Spink, Barry L Civ USAF AETC AFHRA/RS

From: Spink, Barry L Civ USAF AETC AFHRA/RS
Sent: Tuesday, July 21, 2009 8:09 AM
To: 'John Greenewald, Jr.'
Subject: RE: FOIA 2009-01910-F, Greenewald, Air Froce Flight Test Center Jan-Jun 1961 History Request

Sir,
The first 167 pages of K286.69-37, Volume 1, January through June 1961 History of the Air Force Flight Test Center, IRIS Number 489391, has been placed in the U.S. Mail to you. In regards to the terms agreed to, please remit $10.00 by check, made payable to "DDO, MAFB" sent to the address in my signature block, below.
Sincerely,

BARRY L. SPINK
Archivist
Air Force Historical Research Agency
600 Chennault Circle, Bldg 1405
Maxwell AFB, AL 36112-6424
barry.spink@maxwell.af.mil

-----Original Message-----
From: John Greenewald, Jr. [mailto:john@greenewald.com]
Sent: Monday, July 20, 2009 12:28 PM
To: Spink, Barry L Civ USAF AETC AFHRA/RS
Subject: RE: FOIA 2009-01910-F, Greenewald, Air Froce Flight Test Center Jan-Jun 1961 History Request

Dear Mr. Spink,

Thank you for your letter. Please go ahead and include just the first 167 pages of the document.

I appreciate your response, and I look forward to the document.

Sincerely,

John Greenewald, Jr.

From: Spink, Barry L Civ USAF AETC AFHRA/RS [mailto:Barry.Spink@MAXWELL.AF.MIL]

Sent: Monday, July 20, 2009 9:54 AM
To: blackvaultradio@blackvaultradio.com
Subject: FOIA 2009-01910-F, Greenewald, Air Froce Flight Test Center Jan-Jun 1961 History Request

Dear Mr. Greenewald,

Your Freedom of Information Request, 2009-01910-F, was received with a cap of $10.00 payment for the document "History of the Air Force Flight Test Center, 1 January through 30 June 1961."

This document, which is unclassified, is in four volumes. In accordance with the FOIA law, and with the instructions you provided in your initial request, we can supply up to 167 pages of this document for free. The rest of the 1,237 pages of the document will require payment on your part, totaling up to $185.55. You can, however, purchase two rolls of microfilm that includes these four volumes (microfilm roll numbers M2295 and M2296) for $30.00 each, or a total of $60.00.

Before we begin to process your request, we require to know how you wish us to proceed. Will you pay the $185.55 for the complete history, or do you want to pay $60.00 for the two rolls of microfilm? If we do not hear back from you within 30 days (18 August 2009), we will consider your request closed.

Sincerely,

BARRY L. SPINK

Archivist

Air Force Historical Research Agency

600 Chennault Circle, Bldg 1405

Maxwell AFB, AL 36112-6424

barry.spink@maxwell.af.mil

AFSC HISTORICAL PUBLICATIONS 62-110-II

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BY AFHRA SAFEPAPER
DATE 20 Jul 2009

(TITLE UNCLASSIFIED)

AIR FORCE
SYSTEMS COMMAND
UNITED STATES AIR FORCE

HISTORY

of the

AIR FORCE FLIGHT TEST CENTER

EDWARDS AIR FORCE BASE, CALIFORNIA

1 JANUARY - 30 JUNE 1961

VOL NO. 1

PROJECT CORONA HARVEST

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HISTORY OF THE AIR FORCE FLIGHT TEST CENTER

Edwards Air Force Base
California

1 January - 30 June 1961

RCS: AU-D5

VOLUME 1

NARRATIVE

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AIR FORCE SYSTEMS COMMAND
United St...

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DATE 20 Jul 2009

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62-AFFTC-12904

F O R E W O R D

Aircraft flight testing is the primary mission of the Air Force Flight Test Center, Edwards Air Force Base, California. Here industry and the Air Force combined into an integrated team which is testing tomorrow's aerospace systems.

Until July 1961, AFFTC functions also included a missile static test capability. In the past the mighty Atlas, Thor, Minuteman, and Titan missiles were captive fired to check for systems reliability. Saturn and Centaur propulsion systems currently are undergoing contractor evaluations. This facility although no longer assigned to the AFFTC is also responsible for 99 percent of the Air Force's rocket propulsion systems research and development.

The present NASA/Air Force/Navy X-15 program is one of the Center's most important projects. During 1961 this manned research "flying laboratory" achieved speeds in excess of 4,000 m.p.h. and altitudes over 40 miles. These flights provide data on the effects of high altitude on man and plane which will help determine future trends in manned spacecraft. Up-and-coming are the B-70 and Dyna Soar.

Another important development at the AFFTC was establishment of an Aerospace Research Pilot Course. This, the world's most advanced and technical flying school, is designed to provide the USAF with a pool of space oriented pilots from which future spacecraft pilots, project pilots for aerospace activities, and technical managers can be drawn.

Eighteen government agencies occupy Center facilities and 20 firms operate contractor test facilities at the AFFTC. Contractors include Aerojet-General, Boeing, Douglas, General Electric, Lockheed, McDonnell, North American, Norair, Reaction Motors, Westinghouse, and Jet Propulsion Laboratory. Besides government agencies and contractors, the National Aeronautics and Space Administration maintains its Flight Research Center at Edwards Air Force Base, the U.S. Army has its Aviation Test Office here to evaluate helicopters, and the Federal Aviation Agency built and now operates its Radar Approach Control facility here.

The AFFTC workload in 1961 was somewhat evenly divided between aircraft evaluations, missile development, and support of space missions. The AFFTC was either supporting or conducting conventional system tests on bombers, cargo airplanes, fighters, trainers, helicopters, and experimental research airplanes. The AFFTC Experimental Track Branch furnished valuable data to contractors and government agencies concerning components of aircraft, missiles, munitions, and special weapons. The AFFTC Propulsion Branch aided in development of aircraft and rocket gas turbine engines by means of engineering evaluations and test of prototype and new production engines. And the AFFTC was directly supporting contractor development of advanced commercial jet aircraft and supporting the NASA Flight Research Center, the Federal Aviation Agency, the Army, Navy, and other federal agencies.

Obviously there was a plethora of material and information at hand to begin a narrative. But in this history following an introduction as to the origin of the AFFTC, the author attempted to relate only significant administrative, organizational, and operational events which contributed to Air Force Systems Command and U. S. Air Force missions.

Charles V. Eppley
CHARLES V. EPPLEY
AFFTC Historian

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Chapter 1

HISTORY OF ASSIGNED UNITS

Origin of Edwards Air Force Base

As a military base, Edwards dates back to 1931 - 1933 when Colonel Henry "Hap" Arnold was Commander of March Field at Riverside, California, about 80 miles south of the Mojave Desert Base. In search of a bombing and aerial machine gun range for the Army Air Corps, Hap heard of Muroc Dry Lake. He and Captain Ira C. Eaker made a trip to Muroc for a visual reconnaissance and a determination as to land ownership. It was found that the government owned most of the land which is now Rogers Dry Lake and the desert area east of the Lake. In October 1935, five men under a Sergeant Fogelman were airlifted to Muroc from the 19th Bomb Group, March Field. They pitched tents and then put out circular bombing targets in the desert. For the next two years aircraft shuttled back and forth between Muroc Dry Lake and March Field for crew bombing practice.

First major aerial activity occurred at Muroc in 1937 when the entire Army Air Corps participated in a large-scale maneuver here. From then on the bombing range grew in size with title for the area going from the government to the Army Air Corps in 1939. On the afternoon of 7 December 1941, the 41st Bombardment Group and the 6th Reconnaissance Squadron moved to Muroc. Then on Christmas Eve the 30th Bombardment Group and the 2d Reconnaissance Squadron also arrived for crew training.

Designation of the Muroc Bombing and Gunnery Range, Muroc Lake, California, as a separate post (Exempted Status) took place on 23 July 1942.[1] The official base name at the time was "Army Air Base," Muroc Lake.

With the advent of the Bell Aircraft P-59 Jet Fighter, the Mojave Desert station was chosen as a secluded site for testing this super-secret airplane. The first aircraft arrived 21 September 1942, ground tests were underway five days later, and a first flight accomplished on 30 September when the P-59 rose to ten feet altitude for one-half mile during taxi testing. However, the first official flight was 1 October with NACA, Navy Bureau of Aeronautics, Royal Air Force, Army, Bell, and General Electric personnel on hand.

Aircraft testing continued at this desert "Army Air Base" for the remainder of 1942 and in 1943. Then on 8 November 1943, the base title was changed to Muroc Army Air Field, Muroc.[2]

In the fall of 1944, the Eighth Air Force ran tests here to determine how well conventional fighters stood up against jets. Results were obvious. Also, in October 1944, a small detachment arrived at Muroc Army Air Field for experimental work in rocket firing and achieved such success that they remained most of 1945.

Fourth Air Force relinquished command of Muroc Army Air Field 16 October 1945 to Air Technical Service Command,[3] the latter becoming Air Materiel Command in 1946. Test work on the Lockheed P-80 stood in the limelight for the greater part of 1945.

---

1. Hq Fourth AF GO No. 83, 23 July 1942.
2. Hq Fourth AF GO No. 188, 26 Nov 1943.
3. Hq Fourth AF GO No. 146, 16 Oct 1945.

The XP-81 and XP-84 arrived at Muroc Army Air Field in 1946 for testing. It was obvious even at this embryonic stage of base development that the Army Air Force desert station was destined to become a proving ground for aircraft and a testing site for experimental airplanes.

Further evidence of things to come was experienced on 14 October 1947 when Captain Charles E. Yeager, USAF, piloted the Bell X-1 experimental rocket research airplane here to a speed of 760 miles per hour breaking the sound barrier for the first time. Four months later (12 February 1948), Muroc Army Air Field was redesignated Muroc Air Force Base.[4] Units attached or assigned at the time were the 4144th Air Force Base Unit, the 3208th Strato Bomb Test Squadron, and AACS and weather detachments. On 28 August 1948, the 4144th Air Force Base Unit was renamed the 2759th Air Force Base,[5] and was redesignated 20 May 1949 as the 2759th Experimental Wing[#] composed of two groups and two squadrons.[6]

Commanders of the bomber crew training and aircraft test desert base to the time it was named Edwards Air Force Base were:

Major Glenn L. Arbogast	24 Jul 42 - 12 Dec 42
Lieutenant Colonel Frank D. Gore	13 Dec 42 - 13 Mar 44
Colonel Robert O. Cork	14 Mar 44 - 31 Mar 44
Colonel Ralph A. Snavely	1 Apr 44 - 1 May 44
Colonel Gerald E. Hoyle	2 May 44 - 21 Dec 44
Colonel Warren E. Maxwell	22 Dec 44 - 1 May 46
Colonel Signa A. Gilkey	2 May 46 - 31 Aug 49
Brigadier General Albert Boyd	7 Sep 49 -

4. DAF GO No. 2, 13 Jan 1948.
5. Hq AMC GO No. 53, 20 Aug 1948.
Units were: Hqs & Hqs 3076th ABG and Hqs & Hqs 3077th ABG asgd to 2759th Exp Wg, and 2996th AP Sq and 2997th Base Svs Sq under the 3076th ABG.
6. Hq AMC GO No. 41, 1949.

During the time Colonel Signa A. Gilkey commanded the Mojave Desert installation, he was tirelessly working up a base master plan for the orderly development of a flight test activity. Although not resolved until several years later, one of his prime concerns was removal of the Atchison, Topeka, and Santa Fe Railroad line* and commercial "mud-diggings" or "mud mines" from Rogers Dry Lake. Even at such an early date, Colonel Gilkey recognized that larger and faster aircraft would require all of the Lake area in landing, performing taxi tests, and for emergencies.

Brigadier General Albert Boyd followed Colonel Gilkey assuming command of the desert base on 7 September 1949.[7] General Boyd was long-experienced in flight test having been Chief of the Flight Test Division, Headquarters Air Materiel Command, Wright-Patterson Air Force Base, prior to coming to the Mojave Desert. He was well-grounded on the requirements for improved flight test facilities and, despite reductions in the National Defense posture at the time, he went ahead with the Master Plan as initiated by Colonel Gilkey. General Boyd inherited a considerably run-down base. But, on 7 November 1949, the 804th Engineer Aviation Battalion arrived here from Camp Gordon, Georgia, to rehabilitate the Main Base on the southwest edge of Rogers Dry Lake.

Muroc Air Force Base became Edwards Air Force Base, Muroc, on 8 December 1949[8] in honor of Captain Glen W. Edwards, Lincoln, California, who was killed here when his experimental YB-49 Flying

---

* Removal completed 21 Dec 1953 at a cost near $9,000,000.
7. Hq AMC SO No. 155, 22 Aug 1949. Muroc AFB GO No 5, 7 Sep 1949.
8. DAF GO No. 105, 14 Dec 1949.

Wing crashed during a test flight 5 June 1948. From the time Edwards Air Force Base was named on, speed and altitude records began to pile up as new aircraft were developed and the Base started to build and branch out by leaps and bounds.

Probably a great portion of this growth was due to the nearness of West Coast aircraft manufacturers. However, some part of it was due to a decision in 1947 to build a missile captive test facility on the Base.

