THE PHANTOM II

I. DEVELOPMENT HISTORY - The F-4 has pioneered many of the planning phases of the relatively new Weapon System Concept. The basic design of the Phantom II took place in 1953 as the result of extensive studies by McDonnell Aircraft to determine the design parameters for a high performance fighter aircraft. Originally designated the F-3H-G, it was intended as a single place, long range attack aircraft. It was to be equipped with the APQ-50 radar, armed with four 20-mm cannon and would incorporate eleven external store stations for the various ground attack weapons.

The originally proposed powerplants were two J-65 engines, although even then the J-79 was planned as a future production change to provide a programmed increase in performance. The F-3H-G design was carefully studied by the then Bureau of Aeronautics, now Bureau of Naval Weapons, and the Deputy Chief of Naval Operations for Air. They requested that a formal development proposal be submitted, and this was accomplished in August 1954. This resulted in a letter of intent in October 1954 for the fabrication of two prototype and one static test article. At this time the designation was changed from F-3H-G to the AH-1 which reflected the attack mission of the aircraft.

As a result of continuing studies, a number of changes were made in the aircraft configuration by the Bureau of Aeronautics at the time the detail specification was signed in July 1955. The designation was changed from AH-1 to F-4H-1 and then to the present F-4C. This reflected the change in the primary mission to that of all-weather fleet defense, but with much of the attack capability remaining. This detail specification included the following features:

a. J-79 turbo-jet engines.

b. Sparrow III missile armament. Provisions for the 20-mm cannon were deleted.

c. Improved A.I. Radar.

d. A single, lightweight, semi-automatic navigation device.

e. Visual ground attack capability.

f. Maximum speed of at least Mach 2 with missile armament.

g. Two-man crew.

h. Semi-submerged missile installation.

The F-4 made its successful first flight from Lambert Field in St. Louis on 27 May 1958. Up until this time, more than 6,800,000 man-hours had been expended on the design and construction of this number one aircraft, and approximately 1500 subcontractors and suppliers from 28 states were involved in this project.

Following the initial flights of number one aircraft by McDonnell pilots, the Navy Preliminary Evaluation began. These evaluations are divided into five basic phases which are designed to detect trouble areas in the early stages of development.

The Phase I NPE was conducted at Edwards AFB and in St. Louis during the period 15 September through 10 October 1958. Pilots from the Naval Air Test Center at Patuxent River flew a total of 43 flights during this time. Also at this stage the F-4 was in competition with the F-8U-3 for acceptance as the Navy's new Fleet Defense Aircraft. The F-4 emerged as the winner of this race for several reasons, among which was the two-place, twin engine configuration. It was clearly established that a full time Radar Observer improved radar detection probability and enhanced the over-all weapon system effectiveness.

The Phase II NPE was conducted at Edwards AFB and NATC, Patuxent River during the period 27 July to 13 August 1959. In this phase the speed/altitide envelope was expanded and field-carrier landings, mirror approaches and wave-off capabilities were evaluated.

The performance of the Automatic Flight Control System and the Inflight Refueling system was evaluated during Phase III.

The Phase IV NPE was conducted at NATC from 28 April to 11 May 1960. These tests were primarily an evaluation of the production electrical and electronic equipment installed in the aircraft. Also included were evaluation of the centerline fuel tank, rain removal system and additional flight characteristics.

Demonstration of ground attack capability of the F-4, Phase V NPE, was conducted 15 - 17 February 1960.

In addition to these five basic phases of the NPE, the F-4 completed six carrier trials. The First of these was aboard the USS Independence in February 1960. Since that time the F-4 has been aboard the Navy's smaller carriers, such as the USS Intrepid.

In July 1960 the initial trials phase of the Board of Inspection Survey was begun at NATC, Patuxent River. These trials intensified testing of over-all aircraft performance, stability and control, continuation of carrier suitability, maintainability and effectivenss of the Phantom II as an operating weapon system. The performance of the aircraft in its intended mission proved outstanding. Several discrepancies in individual systems were uncovered and subsequently corrected.

Some of you may know that McDonnell designed and built the U.S. Navy's first carrier-based jet aircraft in 1946. This aircraft was named the Phantom which was the first in the series of McDonnell F-2H Banshees, F-101 Voodoos, and F-3H Demons. As a result of many suggestions for names, both from McDonnell and U.S. Navy personnel, the F-4 was officially christened the Phantom II in July 1959 on the occasion of the 20th Anniversary of McDonnell Aircraft.

II. The Phantom II has a dual mission and is uniquely qualified for this twin role. With two engines for reliability, two men for maximum utilization, radar and navigation equipment, the F-4 is an outstanding all-weather fighter for fleet defense, its primary mission, as well as having a modern attack capability.

Appearance of the Phantom II

Upon viewing the F-4 for the first time, people have been struck by the similarities and differences of its external appearance when compared to other designs, and wondered just why it looks the way it does. Every external feature has been just as carefully thought out as any component in the complex internal electronic, hydraulic, power plant, or control systems. The overall arrangement of wings, fuselage, and empennage was primarily dictated by aerodynamic necessities, but subject also to structural, operational and maintenance considerations. Theoretical calculations, results of extensive wind tunnel testing, and flight experience gained on the Banshee, Demon, and Voodoo all contributed to the determination of the final configuration. The F-4 has been assigned a mission which requires high Mach number and high altitude capability, long range, and the ability to land on a carrier. All these requirements have had their influence on its outward appearance as well as its internal structure and equipment. Let's take a look at some of the visible features.

