Aircraft Nuclear Propulsion (ANP) program.

~ Early Experiments ~

The S-50 plant [darker building in this vintage photo] at Oak Ridge had been hurriedly built during World War II as part of the uranium enrichment process. Refinements of that process made the S-50 plant surplus after the war. Various firms that had participated in A-bomb development joined in an effort there to create a reactor small enough to fit inside a bomber, yet powerful enough to lift such an aircraft and sustain it in flight.

Much of the Oak Ridge Lab's efforts were devoted to development of lightweight shielding. Conventional reactor shields, several feet thick and weighing many tons were simply out of the question. Experiments indicated that a single shield surrounding the reactor was not feasible. Various options were considered, including even a 'tug-tow' arrangement in which a flight crew would be positioned in a towed glider! The Air Force didn't think much of that idea…

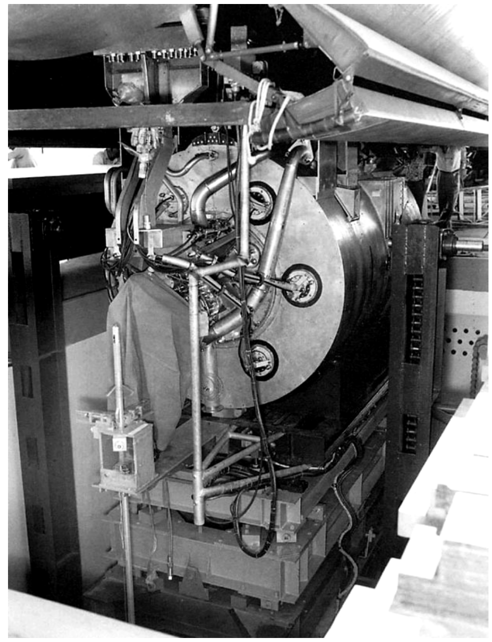
The ANP design team eventually settled on the use of a dual shield concept. One shield was to be placed adjacent to the reactor, providing some protection for the flight crew [positioned further forward in the aircraft]. A second shield to surround the cockpit was envisioned to further protect the crew, and made of relatively lightweight, composite materials.

Next, they created an experimental nuclear device to demonstrate feasibility for use in aircraft. A very small reactor was designed to operate at extremely high temperature, using molten salts as its fuel. The reactor core measured only eighteen inches in diameter. In 1953, this unsophisticated building was erected to house the experimental reactor.

The first test run of the Aircraft Reactor Experiment took place in October 1954. The reactor ran at a power level of one mega-watt for 100 hours. The design and construction of such an exotic device in less than five years was considered a noteworthy achievement.

That success led to additional study, and the eventual creation of a larger, 60-megawatt spherical prototype, nicknamed the ‘fireball reactor’ because some components literally glowed red-hot during operation. In parallel with reactor development, the ANP project also included what was dubbed the X-6 program.

The goal of this effort was to produce a flying test bed, powered by nuclear energy. One of the Air Force’s biggest bombers at that time, a B-36, was converted for this purpose. Designated as NB-36H, it was extensively modified to carry a small air-cooled reactor in its aft bomb bay. The photo to the right, circa 1955, shows the reactor assembly being raised into the aircraft’s bomb bay.



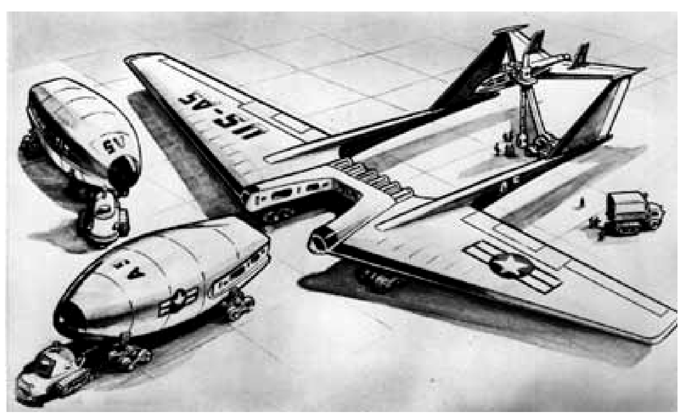
The aircraft’s nose section was fitted with a unique cockpit assembly that encapsulated and shielded the crew whenever the reactor was started up in flight. This addition included twelve tons of shielding material and leaded glass windows ten-twelve inches thick. The following photo shows the assembly just prior to installation in the test aircraft.