Need for a static facility to test high-thrust missile rocket engines was first realized in 1946 by the Power Plant Laboratory, Wright-Patterson Air Force Base. It was their decision that such a facility should be government owned to prevent a single contractor exclusive advantages on Air Force contracts for high-thrust missile rocket power plants, and it would eliminate expensive duplication of like facilities by different manufacturers. Their choice of location in 1947 was Leuhman Ridge east of Rogers Dry Lake on Edwards Air Force Base. Construction began in November 1949 on what was to become the Experimental Rocket Engine Test Station.[9]

Air Force Flight Test Center Activated

Edwards Air Force Base was transferred from the Air Materiel Command 2 April 1951 to the newly created Air Research and

9. Experimental Rocket Engine Test Station went into operation in 1952 with management and technical direction provided by the Rocket Branch, Air Force Flight Test Center. Contract for design and construction of technical facilities was awarded the Aerojet Engineering Corporation. Non-technical design and building was performed by the U.S. Corps of Engineers.

Development Command.[10] Activation of the Air Force Flight Test Center followed on 25 June 1951.[11] Its mission was "to accomplish flight tests of aircraft, power plants, components, and allied equipment, and research and development related to such tests; to plan for, control, and operate special test facilities, and to provide facilities for contractors and for other governmental agencies, in support of the mission of the Air Research and Development Command."[12]

Organization of the newly created Air Force Flight Test Center was Command, Inspector General, Public Information, Comptroller, Surgeon, Judge Advocate, Base Executive, Personnel and Administration, Supply, and the Base Directorate - Experimental Flight Test and Engineering. The latter was the operating unit which carried out the Center mission.

Units designated and assigned to the Center at the time of activation were the 6510th Air Base Wing with its three groups, the 6510th Installation Group, the 6510th Maintenance and Supply Group, and the 6510th Air Base Group. Concurrent with the forming of these units, the 2759th Experimental Wing and the 3077th Experimental Group were discontinued, the 503rd Air Force Band formerly assigned to the 2759th Experimental Wing was reassigned to the 6510th Air Base Group, and all remaining units of the now

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10. Hq AMC GO No. 23, 30 Mar 1951. See SD "A" in History of the AFFTC, 2 Apr - 30 Jun '51.
11. Hq ARDC GO No. 15, 21 Jun 1951. See SD "D" in Hist of the AFFTC, 2 Apr - 30 Jun '51.
12. Hq ARDC Reg 22-4, 12 Jun 51.

defunct 2759th Experimental Wing were redesignated as follows:*

Old Designation	New Designation	Assignment
2798th Medical Group	6510th Medical Group	6510th Air Base Wg
3076th Air Base Group	6510th Air Base Group	6510th Air Base Wg
2996th Air Police Squadron	6510th Air Police Sq	6510th Air Base Gp
2997th Base Service Sq	6510th Base Service Sq	6510th Air Base Gp

Several major events occurred in the Fall of 1951. On 1 August, Headquarters, Air Force Flight Test Center, Edwards Air Force Base, Muroc, was redesignated Headquarters, Air Force Flight Test Center, Edwards Air Force Base, Edwards;[13] and the local railroad station was changed in name on 1 October from Muroc to Edwards by the Atchison, Topeka, and Sante Fe.[14] The Muroc Post Office was also renamed Edwards on 1 November to conform to the area which it served.[15]

In the meantime, a series of proposals and counterproposals were drifting between Headquarters, Air Research and Development Command and Edwards Air Force Base concerning reorganization of the Center. Finally, on 10 September 1951, the Center was

* Upon activation of the 6510th Air Base Wing, 6510th Maintenance and Supply Group units were the 6510th Maintenance Sq, 6510th Supply Sq, and the 6510th Motor Vehicle Sq. Under the 6510th Air Base Group came the 6510th Air Police Sq, 6510th Base Service Sq, 6510th Communications Sq, and the 6510th Food Service Sq. Over the next nine years, all of these unit designations would change except the 6510th Air Base Group, the 6510th Air Police Sq, and the 6510th Food Service Sq.

13. Msg FTAG-8-4-E, 3 Aug 51, CG ARDC to CG AFFTC. SD "E", Hist of AFFTC, 1 Jul - 31 Dec 51.
14. Hist of AFFTC, 1 Jul - 31 Dec 51, p. 53.
15. Ltr, Asst Postmaster General to AAG, AFFTC, 20 Sept 51. SD "F", Hist of AFFTC, 1 Jul - 31 Dec 51.

reorganized in accordance with the demands of ARDC to "achieve a standard form of organization suitable for the Air Force Flight Test Center mission".[1] Center staff offices, 6510th Air Base Wing and the Base Directorate, Experimental Flight Test and Engineering* were affected.

When tne Air Force Flight Test Center was established on 25 June 1951, in almost every respect but facilities, it was perfectly suited as an aircraft testing installation. The Center was easily accessible by air, rail, and highway; its remoteness provided security and safety essential to aircraft testing; and Rogers Dry Lake, the 65 square mile heart of the base, provided the world's largest and smoothest landing field. Edwards Air Force Base was also near West Coast aircraft manufacturers.

But geographical facilities notwithstanding, the Main Base complex was situated on the southwest shore of Rogers Dry Lake in old World War II type wooden buildings. Following activation of the Center, a $120,000,000 Master Plan was approved 17 January 1952 to resite the base two miles northwest and build new facilities specifically designed to flight test aircraft and to captive test missile rocket engines.

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1 The new Center was composed of command; judge advocate general; surgeon; public information; inspector general; air adjutant general; deputies for operations, materiel, personnel, and comptroller; flight test and development division; and the 6510th Air Base Wing. Public information did not last long, for the office was abolished 1 November 1951. (Msg Hq ARDC, to CG AFFTC, RDE-10-14-E, 23 Oct 1951).

* Organizational components were: Flight Test Development Division, Flight Test Operations Laboratory, Engineering Laboratory, Rocket Branch, Photographic Branch, Experimental Track Branch, and Aircraft Maintenance Laboratory.

Approval of the Master Plan signaled start of construction on permanent base facilities at Edwards Air Force Base. Colonel J. S. Holtoner, USAF, assumed command of the Center 18 February 1952[16] and stayed on to see completion of an entirely new base two miles northwest of the original Main Base.

Equally as important to development of Edwards as a permanent installation was approval on 23 April 1952 for additional land acquisition, resolving of a problem favoring the Air Force to remove the railroad bisecting Rogers Dry Lake,[17] transfer of funding and administration of the Experimental Rocket Engine Test Station to the Center, and redesignation of the 6502d Parachute Development Test Group, Naval Auxiliary Air Station, El Centro, California, to the 6511th Parachute Development Test Group with assignment to the Center.[18] The latter unit was formerly assigned to the Wright Air Development Center with a mission to:

> . . . conduct development testing of parachutes and related equipment for the Air Force and Army, and to operate jointly with the Navy parachute unit, in order to avoid duplication of effort and assure maximum joint utilization of personnel, equipment, and technology.

Colonel Holtoner was promoted to Brigadier General 3 December 1952 at a time when over 100 test projects were in a state of active experimentation. In 1953, Holtoner added a technical director to command, reestablished Public Information, and made Flight Test and

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16. Hq AFFTC GO No. 2, 18 Feb 1952.
17. Estimated to cost $4,795,000 and involve relocating 60 miles of Atchison, Topeka, and Santa Fe track.
18. Hq ARDC GO No. 43, 21 Jul 1952.

Development a Directorate. Basically, the mission as handed down by Air Research and Development Command in 1951 had not changed by the end of 1953 but many elements had been added.#

Operations at the Center in early 1954 hinged around eight major test facilities.* In addition to managing the operational activity, the commander was charged with construction of an entirely "new base" while keeping the "old base" running efficiently. Also, Center organization remained a problem. An attempt at reorganization was made on 15 January 1954 when the Chaplains Office was removed from under the Deputy Chief of Staff for Personnel and established as a segment of the Center commanders special staff. On the same date the Office of Information Services was formed by combining Public Information, the Historical Branch, and Information.[19] Another minor change followed on 17 May 1954 when the 6512th Test Pilot Training Squadron (Experimental) was reassigned from the 6510th Maintenance Squadron and attached to Headquarters Squadron Section, Air Force Flight Test Center, for administration and logistical support.[20]

\# The Center was engaged in aircraft flight testing and development, parachute testing and development, rocket engine testing development, support of contractor elements of the aviation industry; administration and support of shoran stations off-base; support of Aberdeen Bombing Mission; support of AACS and NACA; partial support of the 750th Aircraft Control and Warning Unit; support of the USAF Experimental Flight Test Pilot School; indirect support of collateral activities such as SAC, Special Weapons Center, and the Armament Center, all using AFFTC facilities; operation of the power plant test facility; and operation of high speed tracks.

* Rogers Dry Lake, the 10,000-foot Experimental Track, the 2,000-foot Deceleration Track, the Precision Bombing Range utilized by the Aberdeen Bombing Mission, the Universal Thrust Measuring Stand, the All-Altitude Speed Course, the Photographic Resolution Target Range, and the Experimental Rocket Engine Test Station.

19. Hq AFFTC GO No. 1, 19 Jan 1954.
20. Hq AFFTC GO No. 15, 13 May 1954.

Meanwhile, units were moving from the "old base" to the "new base" as facilities became available. The new Airmen's Service Club opened 26 March, the Commissary Sales Store was readied for business 27 April, the new 6510th USAF Hospital was completed in May, and the National Advisory Committee for Aeronautics new High Speed Flight Station was dedicated 25 June. Operationally, the X-4 research airplane was retired to the Air Force Museum, an XF-104 aircraft made its first flight on 5 March, ATLAS missile rocket engine testing was firmed up, X-10 Navaho missile reached a speed of Mach 1.46, hot firings were performed on the BOMARC missile rocket engine, and Center test pilot Major Arthur Murray flew the Bell X-1A research airplane to 90,000 feet altitude on 4 June.

Reorganization of the Air Force Flight Test Center

From 10 September 1951 when the original reorganization of the Air Force Flight Test Center took place until late in 1954, Center officials maintained pressure on Headquarters, Air Reseach and Development Command to realign functions in the Center organization. In particular, it was desired to remove aircraft maintenance responsibilities from within the Directorate of Flight Test and Development. The parent command finally conceded on 8 November 1954.[21]

21. Hq ARDC GO No. 76, 1 Nov 1954.

To improve maintenance administration and maintenance efficiency, the 6515th Maintenance Group was activated with three maintenance squadrons each having a specialized function.* Immediate result of reorganization# was a decrease in the vertical distance between commanders and their maintenance personnel in shops and on the flight line. Concommitantly, loss of maintenance activities gave the Directorate of Flight Test and Development a cleaner and more efficient alignment of functions. A first look, moreover, promised reductions in staff and administrative costs through this reorganization. It was obvious that savings realized could be reprogrammed into the mission effort.

General Holtoner remarked at the time that:[22]

> There must now be complete acceptance of the new organization and the will to make it work. Throughout the entire organizational fabric there must be the finest form of lateral coordination and an eagerness to work toward a common goal. Names and positions have changed, the total job has not.

But this was not the ultimate, for the Directorate of Flight Test still retained a maintenance function--that of armament and electronics. It was not until 1958 that the last vestige of maintenance was removed from the Directorate of Flight Test by establishing

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* Three Sqs were the 6515th Field Maintenance Sq, the 6515th Flight Line Maintenance Sq (Conventional), and the 6516th Flight Line Maintenance Sq (Jet).

\# Reorganization also affected other organizations: The 6510th motor Vehicle Sq was renamed the 6514th Motor Vehicle Sq, the 6513th Supply Sq was established, and the Rocket Branch in the Directorate of Flight Test and Development became the Rocket Engine Test Laboratory as a separate mission element of the AFFTC.

22. Report to Management, 26 Nov 1954, prepared by the DCS/C, Hq AFFTC.

the 6515th Armament and Electronics Maintenance Squadron under the 6515th Maintenance Group.[23]

In the meantime, however, the 6515th Maintenance Group had been augmented by addition of another unit--the 6517th Flight Line Maintenance Squadron (Bomber)--in late 1956.[24] Coupled with this mutation were changes in suffix titles of two other maintenance squadrons to more clearly delineate their job functions.[%]

Although major realignment of the Center took place on 8 November 1954, reorganization actually began in the previous March with loss of the 503rd Air Force Band: a casualty of the Air Force austerity program. Redesignation and reassignment of many units followed on 1 September.[25] One unit, the 6510th Medical Group, had been renamed the 6510th USAF Hospital and assigned to the 6510th Air Base Wing a year earlier.[26] On 4 October 1954, then, the 6510th Air Base Wing and the 6510th Maintenance and Supply Group were discontinued with units previously assigned to both the Group and Wing placed under the 6510th Air Base Group.[27]

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23. Hq ARDC GO No. 25, 1 Jul 1958.
24. 1 Dec 1956, Hq ARDC GO No. 42, 14 Nov 1956.
% The 6515th FLM Sq (Conventional) became the 6515th FLM Sq (Cargo & Miscellaneous) and the 6516th FLM Sq (Jet) was renamed the 6516th FLM Sq (Fighter).
25. Hq ARDC GO No. 48, 12 Aug 1954. The 6511th Parachute Development Test Group was redesignated the 6511th Test Gp (Parachute), the 6510th Maintenance Sq became the 6510th Field Maintenance Sq under the 6510th Maintenance and Supply Group, and the 6512th Test Pilot Training Squadron (Experimental) was renamed the 6512th School Squadron (Test Pilot) and placed directly under the Center Commander from the previous control of Hq ARDC.
26. Hq ARDC GO No. 61, 9 Nov 1953.
27. Hq ARDC GO No. 71, 1 Oct 1954. Also on this order the 6510th Installations Group became the 6510th Installations Squadron.