The wing is set low on the fuselage in order to keep the landing gear reasonably short while allowing enough clearance to carry fuselage and wing-mounted tanks and armament. The main part of the wing structure carries straight through the fuselage for greater strength and for ease of assembly. A low wing is also much better than a high wing in maintaining directional stability at landing altitudes. The same amount of sweepback has been incorporated in the wing as there is in the Demon and in several other modern fighters, but it has a lower thickness ratio

to match its higher speed. Close inspection reveals it is just about as thick at the root as the Demon; this results from the necessity of housing the main landing gear. The chord, therefore, is somewhat longer in this region. The wing tapers sharply both in chord, thickness, and thickness ratio to help compensate for this thicker root. (The tip has a depth of only a little over one and one-half inches!) The sharp taper in planform gives the wing a near-delta look, and there is a discontinuity in the leading edge at the wing fold where the outer panel chord has been increased 10 per cent over the basic planform. This interruption in the leading edge creates a swirl of air on the upper surface at moderate angles of attack which inhibits complete stalling of the airflow on the outer panel. This in turn maintains longitudinal stability in this angle of attack range by distributing the lift more evenly.

The outer panels of the wing have 12 degrees dihedral incorporated to offset a negative dihedral effect resulting from the wing being mounted low on the fuselage. Only the outer panels were bent up in order to preserve the straight-through structure mentioned before, and this bend was conveniently made at the wing fold.

Various moveble surfaces are built into the wing. Both leading and trailing edge flaps are utilized in order to create as much lift as possible when landing and taking off. Spoilers and ailerons are employed to provide good lateral control at both low and high speeds. It was possible to place the spoilers directly in front of the ailerons since, on a given wing, only one surface operates at a time (either a spoiler goes up or an aileron goes down) during a roll. The movable surfaces mounted under the wing ahead of the trailing edge flaps are speed brakes, and are more effective per square foot in producing drag than the more common aft-fuselage types.

One of the striking features which invariably causes comment and serves to differentiate the F-4 from other modern fighters is its "horizontal" tail.

This thin, swept, highly tapered, all-movable surface has approximately 23 degrees of negative dihedral. Mounting the tail in this manner aligns it properly with the swirling airstream which exists at moderate angles of attack in this region, thus avoiding the usual stability reduction associated with swept-wing aircraft. This negative dihedral also permits taking advantage of the weight saving and better ground clearance inherent in an overhanging aft fuselage design. Although its span was kept short for proper hangar deck clearance, directional stability at high speeds is adequate because of the large area and sharp sweep. Although aerodynamic theory would dictate a long, slim fuselage with a needle-like nose, actually the fuselage is three feet shorter than the single-engine Demon, in order to allow for improved deck handling. The necessity for housing two large engines, together with the air inlets, four semi-recessed missiles, the complex electronic gear, and large quantities of fuel results in a fuselage that may seem rather short and stubby for a supersonic fighter. In order to reduce drag due to skin friction only a minimum of openings and protuberances mar its surface. Although the sides of the fuselage are visibly reflexed, "area rule" as such was not an important factor in the design when accelerating through the transonic region. The nose houses the radar gear. The two-man enclosure is depressed as much as possible since the shape of the forward part of the fuselage ("nose fineness ratio") is very important at supersonic speeds. A look at the fuselage aft of the jet exists reveals an arresting hook faired into the centerline keel. At the very end of the fuselage, just below the rudder, is a compartment for the drag parachute which is used to decelerate during field landings and as a possible spin recovery device.

The engine air inlets are located on the sides of the fuselage, which leaves the vital radar gear free to have an unobstructed "view" of the target. They are placed several inches out from the fuselage in the same manner as the Voodoo to

avoid the slow-moving air next to the surface. The air induction system itself is different from any seen to date on McDonnell airplanes. Far from being mere holes to let air in to the engines, the F-4 inlets are carefully designed and even include movable "control surfaces" or ramps, actuated automatically just ahead of the inlet itself. Their function is to turn the air outwards at supersonic speeds, thereby compressing it before it enters the inlet. The upstream ramp is fixed, but the angle of the movable ramp to the airstream varies with Mach number and air temperature. The low-energy layer of air which builds up on the ramp surfaces is sucked off through a gap between the first and second ramps and through the perforations (12,500 of them per side) on the second ramp. This air is expelled through the louvers above the inlets. When the ramp moves it varies the amount of compression and also varies inlet area. Further rationing of the air to the engine takes place near the engine face where some air is bypassed around the engine, cooling it, and exiting through the rear of the engine between the nozzle and shroud. In the process, this bypass air itself forms the expansion portion of the engine's supersonic jet nozzle.

The armament of the F-4, four Sparrow air-to-air missiles, may be seen nestled snugly in recesses in the lower surface of the fuselage. Mounting the missiles in this way results in low drag while not taking up a large volume within the fuselage. The missiles are launched downwards by explosive charges, after which they take off on their own power.