Between July 1955 and March 1957, the NB-36H flew forty-seven flights. On several of these flights, the reactor was operated up to a power level of three megawatts. Despite persistent rumors to the contrary, the test aircraft was not powered by the reactor it carried. The sole purpose of those flights was to gather data useful for future shielding design of an actual nuclear-powered aircraft.

This next image depicts the NB-36H in flight, accompanied by a B-29 fitted with multiple radiation detection and measuring instruments. Because the reactor was not shielded on its sides, back, top or bottom; the B-29 had to fly at a safe distance. Also, whenever the reactor was tested at power on the ground, the entire aft portion of the aircraft had to be shielded externally.

Nevertheless, at the conclusion of the series of test flights, the Air Force stated that “the aircraft normally would pose no threat, even if flying low”. The Air Force optimistically concluded that the radiation risks were no greater than physical risks associated with the development of steam and electric power, the airplane, the automobile, the rocket. Today, those conclusions seem implausible at best. But little was known in the 1950’s about long-range radiation effects. The ‘drive to survive’ the Cold War resulted in such ‘far out’ schemes being pursued.

Further ANP program developments included the creation of a way to harness reactor power to drive multiple turbo-jet engines. But a reactor large enough for this purpose was calculated to weigh 82.5 tons; more than the weight of an entire B-36! Obviously, a much larger airframe would be needed, and some exotic concepts were postulated.

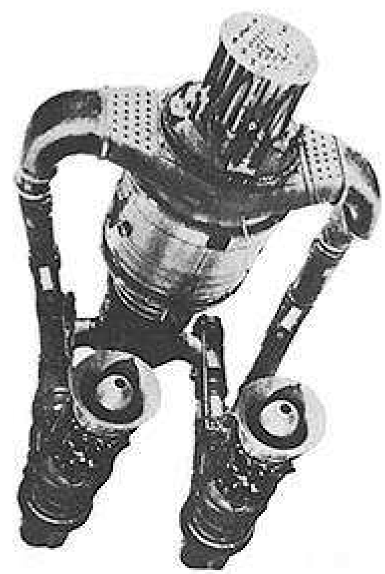


Although work on an actual airframe never got very far, a great deal of work was accomplished on the power plants. General Electric modified the design of one of its proven jet engines to create a power plant that could be coupled with a nuclear reactor. That engine was designed as the X-39.

~ Nuclear Aircraft Engine Development and Testing ~

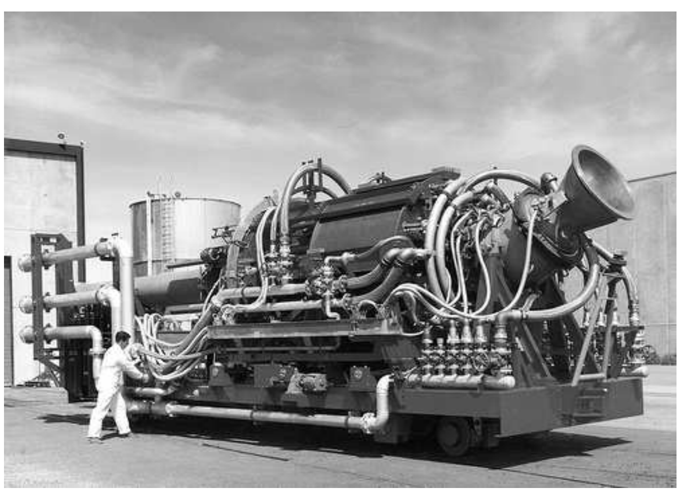
Under contract to the ANP program, General Electric developed and successfully tested a series of nuclear reactors coupled to turbojet engines. Fundamental design work was accomplished at GE's Lockland, Ohio aircraft plant.