Flight test functions continued to increase throughout 1954, and the famous Bell X-2 rocket research arrived at the Center for test. Lieutenant Colonel Frank K. Everest piloted the X-2 on its first glide flight 5 August 1954.

By the end of 1954, operations and activity at the Air Force Flight Test Center far exceeded the mission defined in June 1951 by Headquarters Air Research and Development Command. Consequently, a new mission directive was issued to the Center in May 1955 as follows:[28]

> . . . . to accomplish functional (as distinct from engineering) flight tests of complete, manned aircraft weapon systems, including components and allied equipment; to conduct engineering evaluation flight tests of aircraft and power plants; to accomplish research and development related to such tests; to plan for, control, and operate the Experimental Rocket Engine Test Station, the 6511th Test Group (Parachute) facilities, the USAF Experimental Flight Test Pilot School, AFFTC Track Testing facilities, and other special test facilities, and to provide facilities and special services for contractors and for other government agencies in support of the mission of ARDC.

The $120,000,000 new base was almost completed in 1955 with dedication of the Center Headquarters building on 18 August. On 26 September the new 15,000-foot concrete runway became operational. And in December, facilities of the Rocket Engine Test Station were given over to development and testing of the Intercontinental Ballistic Missile.

28. Hq ARDCR 22-4, 4 May 1955.

Growth and expansion affected Center organizations as in the past. The 511th Air Force Band was activated 18 April 1955[29] followed by activation of the 6510th Support Squadron on 1 June 1956 to perform housekeeping for the Rocket Engine Test Laboratory.[30] Then, on 1 July 1956, the 6510th Installations Squadron was abolished in favor of a newly created Installations Division within the 6510th Air Base Group.[31]

Perhaps 1956 was the peak in aircraft flight testing, for 100 major projects were finished during the year. Moreover, construction which began in 1952 on the Edwards Air Force Base Master Plan resulted in a new $120,000,000 flight test center incorporating the most modern facilities for flight testing aircraft, engines, and components. More would be spent it was true, especially for expansion of the Rocket Engine Test Laboratory on Leuhman Ridge. But the main base complex along with contractor facilities were, in the main, complete.

Experimental research in 1956 included achieving an altitude of 126,200 feet by Center test pilot Captain Iven C. Kincheloe in the X-2 rocket research aircraft on 7 September. Also, Captain Milburn G. Apt attained a speed of 2,094 miles per hour on 27 September before the X-2 spun out of control and crashed to its destruction.

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29. Hq ARDC GO No. 14, 7 Mar 1955. Authorization for the Band was lost in 1959 (Deactivated 1 Oct 59 by Hq ARDC GO No. 84, 17 Aug 1959).
30. Hq ARDC GO No. 20, 15 May 1956. (Abolished 1 Feb 1958 by Hq ARDC GO No. 4, 14 Jan 1958).
31. Hq ARDC GO No. 21, 5 Jun 1956.

Not too many organization changes were undertaken over the next two years.[32] In command, General Holtoner departed the Center 30 June 1957 and was replaced by Brigadier General Marcus F. Cooper, USAF, who assumed command on 3 July.[33] Prior to assignment as Center Commander, General Cooper had been Chief, Air Force Section, United States Air Force Group, Joint American Military Mission for Aid to Turkey.

Possibly the most notable event at the Center during his 20 months as commander was the start of construction on 778 Capehart homes on Edwards and the Category* development of the F-106 all-weather interceptor. Another achievement was a Center developed Air Force "in-house" capability for test of the THOR missile. Over on Leuhman Ridge also, the Rocket Engine Test Laboratory was renamed the Directorate of Missile Captive Test on 26 May 1958.#

32. The 6514th Motor Vehicle Sq became the 6514th Transportation Sq on 1 Oct 1956 (Hq ARDC GO 31, 21 Aug 56), the 16th Physiological Training Flight was activated 15 Jan 1957 and asgd to the 6510th USAF Hosp (Hq ARDC GO 49, 27 Dec 56), and the Office of Procurement became the Directorate of Procurement in early 1957. The CG AFFTC was delegated procurement authority not exceeding $100,000 by CG ARDC, 28 Dec 51. (Ltr, Hqs ARDC to CG AFFTC, RDMP, 28 Dec 51, Subj: Delegation of Authority with Respect to Procurement) SD "F" in Vol 5, Hist AFFTC, 1 Jan-30 June 52. A Procurement Division (FTMP) was established under DCS/M and remained as a division until 1 Sep 55 when a Procurement Office (FTK) was established. (Organization and Functions Chart #11, 1 Sep 55).

33. Hq AFFTC GO No. 10, 3 Jul 1957.

* Category I, II, & III testing replaced the old Phase I through VIII testing in 1958.

\# Directorate of Missile Captive Test was renamed the Directorate of Rocket Propulsion and Missiles on 13 Jul 59 and became the Directorate of Rocket Propulsion 1 Jul 60.

General Cooper was assigned to the newly created Federal Aviation Agency in January 1959,[34] so his deputy, Colonel Paul C. Ashworth, USAF, assumed command of the Center pending arrival of a new commander.[35] Brigadier General John W. Carpenter III, USAF, assumed command on 2 March[36] following an assignment at Headquarters ARDC as Assistant Vice Commander and Director of Plans and Programming.

No sweeping changes in organization were made by General Carpenter. But a Supply Division and a Supply Services Division were activated on 1 May 1959 to replace the 6513th Supply Squadron.[37] The following July, the Rocket Propulsion Laboratory moved from Wright-Patterson Air Force Base to the Directorate of Missile Captive Test at Edwards Air Force Base.[38] Under General Carpenter, also, there was a definite trend away from missile and missile component captive test and increased tempo in propellant and propellant systems research and development in the Directorate of Missile Captive Test.

Mission of the Air Force Flight Test Center in 1959 was "to conduct Category II testing of aircraft systems, accomplish captive evaluation of missile systems, and perform flight

34. DAF SO A-5 and DAF SO A-55, Wash D. C.
35. Hq ARDC SO No. A-25, 3 Feb 59.
36. Hq AFFTC GO No. 3, 2 Mar 59.
37. Hq ARDC GO No. 32, 17 Apr 59.
38. Hq ARDC GO No. 55, 19 Jun 59.

evaluations on designated research vehicles.* In addition to these requirements, the AFFTC supported Category I aircraft development and testing and Category III aircraft evaluations; conducted applied research programs for rocket engines, associated propellants, and accessories; and performed captive research, development, and evaluation tests on rocket engines, their propellants, and their components.[39]

In 1959 also, a new 20,000-foot high speed track was completed at the Center,[40] a 6594th Test Wing Operating Location Number 1 was established here on 6 April,[41] and the 6592d Test Squadron (B-58) was assigned to the AFFTC from Headquarters ARDC effective 1 November.[42] Moreover, two new units--Headquarters 6510th Test Group (Missile) and Headquarters 6512th Test Group (Aircraft)--[43] were activated to administer personnel in the Directorate of Rocket Propulsion and Missiles and in the Directorate of Flight Test.

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* As Center Commander, Gen. Carpenter was charged with responsibility to plan for, control, and operate the USAF Experimental Flight Test Pilot School, the 6511th Test Group (Parachute), and the AFFTC High Speed Track test facilities. It was his responsibility to establish and operate instrumentation and communications sites in support of space track programs, maintain a capability to conduct basic research and participate in applied research, to conduct research and development test projects--whether in-house or by contract, and to provide facilities and special services for contractors and other government agencies in support of the ARDC mission.

39. Hq ARDCR 23-4, 1 Jun 59.
40. George A. Fuller Construction Co., built this track under Contract No. DA-04-353-Eng-5296 starting work on 19 Jul 57 and finishing on 13 May 59 at a cost of $3,744,981.
41. Hq ARDC GO No. 28, 3 Apr 59. Mission was testing for recovery of Discoverer missile nose cones and retrieving telemetry data from down range telemetry ships at sea.
42. Hq ARDC GO No. 214, 15 Oct 59. Mission was to conduct Category III testing of the B-58 Hustler Bomber in conjunction with SAC and the Convair Division of General Dynamics Corporation.
43. Hq ARDC GO No. 60, 24 Jun 59. Effective date was 1 Jul 59.

In sum it should be noted that new Air Force directives and mission changes influenced certain organizational changes in the first nine years following activation of the AFFTC. Moreover, an ever increasing aircraft flight test and missile captive test workload necessitated certain mutations in organization. This was exemplified by establishment of Headquarters 6510th Test Group (Missile) and 6512th Test Group (Aircraft) specifically to administer personnel assigned to the Directorate of Missile Captive Test and the Directorate of Flight Test. Also, organizational titles were sometimes altered to designate more specifically the functions being performed. But the primary reason for so many activations, deactivations, designations, and redesignations was AFFTC adjustment to the requirements of a changing mission both within the Center and in the ARDC--for there was no precedent.

Miscellaneous Unit Additions to the Center

Numerous small off-base and on-base facilities were added to the AFFTC in the last few years mostly in connection with the X-15 rocket research aircraft program.# Recent additions to jurisdiction, control, and accountability of Edwards AFB were activation of the Hidden Hills Lake Test Annex,[44] Ballarat Dry Lake Test Annex,[45] and the Panamint Dry Lake Test annex.[46] Also designated and organized effective 15 April 1961 was Detachment 1, 6515th Maintenance Group at the El Centro, California, Naval Air Station. Personnel were furnished to man the detachment by the AFFTC commander, and equipment was authorized under UAL 6515 464401.[47]

Units Disposed of, Discontinued, or Transferred

Kingman, Arizona, Space Tracking Annex which was designated, activated, and assigned to Edwards AFB 22 April 1959 as Installation Number 6863 was disposed of 1 November 1960.[48] On 15 April 1961, the 16th Physiological Training Flight assigned to the

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\# Ely and Beatty, Nevada, Radio Relay Annexes on 16 Apr 58 (Hq ARDC GO 16, 30 Apr 58) and Hq ARDC GO 42, 11 May 59). Mud Lake Test Annex, Nye County, Nevada, on 7 Nov 58 (Hq ARDC GO 74, 22 Dec 58). End Marker, International Certified Speed Course, San Bernardino, County, California, 1 Jul 57 (Hq ARDC GO 67, 17 Jul 59). Kingman Space Tracking Annex, Kingman, Arizona, 22 Apr 59 (Hq ARDC GO 234, I Dec 59). Lake Isabella Recreational Site, Kern County, California, 1 Jan 60 (Hq ARDC GO 4, 7 Jan 60). Silver Lake Test Annex, San Bernardino County, California, 16 Nov 59 (Hq ARDC GO 15, 8 Feb 60). Saltdale Microwave Repeater Annex, Kern County, California, 13 Oct 60 (Hq ARDC GO 128, 25 Nov 60). Wright Air Development Division Edwards Field Test Office was activated 1 Oct 60 (Hq ARDC GO 92, 9 Sep 60).

44. Hq ARDC SO G-25, 9 Mar 61.
45. Hq ARDC SO G-25, 9 Mar 61.
46. Hq AFSC SO G-44, 7 Jun 61.
47. Hq AFSC SO G-14, 12 Apr 61.
48. Hq AFSC SO G-1, 9 Jan 61.

6510th USAF Hospital was discontinued.[49] Functions and personnel were reassigned to the Bioastronautics Branch in the Directorate of Flight Test and equipment reverted to control of the Center commander. UAL 0016 416510 and 0016 416511 were voided. This unit dated back to 15 January 1957.

Another unit, the 6592d Test Squadron (B-58) assigned to the AFFTC on 1 November 1959, was discontinued 15 June 1961 at Carswell AFB, Texas.[50] Personnel were reassigned by the Center commander, but equipment went to SAC in accordance with AFR 400-26 and an agreement between SAC and AFSC representatives drawn up on 25 May 1961 at Carswell AFB. UAL 6592 566510 was voided. Also, the 6512th School Squadron (Test Pilot), USAF Experimental Flight Test Pilot School, was discontinued 1 March 1961 by ARDC SO G-19, 20 February 1961.

Final unit disposition was transfer on 1 July 1961 of the 6510th Test Group (Missile) from AFFTC to the Space Systems Division (SSD) of Inglewood, California, without change of Station.[51] Concurrently the Headquarters 6510th Test Group (Missile) was redesignated Headquarters 6593d Test Group (Development). Personnel and equipment were reassigned from the AFFTC to SSD. UAL 6510 566410 was voided with UAL 6593 566410 established

49. Hq AFSC SO G-32, 24 Mar 61.
50. Hq AFSC SO G-46, 7 Jun 61.
51. Hq AFSC SO G-27, 19 May 61. See Appendix I.

for the 6593d. Under a memorandum of understanding between the commanders of the AFFTC and SSD, the 6593d was attached to the AFFTC for administrative and logistic support.*

In other action, both the Directorate of Rocket Propulsion and the USAF Experimental Flight Test Pilot School lost their maintenance and shop fabrication functions on 15 January 1961 when the 6515th Maintenance Group adopted the provisions of AFM 66-1.[52] In accordance with the AFM, Headquarters 6515th Maintenance Group assumed responsibility for all maintenance and shop fabrication activity at the AFFTC, Edwards AFB, and El Centro.

Command (1 January - 30 June 1961)

As previously noted, Brigadier General John W. Carpenter III assumed command of the AFFTC on 2 March 1959. He was promoted to Major General on 7 March 1961** and departed the Center 13 June for Headquarters USAF where he was slated to become Deputy Director of Plans.