Simplistically, they utilized a direct air cycle. Air entered through the compressor stage of one or more turbojets. From there the air passed through the reactor core. The compressed air, acting as the reactor coolant, was rapidly heated as it traveled through the core. After passing through the reactor, superheated air was directed to the turbine section of the turbojet(s) to create thrust, and from there it was exhausted through the turbojet(s) tailpipe.



Looking like something from Starwars, a reactor and two turbojets which it powered are shown to the right, minus their supporting mechanical and electrical systems, structure and shielding.

Several Heat Transfer Reactor Experiments (HTRE) were conducted at the Government's National Reactor Testing Station, located in a remote part of Idaho from 1955-1960. The equipment required for these tests was huge, heavy…and expensive. No effort was made to minimize their size for application in airframes.

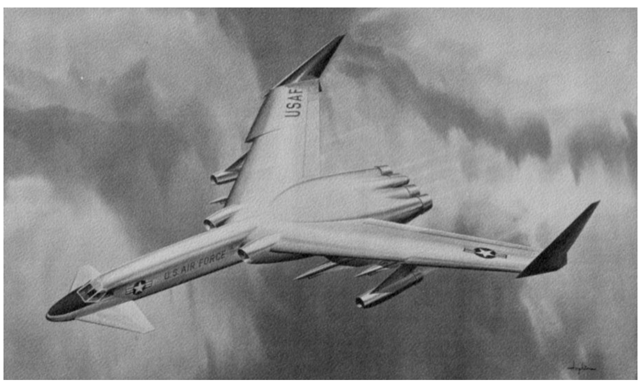


Their purpose was solely to demonstrate feasibility of design. Weighing over a hundred thousand pounds, each, they were built on railcars to facilitate movement to remote test locations. After each test, the reactor's railcar would be returned to a heavily shielded maintenance bay for disassembly & analysis. Their size can best be appreciated when viewing this photo.

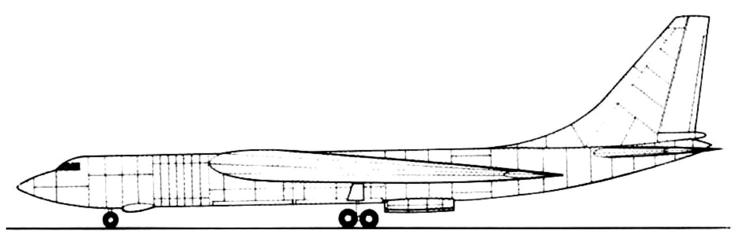
The first one model (HTRE-1), ran one X-39 turbojet and reached power levels as high as 20.2 megawatts. It was later modified, renamed HTRE-2, and ran a further series of tests at a higher power level.

HTRE-3 was the closest to a flight model that the program ever came. The dimensions of the core & its structural characteristics as well as the design temperatures were those of a power plant capable of providing useful in-flight propulsion. HTRE-3 was operated from 1958-60 and achieved power levels up to 35 megawatts. It powered two of the turbojets, but it could have easily driven more or larger turbo jets.

At the end of the series of HTRE testing, the probability of flying a nuclear-powered aircraft seemed high. Thus encouraged, the Air Force, began to work with firms skilled in the development of airframes, jet engines and nuclear reactors. Two of their conceptual designs are shown below. The first bears a striking resemblance to a conventionally powered bomber, the B-70 Valkyrie, which was developed in the late 1950's. A photo of a B-70 is included on the right for comparative purposes.



The B-36's manufacturer suggested a more conventional approach, with four turbojets mounted beneath the fuselage, aft of the proposed aircraft's bomb bay. Designated as the X-6, it never got past the conceptual design stage.



Borrowing a page from Admiral Rickover's 'play book' for simultaneously and successfully developing practical reactor designs, the Air Force expended millions of dollars to build facilities intended for future support of the ANP program in parallel with the HTRE testing program. Never utilized as planned, some of those facilities were later adopted to other benefical uses.

~ Test Area North ~

Code-named Test Area North (TAN), several multi-million dollar support facilities were constructed on the high desert plain of Idaho. Amongst these was a huge hangar, 350 feet wide, intended to house and service the X-6 aircraft.

This hangar was equipped with thick walls for shielding and plans were made to enable extraction of an aircraft's reactor and place it in a shielded storage bay using remote control methodology. Included in these never-realized plans, were closed-circuit television systems and remote manipulator arms to allow technicians to work on the aircraft & its power plant without direct exposure to the intense radiation fields that would exist even shortly after reactor shut down.

The tremendous weight of a nuclear propelled X-6 bomber would have required a runway 15,000 feet [over 2.8 miles] long. However such a runway was never constructed in Idaho. One reason, perhaps, is that by 1960 a safety oversight group had recommended that nuclear-powered aircraft not be operated over America's land mass, and that such aircraft should be based on islands.

After the ANP program was terminated in 1961, TAN was converted to facilitate other nuclear-related experiments and tests. Amongst numerous other activities, the badly damaged reactor core from the Three Mile Island Nuclear Power Plant was shipped there in 1986 for examination and evaluation.

In the first decade of the 21st century, personnel at Test Area North completed all programs assigned to that facility and began deactivating the complex. Currently, TAN is being dismantled and environmental restoration is ongoing.

~ Monuments to the ANP Dream ~

In due time, Test Area North will no longer exist, except in history books. However, two reminders of what once took place there will remain for the foreseeable future. De-fueled, decontaminated and moved to another part of the National Reactor Testing Station, the only prototype nuclear aircraft engines ever developed and tested in this nation can currently be viewed…but not touched…by the general public.

They are positioned adjacent to a designated National Historic Landmark, the Experimental Breeder Reactor (EBR-1). That facility, where the feasibility of generating electricity using nuclear power was demonstrated for the first time [in 1951], is even more unique than the near-twin 'monuments' shown above.

~ Postscript ~

Today, some may ask: *"What were they thinking?"* My feeling is that at the time, the ANP program obviously made practical sense to a number of very talented, intelligent and responsible people. Accordingly, I make no 20-20 hindsight judgments of their decisions and actions.

My interest in this largely forgotten program was initiated some years ago when I first learned of it and had the rare opportunity to hear 'insider' tales about ANP from a man who had been directly involved. That individual was **Tom Nemzek**, a gifted engineer and administrator who also was always a gentleman.

Tom participated in the ANP reactor developmental work at Lockland, Ohio in the early 1950's. How he got there is pretty unique. A member of the Naval Academy Class of 1949, he was one of 55 midshipmen in that class who were 'volunteered' to become Air Force officers upon graduation. The Air Force sent him to North Carolina State to obtain a Master's degree in Nuclear Engineering, and then assigned him to the ANP project.

Tom Nemzek joined the AEC in 1957, and held an impressive number of responsible and high level positions with that organization and its successor governmental agencies. He retired from government service in 1976 and joined the J.A. Jones Construction Company. Two years later he was instrumental in establishing the Electric Power Research Institute's Non-Destructive Evaluation Center, which Jones operated under Tom's leadership for several years. After retiring again in 1992, Tom passed away at age 81 in 2008.

Between approximately 1975 and 1995, it was my good fortune to be professionally associated with Tom and to enjoy a warm friendship with him, as well. On several occasions, he regaled me with stories about the Aircraft Nuclear Propulsion program and other ill-fated government projects. His stories, always laced with dry humor were fascinating, often amusing and sometimes even a bit scary. But some of what he shared with me will remain private, since he never publicly spoke ill of anyone…a trait I would be wise to better emulate!

Nevertheless, anyone who has ever been involved with any aspect of nuclear power work can probably read between the lines of this story and easily imagine *'the rest of the story'*!

Bill Lee
April 2012