Colonel Paul C. Ashworth, USAF, the AFFTC deputy commander since 23 June 1958, assumed command of the AFFTC upon six different occasions during temporary absences of Major General Carpenter.[53] Colonel Ashworth also departed the Center in late

* Transfer Agreement between Space Systems Division, DCAS (AFSC) and Air Force Flight Test Center (AFSC) for transfer of 6593d Test Group (Development) approved 7 Aug 1961 by AFFTC Deputy Commander Col Donald P. Hall and SSD Commander Maj Gen Osmond J. Ritland. SD "B" in Vol 2, this history.

52. Hq AFFTC SO G-1, 13 Jan 61. SD "A" in Vol 2, this hist.

** DAF SO AA-279, 7 Mar 61. Temporary Maj Gen with DOR 1 Jul 56.

53. Hq AFFTC SO's G-2, 26 Jan 61; G-6, 2 Feb 61; G-10, 27 Feb 61; G-11, 13 Mar 61; G-13, 28 Mar 61; and G-23, 2 May 61. SD "A" in Vol 2, this hist.

June for Ellington AFB where he was scheduled to assume duties as deputy commander of the Civil Air Patrol.

Although General Carpenter's successor was not named immediately, Colonel Roger E. Phelan, 1659A, USAF, the AFFTC Chief of Staff since 26 August 1959, was designated acting commander by direction of the President on 13 June 1961.[54] On 28 June during the temporary absence of Colonel Phelan, Colonel Adolf M. Wright, USAF, Commander of Edwards AFB and the 6510th Air Base Group, assumed command of the Center.[55]

Directly under the Commander heading the AFFTC Dyna-Soar Test Force since 15 May 1958 was Colonel Harold G. Russell, USAF.[#] Technical Director for the Center commander since 25 January 1960 was Francis H. Richardson.

AFFTC Staff Changes

Only four Center staff changes occurred this six months, and two of these were a result of staff redesignations. The latter were the DCS/Operations and DCS/Intelligence becoming the DCS/Plans and Operations (8 May) and Deputy for Foreign Technology (13 Jun) with Colonel Clay Tice Jr, USAF, heading Plans and Operations[56] and Lieutenant Colonel Jack J. Greger, USAF, named as Deputy for Foreign Technology.[57]

54. Hq AFSC SO G-47, 9 Jun 61. Col Phelan assumed command on 13 Jun by Hq AFFTC SO G-42, 13 Jun 61. SD "A" in Vol 2, this hist.
55. Hq AFFTC SO G-61, 28 June 61. SD "A" in Vol 2, this hist.
\# Hq AFFTC GO 11, 1958.
56. Hq AFFTC SO G-24, 8 May 61. SD "A" in Vol 2, this hist.
57. Hq AFFTC SO G-44, 15 Jun 61. SD "A" in Vol 2, this hist.

In one of the other two staff changes, Colonel John H. Mallett, USAF, became DCS/Materiel 11 May replacing Colonel Paul F. Helmick, USAF, who was named special assistant to the AFFTC commander. In the other change, Lieutenant Colonel Robert M. Howe, USAF, became Commandant of the USAF Experimental Flight Test Pilot School on 17 June replacing Major Richard C. Lathrop, USAF,[58] who departed for the Air Force Academy where he was to become an instructor.

Key Personnel

Other than the redesignation of Center Operations and Intelligence mentioned in the previous subject and the command change which occurred late in June, current AFFTC organization and key personnel follow on the next page of this narrative. The author encourages use of the Roster of Assigned Officers* listed as Supporting Document C in Volume 2, this history.

Mission

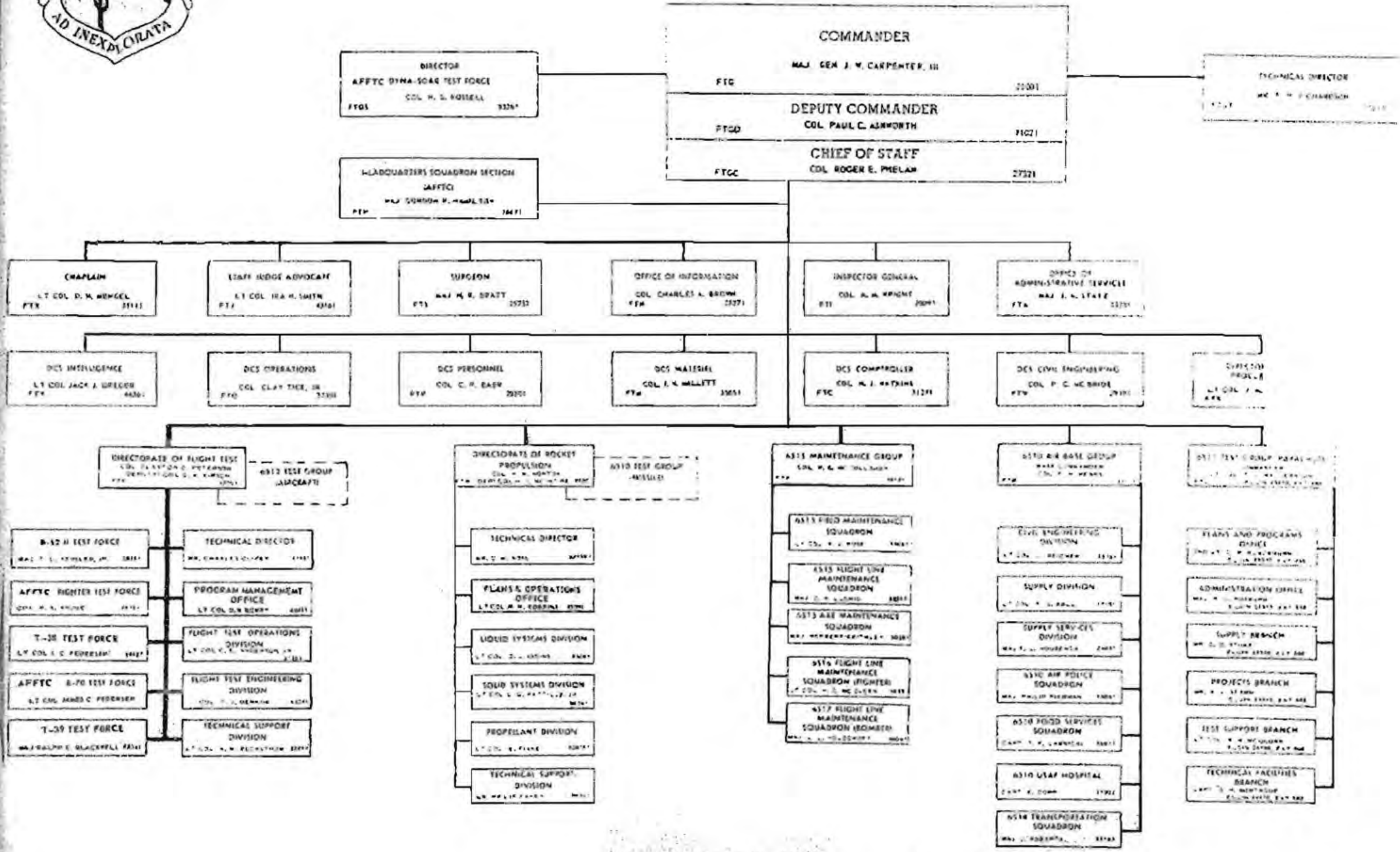
Headquarters ARDC restated the AFFTC mission in 1959.[59] Concisely speaking it was to conduct Category II test of aircraft systems, captive evaluation of missile systems and subsystems, and flight evaluation of designated research vehicles.

Center Personnel

For mission performance, the AFFTC was authorized 2,977 military personnel and 2,677 Air Force employees on 30 June with 2,929 military and 2,672 civilians assigned. Concerning the

58. Hq AFFTC SO G-39, 9 Jun 61. SD "A" in Vol 2, this hist.
* Also see Appendix "G".
59. Page 17, this chapter.

AIR FORCE FLIGHT TEST CENTER



JOHN W. CARPENTER III

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military, 460 officers and 2,517 airmen were authorized but 466 officers and 2,463 airmen were assigned.[60] Nineteen government tenant units added another 55 officers, 257 airmen, and 555 Air Force employees.[61] Another 1,573 civilians were under hire to 17 Air Force contractors at the Center.[62] In all there were 8,041 people on the Center not including construction workers--3,241 military and 4,800 civilians.

Awards and Decorations

Fifteen Air Force Commendation Medals were awarded AFFTC personnel for meritorious service, four Commendation Medals were passed out for meritorious achievement, and two officers were given first oak leaf clusters to the Air Force Commendation Medal.[63] In addition, 146 Center personnel assigned to the Directorate of Rocket Propulsion were awarded the Guided Missile Insignia.[64]

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60. Appendix C presents a breakdown by assigned unit.
61. Appendix D presents a breakdown by tenant unit.
62. Appendix D presents a breakdown by contractor.
63. Hq AFFTC SO's G-series (SD "A" in Vol 2, this hist) as follows: Lt Col Herbert W. McQuown and SMSgt Carl R. Ryan G-16; Maj Richard C. Lathrop G-26; Col Paul F. Helmick, Col Frank H. Mears, and Col Paul C. McBride G-40; Col Paul C. Ashworth and Col Carl A. Ousley G-41, Col Joseph J. Berkow, Maj Robert G. Ferry, Maj Swart H. Nelson, Capt Harrison B. Lethbridge, MSgt James H. Bolander, MSgt Wiley S. Green Jr, and TSgt Harold Quiring G-62 all for meritorious service. Lt. Col James C. Pedersen, SSgt Bobby L. Williams, A1C James A. Ford, and A1C Kenneth M. Southard G-62 for meritorious achievement. First oak leaf cluster went to Col George A. Kirsch G-40 and Maj Reese S. Martin G-62.
64. Hq AFFTC SO's G-series 27, 28, 29, 37, 38, 43, and 63. SD "A" in Vol 2, this hist.

Retirements

Master sergeants topped the exodus of Air Force personnel via the retirement route from January through June with 15 of the 35 retirements processed. Departing the Center on 31 January were MSgt Robert Risley,[65] TSgt Leslie Hurley,[66] and TSgt Raymond Rauch Jr.[67] Retired on 28 February were SMSgt Arthur Eberhardt,[68] MSgt Gilbert Dovalina,[69] and SSgt Edward Guston.[70] Following on 31 March were MSgt Charles May[71] and TSgt Harold Quiring.[72] Leaving on 30 April were Major Phyllis N. Burns (NC),[73] MSgt George Haywood,[74] MSgt Donel Pittman,[75] TSgt Walter Yauorsky,[76] and SSgt Charles Bates.[77] And those retired on 31 May were Major Rowland A. Bass,[78] MSgt Allison Farmer,[79] MSgt Guy McDaniel,[80] MSgt Lloyd Young,[81] TSgt Paul Carriger,[82] and TSgt William Wynn.[83]

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65. Hq AFFTC SO G-3, 30 Jan 61. SD "A" in Vol 2, this hist.
66. Hq AFFTC SO G-4, 30 Jan 61. SD "A" in Vol 2, this hist.
67. Hq AFFTC SO G-5, 30 Jan 61. SD "A" in Vol 2, this hist.
68. Hq AFFTC SO G-7, 24 Feb 61. SD "A" in Vol 2, this hist.
69. Hq AFFTC SO G-8, 24 Feb 61. SD "A" in Vol 2, this hist.
70. Hq AFFTC SO G-9, 24 Feb 61. SD "A" in Vol 2, this hist.
71. Hq AFFTC SO G-15, 29 Mar 61. SD "A" in Vol 2, this hist.
72. Hq AFFTC SO G-14, 29 Mar 61. SD "A" in Vol 2, this hist.
73. Hq AFFTC SO G-18, 18 Apr 61. SD "A" in Vol 2, this hist.
74. Hq AFFTC SO G-19, 24 Apr 61. SD "A" in Vol 2, this hist.
75. Hq AFFTC SO G-20, 24 Apr 61. SD "A" in Vol 2, this hist.
76. Hq AFFTC SO G-21, 24 Apr 61. SD "A" in Vol 2, this hist.
77. Hq AFFTC SO G-22, 27 Apr 61. SD "A" in Vol 2, this hist.
78. Hq AFFTC SO G-30, 25 May 61. SD "A" in Vol 2, this hist.
79. Hq AFFTC SO G-33, 29 May 61. SD "A" in Vol 2, this hist.
80. Hq AFFTC SO G-34, 29 May 61. SD "A" in Vol 2, this hist.
81. Hq AFFTC SO G-35, 29 May 61. SD "A" in Vol 2, this hist.
82. Hq AFFTC SO G-31, 29 May 61. SD "A" in Vol 2, this hist.
83. Hq AFFTC SO G-32, 29 May 61. SD "A" in Vol 2, this hist.

Of the 35 retirements processed, 16 retired 30 June. They were Colonel Clarence Weidner,[84] Colonel Paul C. McBride,[85] Colonel Paul F. Helmick,[86] Lt Colonel Gordon R. Hamilton,[87] Lt Colonel Henry C. MacQueen,[88] Major Robert O. Smith,[89] SMSgt Leslie Frey,[90] and SMSgt Arthur Kellogg.[91] Also MSgt Francis Kalinowski,[92] MSgt Nemesio Arzaga,[93] MSgt Kenneth Marshall,[94] MSgt Edward Lehton,[95] MSgt James Cannady,[96] MSgt Jacob Wurman,[97] MSgt Edward DeVries,[98] and TSgt Edward Cassidy.[99]

Office of Career Management Established

Motivated by the ARDC Commander's "Accent on People" program, the DCS/Personnel on 1 December 1960 established an Office of Career Management which was readily approved by the AFFTC Commander. Purpose of the new office was to monitor, recommend, and direct through planned personnel actions efforts of individuals towards a career of value to the USAF and satisfying to the person. Areas covered initially included

84. Hq AFFTC SO G-47, 22 Jun 61. SD "A" in Vol 2, this hist.
85. Hq AFFTC SO G-49, 22 Jun 61. SD "A" in Vol 2, this hist.
86. Hq AFFTC SO G-50, 22 Jun 61. SD "A" in Vol 2, this hist.
87. Hq AFFTC SO G-45, 22 Jun 61. SD "A" in Vol 2, this hist.
88. Hq AFFTC SO G-48, 22 Jun 61. SD "A" in Vol 2, this hist.
89. Hq AFFTC SO G-46, 22 Jun 61. SD "A" in Vol 2, this hist.
90. Hq AFFTC SO G-51, 22 Jun 61. SD "A" in Vol 2, this hist.
91. Hq AFFTC SO G-55, 22 Jun 61. SD "A" in Vol 2, this hist.
92. Hq AFFTC SO G-53, 22 Jun 61. SD "A" in Vol 2, this hist.
93. Hq AFFTC SO G-54, 22 Jun 61. SD "A" in Vol 2, this hist.
94. Hq AFFTC SO G-56, 22 Jun 61. SD "A" in Vol 2, this hist.
95. Hq AFFTC SO G-57, 22 Jun 61. SD "A" in Vol 2, this hist.
96. Hq AFFTC SO G-58, 22 Jun 61. SD "A" in Vol 2, this hist.
97. Hq AFFTC SO G-59, 22 Jun 61. SD "A" in Vol 2, this hist.
98. Hq AFFTC SO G-60, 27 Jun 61. SD "A" in Vol 2, this hist.
99. Hq AFFTC SO G-52, 22 Jun 61. SD "A" in Vol 2, this hist.

educational assignment and reassignment, classification, selective enlistment, and reenlistment counselling--anything that affected the military career of the individual.[100]

Colonel Charles P. Baer the DCS/Personnel named Major Neil D. Maxwell, USAF, as chief of the Career Management Office. Major Maxwell's duties would include coordinating with the Base Education Office, the AFFTC Military Training Division, and affording assistance to unit commanders in their officer and airmen career counselling.

By late June 1961, it was apparent the Office of Career Management was a worthy endeavor. The junior officer career guidance and counselling effort was credited with moving the retention rate over the 50 percent mark, airmen on-the-job training program had been evaluated and found wanting in the area of number in extended training, and regulations were in process for each area of the collateral training program. Of more import, however, was the fact that career counselling service was provided in a centrally located office convenient to all military personnel. Plans were also under consideration to consolidate both the AFFTC Military Training Division and the Base Education Office into the Office of Career Management.[101] The one diffculty anticipated by such action was a possible conflict between education testing and military testing if rigid scheduling were attempted.

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100. DCS/P Hist, Jan 61.
101. DCS/P Hist, May 61.

Appropriations

Appropriations to fund AFFTC activities doubled in the last few years with Fiscal Year 1961 topping any past year. However, obligation authority from other commands, military interdepartmental purchase requests, and special funding authorization for base housing rehabilitation added five million dollars in FY 1961. The following rounded to millions and thousands of dollars indicates the upward trend of the AFFTC financial function:[102]

APPROPRIATIONS	FY 57	FY 58	FY 59	FY 60	FY 61
R & D, Test, & Eval	31,062	35,561	38,453	62,974	59,782
Operation & Maintenance	353	352	378	438	455
Military Personnel (PCS & Subsistence)	397	496	395	340	425
Military Construction	123	352	119	53	157
Reserve Personnel	2	5	8	15	26
Military Assistance (Executive Approp)	-	-	-	52	24
Military Personnel (Pay)	8,800	9,800	11,000	11,600	12,000
Advanced Research Proj	-	-	-	2,681	3,365
AF Stock Fund	1,400	2,500	2,700	2,700	2,600
Housing Rehab (Spec)	-	-	-	-	3,000
OA's and MIPR's	1,000	1,000	1,500	1,500	2,000
TOTAL	43,137	50,066	54,553	82,353	83,838

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102. Data were furnished by Ellsworth Beckett, Chief of Budget and Analysis Division, DCS/Comptroller, Hq AFFTC, 10 Oct 61.

Aircraft Inventory

Ninety-one aircraft were assigned to the Center on 30 June 1961. Of the 91, twelve were utilized in aircraft or aircraft component testing, 34 were necessary as test support such as escort,[103] another 18 were designated special activity (USAF Experimental Flight Test Pilot School), 17 were operational support types for use in combat readiness training, four were marked for AFFTC command mission purposes such as passenger travel, and six were in storage awaiting modernization.[104] In addition to assigned aircraft, tenant organizations kept from 11 to 14 aircraft on the Center each month, contractors possessed 27 aircraft undergoing research and development or in use as test beds, and the National Aeronautics and Space Administration (NASA) possessed five airplanes on loan from the Air Force and owned three others.[105]

Flying Hours

Prior to January, the AFFTC programmed 14,477 flying hours for the period ending 30 June. However, the six month total fell short of the AFFTC intent by 2,444 hours. Hours flown per month were as follows:[106]

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103. Test support is escort aircraft (Pace, chase, photo chase), test bed, (black box testing, aerial delivery platforms,) and AFFTC support, all as defined in AFR 65-110.
104. AFFTC Assigned Aircraft Inventory, 30 Jun 61, SD "C" in Vol 2, this hist.
105. Ibid.
106. Extract of ARDC Form 185D, Flying Hours by Utilization Code, prepared by Hq AFFTC, FTOO, DCS/O, and authenticated 17 Jul 61. Flying hours for period 1 Jul 59 through 31 Dec 60 are included herein as Appendix E. Prior to 1 Jul 59, flying hours were included in Appendix titled "Thumbnail Statistics".

JAN	FEB	MAR	APR	MAY	JUN
2,215	1,925	1,941	1,924	2,014	2,014

Flying hours monthly-test aircraft:

373	163	54	101	104	156

Test support:

836	620	702	881	743	609

Operational support:

425	496	510	509	626	698

Special activity:

423	443	464	304	301	266

Command mission:

158	203	211	129	240	285

Aircraft Accidents

On 9 February 1961, F-104A USAF S/N 56-761 was completely demolished on impact. Description of the crash by fire truck crews standing alert on runway was that afterburner stopped and started three times then a huge ball of fire was seen at the aft end of the aircraft. After the F-104 caught fire the pilot parachuted to safety. Aircraft was valued at $1,704,228 and was a total loss.[107]

J79-GE-3A engine Serial Number 147254 was investigated following the crash of the F-104 and revealed a possible design problem in the number two bearing area. When AFFTC Propulsion

107. Hist of the Civil Engineering Div, 6510th ABG, Feb 61. For details of accident see Appendix A, this Vol.

Branch inspection of all other J79-GE-3A engines on the Center bore out this finding, several fixes went into effect such as better machined parts and better seating of the number two bearing.[108]

See Appendix A for a report of aircraft incidents and accidents.

108. Interview by MSgt Charles V. Eppley with Mr. Glenn Felix, Asst Ch, Propulsion Branch, AFFTC, 15 Nov 61.

Chapter 2

HIGHLIGHTS, ACHIEVEMENTS, AND PROBLEM AREAS

In the past the temptation arose often to title this chapter "Highlights and Breakthroughs", but a look at the Air Force Dictionary definition for "Breakthrough" discouraged one from throwing the word around loosely. Therefore, the decision was made to title this chapter more in line with what it contained--highlights, achievements, and problem areas, a condensed report of items not necessarily covered elsewhere.

Highlights and Achievements

Great strides forward were made in the speed and altitude regimes of piloted aircraft under the joint Air Force, National Aeronautics and Space Administration (NASA), and Navy X-15 rocket research aircraft program. First AF/NASA/Navy flight of the airplane using the XLR-99 engine with 57,000 pounds of thrust was performed by Major Robert M. White, USAF, on 7 March 1961. In this six months interim, nine research flights were attempted and five resulted in powered flights. Altitude was extended to 169,600 feet on 30 March by NASA pilot Joe Walker, and speed was upped to 3,603 miles per hour by Major White on 23 June.

While the X-15 rocket research aircraft was nearing its design goals, another manned space program was just getting underway. Its title, Dyna-Soar, was based on its boost-glide principle. Responsibility was assigned to the Air Force Flight Test Center (AFFTC) in July 1961 for organization of the Dyna-Soar test force and development of the Dyna-Soar flight test program. The AFFTC Dyna-Soar Test Force Director, Colonel Harold G. Russell, USAF, in July named eight agencies[1] associated with the test force. Responsibilities of the AFFTC included pilot selection and training, flight test engineering, flight planning, bioastronautics support, and flight and maintenance of the B-52 carrier airplane as well as other test support aircraft. By 30 June 1961, Dyna-Soar pilots[2] selected for the program were undergoing initial training at the Boeing Airplane facility in Seattle, Washington.

In January 1961, two Strategic Air Command B-58 Hustler Bombers with SAC crews teamed up at the Center to establish six new speed records, five of which were formerly held by Russia. New marks by the delta-winged, four-jet, Convair-built Hustlers were established over the AFFTC 1000 and 2000 kilometer courses. Records set over the 1000 kilometer course were a speed of 1,284.73 miles per hour with a 2,000 kilogram payload, the same speed over the same course automatically bested any

1. AFFTC, AFMTC, NASA, Boeing Airplane Co (systems contractor), Martin Co (Titan II booster contractor), Radio Corporation of America (communications and data link contractor), Minneapolis-Honeywell Co (flight control system), and Aerojet-General Corp (engine manufacturer for the Titan booster).
2. Majors Robert M. White and James W. Wood; Captains Robert A. Rushworth, William J. Knight, Russell L. Rogers, Henry C. Gordon, all of the USAF; and Neil A. Armstrong, William H. Dana, and Milton O. Thompson, all NASA civilian test pilots.

previous records for a 1,000 kilogram payload, and the same speed and course with no payload record held by an Air Force F-101 at 700.47 miles per hour was bested by the B-58's record dash. Speed over the 2000 kilometer course with a 2000 kilogram payload was 1,061.808 miles per hour. This almost doubled the previous mark claimed by Russia with a TU-104, and it also bettered the record claimed by Russia for the same speed and course with a 1,000 kilogram payload and with no payload. The B-58 speed runs were made from Edwards AFB to a point slightly east of Yuma, Arizona, and were monitored by the AFFTC Space Positioning Branch.

Another SAC B-58 Hustler and crew utilized the AFFTC 500 kilometer course in May to set a new closed circuit speed mark. This flight was also monitored by the AFFTC Space Positioning Branch and indicated an average speed of 1,302.04 miles per hour.

Also, the AFFTC Directorate of Flight Test initiated nine new flight test programs[3] and completed 24 projects[4] related to aircraft flight test in the first six months of 1961. One of those initiated was the T-38 Talon Trainer Category II performance evaluation with production engines on 22 May 1961. Category II performance tests of the T-38 Talon with prototype engines began 22 February 1960 and ended 28 July 1960 by an engine explosion. Just prior to start of Category II performance test of the T-38 Talon, the AFFTC T-38 Test Force completed evaluation of production engines for the Norair-built T-38 supersonic trainer.

Nearly five years of research and development work on the F-106 aircraft crew escape system terminated in this historical

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3. YHW-1B Category II Performance Test, YHW-1B Category II Stability and Control Test, H-13K Limited Performance Evaluation, T-38 Category II Performance Test, F-100D Optimum Flap Position Evaluation, F-100D Performance with 335 Gallon Tanks, B-58A Multiple Weapons Evaluation, F-104 High Density Fuel-Range Tests, and AVROCAR Flight Evaluation.
4. Universal IFR Suitability Test (F-100 & F-101), F-106A Category II Performance and Stability and Control Tests, T-33A Electrical Gang Start Switch, Zero Gravity Tests of the X-15 Nitrogen Tank, Flight Test of Fletcher 200 Gallon External Fuel Tanks, HU-1 Stability and Control Evaluation, C-130 BL Category I Performance, C-133B Category II Performance Tests, Re-evaluation of Stability and Control of the B-58A, F-104G Suit-Cockpit Compatibility, Evaluation of an Artificial Stall Warning System and a Redesigned Airspeed System for C-133 Aircraft, JC-131B Limited Flight Test, B-52G/Gam-77 Category II Performance-Stability and Control Tests, YHC-1A Flight Evaluation, S-62A Limited Stability and Control Evaluation, Modified JC-54G Limited Flight Test, Arresting Cable Pop-up Device Test, Analytical Investigation of the Effect of Vertical Wind Gradients on High Performance Aircraft, T-37B Category II Performance Test, Limited Performance - Stability and Control and Structural Test of a C-130B Modified for Satellite Recovery, USAF Flight Evaluation of the VULCAN Mark II Bomber, B-58 Non-Frangible Wheel Tests, Optimization of Trajectory Equations to Provide Rapid Prediction of Range and Maneuvering Capability for Re-entry Glide Vehicles, and Calculation of Trajectories in Earth-Moon Space by Numerical Integration.

interim with a live test ejection over White Sands Missile Range from a specially instrumented F-106 traveling better than 500 miles per hour. The live test volunteer was Technical Sergeant James A. Howell of the AFFTC's 6511th Test Group (Parachute) at El Centro, California. Howell ejected successfully from 22,000 feet to prove out the advanced ejection seat escape system under development since 1956 by a joint Air Force Systems Command/ aircraft industry group which became known as the Industry Crew Escape System Committee (ICESC).

Perhaps the foremost achievement in AFFTC range instrumentation history was derived from a jointly funded effort between the Center and the National Aeronautics and Space Administration Flight Research Center. Result was development and installation of a microwave system interconnecting High Range, Air Defense Command, and the AFFTC instrumentation sites from Beatty, Nevada, to the Center. Introduction of microwave to the system provided for transmission simultaneously of instrumentation radars, telemetry, Air Defense Command video, and communications data.

AFFTC Aerospace Data Facilities developed two real-time display consoles, one revealing aircraft parameters and the other physiological parameters. Another notable development was construction of a pulse code modulation/telemetry (PCM/TM) acquisition and display capability to meet varied flight test requirements unique to the Center. Also, a large optical tracker with variable focal lengths up to 500 inches was developed to extend optical coverage for historical information on vehicles undergoing flight test, and a shaft angle digitizer for optical instruments was developed to a point where shaft angle measurements could be provided of one part in 200,000.

In addition, an interferometer, automatic tracking antenna was developed to operate in the 1400/2200 megacycle bands which the Department of Defense desired to have operational by 1965. AFFTC success with this development was phenomenal, and continued success of such a capability in the higher frequency bands would have direct application to testing of hypersonic vehicles during their recovery phase.

On 15 April 1961 the 16th Physiological Training Flight, 6510th USAF Hospital, was discontinued with personnel and equipment absorbed by the Bioastronautics Branch in the Directorate of Flight Test and titled as the Environmental Section.[5] This action was in line with the desires of Air Force Systems Command and in support of the AFFTC expanded Bioastronautics Branch mission. Success of the bioastronautics mission of investigating the problems of man and space flight was apparent by the monitoring of in-flight physiological data in connection with the X-15 rocket research aircraft program. Values of suit-helmet differential pressure, suit versus cockpit pressure differential, and cabin pressure were telemetered to the ground while electrocardiograph, respiration, and body temperatures were recorded onboard the aircraft. Responsibility

5. Hist of the Flight Test Engineering Div., Directorate of Flight Test, Apr 1961. In files of the AFFTC Hist Div.

for maintenance and development of the A/P22-S pressure suit and helmet operationally in use on all X-15 flights was assigned to the Bioastronautics Branch. It was significant to note that the X-15 never experienced a delay or canceled flight because of the pressure suit or helmet.

Of equal import was an AFFTC study which related to the feasibility of an instrumentation recovery control center. This technical study provided data required for future planning of instrumentation at the Air Force Flight Test Center which could augment development of a recovery capability for future Air Force hypersonic vehicles.

In January 1961, the Data Processing and Computing Branch was redesignated as the Aerospace Data Systems Branch. The latter also absorbed the Data Acquisition Branch as a section. A modification contract was approved for Building 3940 and work began in May 1961 to remodel the building for Aerospace Data Systems Branch and its IBM 7090/1401 computer system. IBM 1401 was installed and placed in operation in June. IBM 7090 was programmed for installation in either September or October.

Aerospace Data System's Pulse Width portion of the new Digital Data Processing System designated Project UPDATUM was completed in June 1961. Also, the IBM Transceiver system between Edwards AFB and El Centro was converted from toll service to leased line service in June, and the link between Pasadena and El Centro was discontinued in the interest of economy.

An Aerospace Research Pilot Course designed to be the most advanced instruction ever offered in a flying school began in June at the Center. Enrollment was five students,[6] four of whom were members of the USAF Experimental Flight Test Pilot School staff. Course activities included familiarization with sub-gravity, training with reaction controls, evaluation of stability characteristics of space flight profiles, and study of functions and test methods peculiar to space flight. Additional studies would embrace Newtonian mechanics, thermodynamics, fluid mechanics, boundary layer theory, high speed aerodynamics, heat transfer, dynamics of rarefied gases, Einstein's theory of relativity, meteorology, astrology, propulsion, orbital mechanics, trajectories, and other subjects essential to outer space flight.

Highlights and achievements at the Center's Directorate of Rocket Propulsion were too numerous to mention in this narrative.[7] Suffice it to say the Directorate in 1961 had reached a state of professional proficiency in the field of missile component environmental testing and in the area of liquid and solid propellant investigations. For example, development of thixotropic fuels (fuels which were stored in jelly form and returned to liquids under pressure for rocket engine firings) was expected to eliminate problem areas in handling high energy storable

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6. Major Robert S. Buchanan and Thomas U. McElmurry, Captains Frank Borman and James A. McDivitt, and Mr. William Schweikard.
7. Ltr Hqs AFFTC (FTNH) to AFSC (SCEH), 31 Jul 1961, Subj: AFSC Commander's Annual Progress Report to the Chief of Staff, USAF, (RCS: AFSC U-36). SD "E" in Vol 2, this hist.

liquid fuels. Development of segmented solid rocket motors was another example of highlights and achievements at the Directorate of Rocket Propulsion. The Directorate was one of the originators of the segmented solid rocket motor, and furnished technical direction for successful firing of a 25 ton sub-scale motor 5 May 1961 at the Aerojet-General Corporation test facility in Sacramento, California.

Problem Areas

Although Category I and II aircraft performance, stability and control, and systems evaluation testing remained relatively constant, category testing generated a requirement for engineers to be assigned to a program earlier and later in the development cycle particularly in aerospace vehicle test programs. This coupled with increasingly complex systems which required more engineers for longer periods created engineer shortages in all fields.[8]

Delay in receipt of aircraft (an F-104A and an F-104B) for the Aerospace Research Pilot Course of the USAF Experimental Flight Test Pilot School prevented installing of special instrumentation prior to start of the course. Vitally needed training aides such as analog space simulators, human centrifuges, reaction control simulators, and variable stability aircraft were not available at the AFFTC for use by the school in its first Aerospace Research Pilot Course.

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8. 2d Ind, FTFE to FTNH, 18 Jul 61, to Ltr FTFPA, 10 Jul 61, Subj: AFFTC Annual Progress Report (RCS: AFSC - U-36).

Funds were denied for development of track test techniques and facilities such as waterbrake development for the Mach 3 parachute and the B-70 crew escape system programs. Track test operations and administrative functions were hampered by lack of adequate housing and maintenance shops and laboratories were needed to house personnel and equipment.

Personnel shortages were a predominant problem in the AFFTC Propulsion Branch, Technical Support Division, Directorate of Flight Test. During the past year ending 30 June 1961, approximately $100,000 of overtime money was expended in support of the assigned workload. Areas where personnel shortages existed were not isolated, for both the gas turbine and rocket engine evaluation test shops experienced difficulty for lack of qualified military and civilian personnel.[9]

Also, inadequate manning of the AFFTC maintenance activity assumed proportions of a major problem. Heavy overseas levies coupled with numerous retirements brought on a serious loss of supervisory skills. The difficulty was aggravated by receipt of replacements with little or no practical experience direct from technical schools.

Supply discipline at unit level was another problem of some significance. Major discrepancies were poor records keeping, hoarding of excesses, lack of authorization for items on hand, and equipment not properly identified.

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9. 3rd Ind, FTFSP to FTFS, 12 Jul 61, to Memorandum, AFFTC (FTN) 10 Jul 61, Subj: AFFTC Annual Progress Report (RCS: AFSC U-36).

Both the Base Exchange and the Commissary were restricted operationally by lack of space. Repeated attempts to obtain new construction approval were to no avail, but the depot responsible for USAF Commissary operations recently performed a survey to justify requirements for additions to the Base Commissary.

Problem areas at the Directorate of Rocket Propulsion included development of high energy storable liquid propellants with long-time storage characteristics, development of satisfactory liquid monopropellants, and application of simplified rocket propulsion concepts to ultra-large booster engines. Also, there were many problems involved in attempts to improve the efficiency and reliability of space rockets, improve solid rocket motor cases and nozzles in terms of temperature resistance, apply nuclear energy to rocket propulsion systems, and increase the energy of solid propellant systems.

Chapter 3

THE AIR FORCE FLIGHT TEST CENTER 1961 - 1976

"The potential of an installation to meet future mission requirements rather than its current assigned workload will largely decide its future role." This was the philosophy of AFSC and it was logical in view of AFSC's future contributions to the USAF for achieving a true military capability in the aerospace environment. But what potential did the AFFTC possess that would meet the requirements of the AFSC mission over the next 15 years? Major General John W. Carpenter III, Commander of the AFFTC, wanted the answer so he turned to his plans and operations staff under the direction of Colonel Clay Tice Jr. Their study began with a determined investigation of AFSC planning objectives, advanced development objectives, and specific operational requirements. When the results were in, they projected the AFFTC workload into the future. The answer was clearly apparent--if the AFSC would take full advantage of AFFTC existing capabilities and potentials there would occur a logical transition whereby the AFFTC would play a major role in bringing about a true USAF military capability in the aerospace environment.[1]

A few of the more significant factors that made up the potential of the AFFTC and which supported its claim to a dominant role in the research, development, and evaluation of

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1. Hq AFFTC Long Range Plans and Program Guidance Document, 18 Mar 1961. (Hereinafter referred to as Long Range Plan).

space systems included its facilities "in-being", its collective skills, its isolation, vast land area, excellent weather, and security.

Specifically, the AFFTC represented an Air Force investment of nearly $200,000,000 with approximately 5,800 technically skilled Air Force personnel currently participating in the AFFTC mission. There was no great population density within 50 miles of the AFFTC which would create problems from unpleasant by-products of research and development. Yet there was a highly industrialized area with a skilled labor market within 75 miles of the AFFTC. The AFFTC land area covered 301,209 acres with a 65 square mile dry lake which would permit controlled recovery of space systems from any direction. This land mass also was well suited for aerospace propulsion test facilities and launching sites. Additionally, the weather permitted flight 350 days per year and a mountain range between the AFFTC and the Pacific Coast protected it from observation off the Pacific Ocean.

In 1961 the AFFTC workload which contributed to the AFSC mission was somewhat evenly divided between aircraft, ballistic missiles, and orbital space missions. The AFFTC was either supporting or conducting conventional system tests on bombers, cargo aircraft, fighters, trainers, helicopters, and experimental research airplanes, and was involved with planning for the B-70 aircraft test program. In addition, the AFFTC was providing direct support of contractor development of advanced

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commercial jet aircraft, and was cooperating with and supporting the Flight Research Center of NASA, the Federal Aviation Agency, the Army, Navy, and other federal agencies.

The AFFTC would continue its general support of the AFSC and USAF objectives in the future, but manned space systems seemingly held the most promise for full utilization of the AFFTC potential. This was premised upon what was available at the AFFTC to work from such as expanding the telemetry facility into a Recovery Control Center, extending current instrumentation into a test and recovery range, enlarging the bioastronautics capability, expanding the parachute test facility, and modifying the missile captive test site.

Recovery Control Center

Launch of manned ballistic and aerodynamic weapon systems from Cape Canaveral and Vandenberg placed the AFSC in a position to provide controlled land recovery of space systems. Initial requirement for such a facility would be Dyna-Soar (Step II) and the requirement would continue into the future, for it would provide all necessary information to effectively control and recover a vehicle and its payload. Nucleus of the Recovery Control Center could be formed around the present AFFTC telemetry facility as supplemented by the data processing facility and the IBM 7090 computer system. A concentration of information at the Recovery Control Center would allow immediate processing and display of information for decision making purposes and for test and recovery control of orbital and space systems. To the AFFTC, development of a capability to effectively control and recover hypersonic aerospace vehicles was the most important new aerospace facility complex required by AFSC in the 1965 - 1966 time period.[2]

Test and Recovery Range Integration

The initial one orbit test flight of Dyna-Soar called for recovery of the system at the AFFTC through a tie-in to an extensive world-wide range complex starting at Cape Canaveral, down range across Johannesberg, to Hawaii, and terminating at the AFFTC. By a nominal extension of presently established instrumentation facilities at the AFFTC, a 360 degree range instrumentation capability was feasible for use in the range-command-tracking and recovery control approach of aerospace systems terminating at the AFFTC.[3] A straight line extension from the AFFTC out along High Range, across Pine Tree Line, Mid-Canada Early Warning Line, and the Distant Early Warning Line to Thule provided a potential 3,500 mile straight line inland range for the testing of high speed aerospace vehicles.

Another range instrumentation potential was a 2,500 mile range from Fairbanks through the Pacific Missile Range to the AFFTC. Still another was a straight-line 2,300 mile range from Cape Canaveral. But the most important was a 4,100 mile straight-

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2. Long Range Plan, p. 71.
3. Ibid., p. 229.

line range southward to the Easter Islands that would close the southern exposure which could tempt Russia to use lifting re-entry vehicles for flights over the United States. By extension of the AFFTC existing space positioning, data communications, data processing and computing, and airspace and traffic control facilities, the 360 degree range complex could be established with a minimum of expense.

Bioastronautics Capability

Research, development, test, and evaluation of manned aerospace systems would necessitate concentration upon associated bioastronautic problems. The AFFTC with a bioastronautic mission would be compelled to assure that life-environmental systems and equipment were functional and reliable. In addition, the AFFTC would require facilities to determine proper selection and thorough training of prospective aerospace crew members. Simulation facilities at the AFFTC could be expanded to demonstrate 100 percent life-environmental functional reliability prior to and during future space operations.[4] This same facility would include a centrifuge incorporating a "six degrees of freedom" analogue computer which would demonstrate closed-loop, pilot controlled, dynamic simulations for aircrew training.

The present AFFTC physiological training facility would be expanded to include a biological laboratory, chemical laboratory, radiation laboratory, flight surgeon's office, crew quarters,

4. Hq AFFTC Study: (U) AFFTC Looks to the Future 1961 - 1976. Prepared by the DCS/Plans and Operations, AFFTC.

dining facilities, recreation area, physical conditioning equipment, flight simulator, maintenance shop, decontamination, and physiological data monitoring equipment. Departing and returning aerospace mission crews would be quartered in the Bioastronautics facility for extensive examination, briefing, and screening. (End of SECRET).

Aerospace Environmental Complex

([redacted]) Development and testing of manned orbital and space vehicles at the AFFTC also would generate the need for a large space environmental facility. Separate testing of system components under single or reduced environments and a summation of individual test results to determine the simultaneous effect of all environments upon a complete system, as performed in the past, presented critical problems. Headquarters USAF recognized the need for a single facility which would support development and test of complete military aerospace systems. USAF already had studied designs where all vehicle systems such as guidance, propulsion, control, communications, reconnaissance, and life support could be operated at one time in an environmental facility.[5] Basically, the facility would consist of a 200-foot in diameter vertical cylinder about 170 feet high with several airlock chambers located around the main chamber. A facility of this nature would enable an aircrew to make simulated space flight in the actual test vehicle, perform tests and training,

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5. Long Range Plan, p. 224.

practice rendezvous with another vehicle, and practice external vehicle repairs. (End of CONFIDENTIAL)

USAF Experimental Flight Test Pilot School

([redacted]) This school located at the AFFTC included an aerospace research pilot course which was designed to provide experienced test pilots with unique and extensive training to qualify them for spacecraft testing. Training was concentrated in academic, simulator, flying, and bioastronautics, with possibilities for extension from actual flight training into spacecraft flight conditions by use of the aforementioned Aerospace Environmental Complex. Bioastronautic training in the alien space environment and the physiological stresses generated by large acceleration, pressure, and temperature variations would be given in the AFFTC Bioastronautic facility and like facilities at other locations.[6]

Perhaps the greatest problem over the next 15 years schoolwise would be the acquisition of course instructors and suitable space trainers. The problem of obtaining highly qualified graduate instructors to teach engineering subjects related to aerospace design and testing should resolve itself as the course progresses and graduates become available for instruction of others. However, the problem of simulators and space trainers probably would be more acute and be with the school for an extended period of time.

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6. Ibid, p. 11.

Deployable Aerodynamic Decelerator Applications

Mission of the AFFTC's 6511th Test Group (Parachute) El Centro, California, was the development testing of aerodynamic retarders and development of parachutes, parachute components, and parachute techniques. Currently, development and testing of deceleration devices ran the gamut from the smallest parachutes, SAMOS air-to-air pick-up system, to recovery systems for loads over 41,000 pounds. Parachute test facilities "in-being" included an instrumented land range capable of handling tests to speeds of Mach 3 at 100,000 feet along with technical support facilities. Parachute test requirements already documented dictated need for addition of a water recovery capability at Salton Sea near El Centro. Test requirements also indicated justification for an extension of the present capability to speeds of Mach 9 with loads of 500,000 pounds and altitudes to 250,000 feet.

Anticipated future development and testing of deceleration devices for terrestrial space recovery and small retarders for landing packages on lunar surfaces would demand rocket launching facilities to carry test loads deeper into space. Expansion of the present parachute test facility through 1976 would also give the USAF a capability to lower instrumented packages, supplies, or personnel from solar space to the surface of a planet, moon, or astroid.[7]

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7. Long Range Plan, p. 42.

Solid Rocket Captive Test Facility

Modification of present test structures and extension of existing facilities at the AFFTC would provide with minimum funding a capability for static firing of motors with thrusts up to 10 million pounds. Addition of a space environmental rocket propulsion test facility would overcome technological problems such as effects of space upon propulsion systems including start and restart, propellant storability, tank insulation, propellant flow control, and propellant venting. Development of nuclear rockets for military application would also fall under the technical supervision of the Edwards AFB rocket propulsion capability.[8] (End of [redacted]

Although the solid rocket captive test facility remained at Edwards AFB, administrative management responsibility transferred to the Space Systems Division, AFSC, effective 1 July 1961.[9] However, the AFFTC was charged with support of Space Systems Division rocket and missile propulsion effort.

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8. Ibid., p. 125.
9. Hq AFSC SO G-27, 19 May 1961. Appendix I.

Chapter 4

DIRECTORATE OF ROCKET PROPULSION

Realignment of the Air Force command structure on 1 April 1961 in which the Air Research and Development Command lost its identity and the Air Force Systems Command (AFSC) came into being also had its impact on the Air Force Flight Test Center (AFFTC). In just three months the AFFTC lost its Directorate of Rocket Propulsion to the Space Systems Division. Effective 1 July 1961, the 6510th Test Group (Missile), administrative unit of the Directorate of Rocket Propulsion, was designated the 6593rd Test Group (Development) and transferred to the Space Systems Division, Deputy Commander (AFSC) for Aerospace Systems.[1] Transfer came about under AFSC's command philosophy that each of its divisions would control development testing and resources within its particular functional area of responsibility. Although the AFFTC would support Space Systems Division's 6593rd Test Group (Development),[2] the AFFTC would no longer be charged with an unmanned weapon systems mission.

Transfer of the unmanned weapon systems mission was a major loss to the AFFTC for the missile static test capability had a preponderant influence on United States rocket and missile technology during the past decade. In cooperation with and in

1. Hq AFSC SO G-27, 19 May 1961. Appendix I. Also see Hq AFSC Operations Order 61-4, 1 April 1961.
2. Hq AFSC SO G-27, 19 May 1961. Appendix I.

support of industry, the AFFTC captive tested missiles and rockets at Edwards AFB to prove their capabilities for effective free-flight prior to launch at the Air Force Missile Test Center (AFMTC). In addition, the missile static test facility investigated rocket and missile sub-systems like those which failed in free-flight. This was especially significant since it was prohibitive cost-wise to continue free-flight firing multi-million dollar missiles to determine cause of small-cost component failures. Moreover, propellant investigations conducted by the Directorate enhanced the state-of-the-art by introducing new storable exotic fuels.

Genesis of the Directorate

The AFFTC missile static test capability originated as long ago as 1950 when in August Colonel Albert Boyd, USAF, organized a Rocket Branch at Edwards AFB as a part of the Engineering Section, Directorate of Experimental Flight Test and Development.[3] However, requirement for a static test facility for high-thrust rocket engines was first considered by the Power Plant Laboratory at Wright Patterson AFB in 1946. Following considerable study a decision evolved that this facility should be government owned and operated to prevent giving a single contractor exclusive advantages to U.S. Air Force contracts for high-thrust rocket and missile engines.[4]

In 1947 Power Plant Laboratory planners chose a site on Leuhman Ridge at Muroc Army Air Base (Edwards AFB) as the

3. Hist of the AFFTC, Jul - Dec 1953, p. 150.
4. Hist of the AFFTC, Jul - Dec 1952, p. 474.

appropriate location for an experimental rocket engine test station. The site chosen was remote with plenty of usable land area, it was a natural area terrain-wise for rocket and missile gantry construction, and it was isolated--a must because of noise, danger of explosions, and the toxic nature of missile and rocket propellants.[5]

Contract for initial design and construction was awarded to the Aerojet Engineering Corporation of Los Angeles in April 1947. Design and construction of non-technical facilities was accomplished through the U. S. Corps of Engineers.[6] These agencies began their work in November 1949 and finished in early 1952. Completed work included two static test stands (1-3 and 1-5 at 400,000 pounds thrust rating each) for rocket engines, a control station (1-7), and propellant storage facilities. Basic utilities included water wells, water storage and distribution, electrical power, and roads. Support items included an administration building, a fire and first aid station, warehouses, a motor pool, and an installation maintenance building. Cost of the initial rocket engine test complex was $5,000,000.[7]

Back in 1950 when Colonel Boyd established a Rocket Branch, he named Richard F. Compertz to head the new element. Gompertz retained the Rocket Branch and its successors

5. Photographic Hist of the Rocket Engine Test Laboratory, Jan 1952 - Sep 1957, Tab A.
6. Hist of the AFFTC, Jul - Dec 1952, p. 474.
7. Photographic Hist of the Rocket Engine Test Laboratory, Jan 1952 - Sep 1957, p. 41.

until 1 February 1958 when he was replaced by Colonel Harold W. Norton, USAF.[8] The Rocket Branch moved into its administration building at the rocket test site on 28 January 1952 to mark the beginning of operations for the experimental rocket engine test station.[9] Strength at this early date was six officers, seven airmen, and 25 civilians.

From the very beginning, management and technical direction of the experimental rocket engine test station was accomplished by the Rocket Branch. The Branch mission was to:[10]

> accomplish research, development, and static testing of experimental and production rocket power plants, provide contractors and other government agencies with facilities and engineering assistance in research, development, and testing of experimental rocket power plants; perform liquid rocket propellant servicing operations for aircraft and provide engineering and consultation service for AFFTC activities using rocket engines and their components.

First full scale hot test firing of a major liquid rocket engine was performed on 26 February 1953 when an Aerojet engine for the BOMARC missile was fired for 32 seconds on Test Stand 1-5 to develop 35,000 pounds of thrust.[11] The firing was made under Project MX-1599 (later identified as WS-200A). Modifications to the BOMARC engine were tested until February 1958.

Second major task for the Rocket Branch and its new experimental rocket engine test station was Project MX-770 (later changed to WS-104A) which began in March 1953 on Test

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8. Hq AFFTC GO 2, 30 Jan 1958.
9. Hist of the Rocket Branch, Jan 1953.
10. Hist of the AFFTC, Jul - Dec 1952, p. 474.
11. Hist of the Rocket Branch, Feb 1953.

Stand 1-3.[12] This was Rocketdyne's NAVAHO missile booster engine which was fired on 3 March, 5 March, and 9 March 1953. NAVAHO booster engine tests continued on an average of 25 per month until June 1956 when the Project ended after 567 static rocket engine firings.[13]

In 1953 also, preparation for ATLAS ballistic missile tests was undertaken by the Rocket Branch.[14] Project identification was MX-1593 (later 107A), a project that would enlarge and expand the experimental rocket station far beyond the aims of early facility planning. The most immediate impact was the pointing up of facility deficiencies and a lack of unified policy throughout the Air Force in the operation, utilization, and future planning for the experimental rocket engine test station. In conference with Air Research and Development Command (ARDC) and the Wright Air Development Center (WADC) on 19 March 1953, the AFFTC sought clarification of the role the rocket test station would play in future events in order that an intelligent presentation could be made to Congress for essential facility construction funds.[15] Even at this early date it was clear that the experimental rocket engine test station had too little to satisfy industry's requirements for rocket and missile engine testing. It is especially significant to note here that the purpose of the ATLAS missile program test was to develop a complete rocket power plant and missile propulsion system.

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12. Hist of the Rocket Branch, Mar 1953.
13. Hist of the AFFTC, Jan - Jun 1956, p. 145.
14. Hist of the AFFTC, Jan - Jun 1957, p. 191.
15. Hist of the Rocket Branch, Mar 1953.

In mid-April 1953, the Aerojet General Corporation, Consolidated Vultee Aircraft Corporation (later the Convair Division, General Dynamics Corporation), North American Aviation, the WADC Fighter and Bombardment Section and Power Plant Laboratory, and the AFFTC reached agreement that the only means of conducting the vast ATLAS test program within schedule limitations and on limited facilities of the AFFTC Rocket Branch was multiple utilization of test stands initially. This would be accomplished by establishing additional test locations on Test Stands 1-3 and 1-5.[16]

In 1954, a new side test position (1-3B) was added to Test Stand 1-3 by the Apex Steel Corporation.[17] First Rocketdyne hot firing of the ATLAS single engine test vehicle for research and development was performed 10 November 1954.[18] These were preliminary attempts, however, only to get the Convair built ATLAS test underway. Several new test stands would be needed to accomplish the task properly. The new stands would become Test Stand 1-A, 1-1, 1-2, and 1-4 and control station 1-6, all under study and design in 1953 and 1954.

Test Stand 1-A was foremost of the new facilities. With 1,000,000 pound thrust capacity, Test Stand 1-A was the first stand ever designed to accommodate a complete intercontinental ballistic missile (ICBM). Final drawings and specifications were

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16. Hist of the Rocket Branch, Apr 1953.
17. Hist of the Rocket Branch, Oct 1954.
18. Hist of the AFFTC, Jan - Jun 1957, p. 192.

prepared by the Ralph M. Parsons Company in November 1954.[19] G. A. Fuller Construction Company was awarded the construction contract by the Corps of Engineers on 31 March 1955 and ground breaking for Test Stand 1-A was held 10 May 1955.[20] Test Stand 1-A facility complex including fabrication and erection of the missile adapter and tower was completed in November 1956.[21] First flight weight firing of the ATLAS, a test to check the compatibility of engines, airframe, test facility, and personnel familiarization, was made on 5 March 1957.[22] Test Stand 1-A thus became the first test position in which the complete ATLAS missile system could be tested.

On 27 March 1959, an ATLAS missile exploded during a captive test destroying Test Stand 1-A[23] The stand was not repaired for the ATLAS program but transferred to the National Aeronautics and Space Administration (NASA) for the F-1 rocket engine of 1,500,000 pounds thrust being developed by Rocketdyne for use in space exploration.

In the meantime since the first firing of the ATLAS in 1954, facility development at the rocket engine test station was bursting forth in all areas as a result of Air Force requirements to provide captive flight test facilities for both ICBM and intermediate range ballistic missiles (IRBM). Between January 1955

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19. Hist of the Rocket Branch, Nov 1954.
20. Hist of the Rocket Engine Test Lab, May 1955.
21. Hist of the AFFTC, Jan - Jun 1957, p. 159.
22. Hist of the Rocket Engine Test Lab., Mar 1957.
23. Hist of the AFFTC, Jan - Jun 1959, p. 123.

and October 1957, over $40,000,000 was spent for build-up on a crash basis.[24]

Expansion of Rocket Branch activities also affected unit capability to do the job. By late November 1954 it became apparent that reorganization was essential to operate effectively. On 8 November the Rocket Branch, Engineering Section, Directorate of Experimental Flight Test and Development, became the Rocket Engine Test Laboratory.[25] Reorganization placed the rocket engine test station on an operating level directly under the Commander, AFFTC. The new Rocket Engine Test Laboratory now took on the appearance of a major organization.[26]

Mission of the Laboratory at the time was to:[27]

> perform administration for all phases of the rocket engine test station; plan and monitor development and construction of facilities; perform liaison between the AFFTC and Air Force rocket engine and missile contractors; conduct tests required by the AFFTC; and support contractors utilizing the test stands and back-up facilities.

Contractors were North American Aviation with its NAVAHO surface-to-surface missile; Aerojet General with the booster rocket for BOMARC; Convair Division, General Dynamics Corporation, with the ATLAS ICBM; and the Rocketdyne Division, North American Aviation, with engines developed for the ATLAS but used with the THOR as well.

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24. Hist of the AFFTC, Jan - Jun 1957, p. 157.
25. Hq ARDC GO No. 76, 1 Nov 1954.
26. RETL Organization Chart, 9 Dec 1954. Appendix J.
27. Hist of the AFFTC, Jan - Jun 1958, p. 200.

Besides reporting to the Commander AFFTC, the Rocket Engine Test Laboratory (RETL) reported to WADC, Headquarters ARDC, and to the Western Development Division, Inglewood, California, an organization headed by Brigadier General Bernard A. Schriever which would later become the Air Force Ballistic Missile Division.[28]

Next major test project initiated at RETL following ATLAS was the Douglas Aircraft Company THOR IRBM designated WS 315A. THOR began with a letter from the Ballistic Missile Division (BMD) on 7 January 1956, rocket engine installation started on 6 July 1956, and the first Douglas operated firing of THOR was accomplished on 27 August 1956.[29] THOR testing continued by Douglas with support from RETL until June 1959.[30] However, an Air Force "in-house" evaluation of the THOR IRBM was performed in 1959 and 1960.[31]

Concerning Air Force "in-house" testing of missiles, it had long been a desire of ARDC that the Air Force participate in development testing of guided missiles in the same fashion as development testing of aircraft. This new concept for missile testing first came to light in July 1956 by letter from Major General Bernard A. Schriever, Commander, AFBMD to Brigadier General S. J. Holtoner, USAF, Commander, AFFTC.[32] "In-house" was given some support in April 1958 when the ARDC Commander, Lieutenant General Samuel E. Anderson, wrote the AFFTC Commander,

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28. Ibid.
29. Hist of the AFFTC, Jan - Jun 1957, p. 194 - 195.
30. Hist of the AFFTC, Jan - Jun 1959, p. 141.
31. Hist of the AFFTC, Jan - Jun 1959, p. 134.
32. Hist of the AFFTC, Jan - Jun 1958, P. 201.

Brigadier General Marcus F. Cooper, that ARDC had long recognized the value of an AFFTC capability to evaluate and test ballistic missiles. General Anderson also outlined a few procedures to be followed in achieving such a goal and designated Test Stand 1-5 as the facility on which to begin training.[33]

Colonel Harold W. Norton replaced Richard F. Gompertz as Chief of the Rocket Engine Test Laboratory on 1 February 1958 as previously noted in this chapter. On 26 May 1958, Colonel Norton reorganized the Rocket Engine Test Laboratory to create an Air Force "in-house" missile evaluation capability. Under reorganization, the Rocket Engine Test Laboratory was raised to the directorate level and became the Directorate of Missile Captive Test. Colonel Norton was designated as Director.[34] Assigned strength on 30 June 1958 was 44 officers, 142 airmen, and 386 civilians. Yet Colonel Norton was faced with manpower shortages for his new "in-house" testing concept.[35] The new mission for the Directorate of Missile Captive Test was to:[36]

> Direct the research, development, and evaluation required in the performance of Air Force Flight Test Center captive evaluation testing of missile systems and components; direct the accomplishment of technical and logistical support to missile contractors conducting tests at the Air Force Flight Test Center; and direct the study of test methods and facilities needed to accomplish potential future mission responsibilities.

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33. Ibid.
34. Ibid, p. 203.
35. Ibid, p. 206
36. Hq AFFTC Organizational and Functions Chart No. 24, 26 May 1958.

Despite reorganization and new mission statements, the AFFTC Air Force "in-house" program lagged over the next 12 months. Lack of firm directives for accomplishing "in-house" work hampered programming, and lack of facilities due to contractor THOR and ATLAS tests deterred the program. Moreover, there was a continual struggle to justify additional manpower for valid authorization had not been provided by high headquarters.[37] It was not until May 1959 that additional authorizations came through for "in-house" test programs.[38] Finally, "in-house" capability was achieved during the autumn of 1959 and an all Air Force crew began captive environmental follow-on testing of the THOR.[39]

Prior to the start of "in-house" missile testing, however, organizational changes occurred which again changed the name, mission, and organization of the Directorate of Missile Captive Test. Effective 1 July 1959 the 6510th Test Group (Missile) was organized[40] to alleviate a management and personnel problem (administration and reporting) at the Directorate of Missile Captive Test.[41] On the same date, responsibility for rocket propulsion and development was transferred from the Wright Air Development Center, Wright-Patterson AFB, to the AFFTC.[42] This move was made to consolidate the Air Force's

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37. Hist of the AFFTC, Jan - Jun 1958, p. 206.
38. Hist of the AFFTC, Jan - Jun 1959, p. 136.
39. Hist of the AFFTC, Jul - Dec 1959, p. 201 and Jul - Dec 1960, p. 175.
40. Hq ARDC GO No. 60, 24 Jun 1959.
41. Hist of the AFFTC, Jan - Jun 1959, p. 124.
42. Hq ARDC GO No. 55, 19 Jun 1959.

propulsion development effort at the AFFTC, increase AF influence and participation in the ARPA and NASA propulsion programs, and expedite rocket propulsion development by uniting the WADC function with the AFFTC rocket and missile test facilities.[43]

The Directorate of Missile Captive Test was redesignated the Directorate of Rocket Propulsion and Missiles on 13 July 1959 and its mission restated to harmonize with its added functions. Revisions changed the mission to read:[44]

> Direct research and development of complete rocket propulsion systems and components as well as ground service equipment in support of the Air Force mission. Direct evaluation and development testing in support of research and development. Direct evaluation testing of complete missile systems and components. Provide technical and logistic support to Air Force contractors. Direct studies of test methods and facilities needed to accomplish future mission responsibilities.

It was obvious in 1958 and 1959 from both the changing mission statements and the development of an Air Force "in-house" rocket and missile test capability that the Directorate was undergoing a transition to Air Force development and test of contractor's weapons. The reason for this transition was also obvious: it would provide the Air Force with an inspection system capable of determining the quality of contractor products from a military standpoint, and it would provide ARDC with a facility to obtain knowledge needed to direct contractors in their missile development efforts.[45] Transition to "in-house"

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43. Hist of the AFFTC, Jan - Jun 1960, p. 171.
44. Hq AFFTC Organization and Functions Chart No. 24-A, 13 Jul 1959.
45. Hist of the AFFTC, Jan - Jun 1959, p. 134.

rocket and missile propulsion evaluations continued to expand, but transition to "in-house" complete rocket and missile weapon systems testing was short-lived.

Immediately following the ATLAS and THOR contractor captive testing, Boeing Airplane Company began moving into the Directorate of Rocket Propulsion and Missiles facility for test of the Boeing built MINUTEMAN ICBM designated WS-133A. Preliminary development of test procedures and actual testing of silo launchers was undertaken by the Directorate back in 1958.[46] MINUTEMAN flame deflector development was also accomplished by the Directorate in 1958[47] and a one-third scale silo launcher development program was conducted in 1958 and 1959.[48] First firing of the one-third scale MINUTEMAN was 17 February 1959. Boeing arrived in force by spring and officially took over the project on 15 May 1959 after Directorate personnel had performed four successful firings.[49]

By mid-1960 after one year of spreading its capability over three functional areas (missile systems testing, engine component testing, and propulsion development), the Directorate of Rocket Propulsion and Missiles became the Directorate of Rocket Propulsion on 1 July 1960 and was reorganized again. One of the primary changes was deletion of missile systems testing from the mission statement. The new mission read:[50]

46. Hist of the AFFTC, Jul - Dec 1959, p. 193.
47. Ibid, p. 196.
48. Ibid, p. 199.
49. Ibid.
50. Hist of the AFFTC, Jan - Jun 1960, p. 166.

> Directs the research and development of complete rocket propulsion systems and components as well as ground service equipment in support of the AF mission. Directs the evaluation and development testing in support of research and development. Directs evaluation testing of rocket engines and components. Provides technical and logistic support to AF contractors. Directs studies of test methods and facilities needed to accomplish future mission responsibilities.

With the mission clearly defined, three divisions (liquid systems, solid systems, and propellant) were organized to support it.[51] Each of the divisions was responsible for activities with industry and exploratory testing "in-house".

Events leading up to re-direction of the mission were numerous. But one of the major reasons was couched in the Directorate's inability to sustain further "in-house" missile systems testing at the AFFTC and Directorate level. The USAF had hesitated to announce firmly that missile testing "in-house" was authorized, and the Directorate found this reluctance to approve projects for "in-house" missile evaluation made it extremely difficult to obtain funds, manpower, and materials.[52] Another reason for re-directing its mission effort was the Directorate's lack of trained personnel to continue missile systems testing. And not to be overlooked was duplication of contractor effort when the Directorate became involved with missile systems testing.[53] Without Air Force and command support, it was best to delete or minimize missile systems testing and concentrate on rocket propulsion development.

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51. Ibid, 169.
52. Ibid, 167.
53. Ibid.

[redacted]

The Directorate of Rocket Propulsion continued to support contractors in their rocket and missile evaluations. Areas of primary interest for contractor support were performance, durability, reliability, determination of safety criteria, and hazard classifications. But in the majority, Directorate of Rocket Propulsion effort was devoted to propellant and propulsion system research and development. Propulsion development included many areas such as the development and testing of high energy fuels, component testing, and "thinking and developing propulsion systems" in advance of contractors.[54] Out of this advanced thinking or applied research had come the Joshua Project and the Mojave Concept.

([redacted]) The Mojave Concept, actually paper proposals, was prepared originally for lightweight, unguided, single-stage ballistic missile systems capable of delivering 140-pound payloads 6,100 nautical miles or 350-pound payloads 6,460 nautical miles. Size of these missiles would permit their installation beginning in 1962 at missile sites with a minimum of interference to ATLAS, TITAN, and MINUTEMAN programs. Estimates of development costs excluding payload was $28,000,000 for the smaller and $48,000,000 for the larger. One-thousand missiles and launchers less payloads could be manufactured for an estimated $106,515,000 (short range) and $255,544,000 (long range). In theory the Mojave missile was a king-size mortar. It would

54. Hist of the AFFTC, Jul - Dec 1960, pages 166-177.

[redacted]

launch from a tube in a spinning attitude and fire in a ballistic trajectory.[55] The Directorate's proposal was supported by the Ballistic Missile Division and then went forward to Headquarters USAF for additional study and possible funding.[56]

In the meantime, engineers at the Directorate continued to refine their Mojave Concept theories. Their final proposal was a three-stage missile with a solid propellant cluster and flare and fin stability. It would be 40 feet long and weigh 16,000 pounds. Thiokol furnished an analysis for the solid propellant and Douglas Aircraft Compamy (Charlotte Division) prepared a design for the proposed missile. Theoretically, its circular error probability was 24.6 nautical miles at 5,500 miles which gave it an excellent advantage for barrage effect or for use as a decoy with the MINUTEMAN. Estimates by the Directorate placed the cost of 1,000 Mojave missiles including development at $339,000,000.[57]

The Ballistic Systems Division (BSD) granted Directorate personnel a Mojave Concept audience on 20 June 1961. During the conference, Major General T. P. Gerrity, the BSD Commander, indicated he thought the program possessed considerable merit. But he questioned the Mojave missile reliability. As a result of this meeting and General Gerrity's comments, the Directorate implemented a 90 day feasibility study on 30 June 1961.[58](End of SECRET)

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55. Hist of the AFFTC, Jan - Jun 1960, p. 209.
56. Ibid, p. [illegible].
57. Interview by C V Eppley with Capt R. G. Dingman, Project Engineer, Advance Motor Technology Section, 6593rd Test Group, (Development), SSD, 4 April 1962.
58. Ibid.

([redacted]) Project Joshua, another lightweight missile theory, went from a propulsion study, to drawing board, to fabrication of hardware, and to testing. Fuel for the single stage missile was hydrazine and pentaborane.[59] First subscale firing was performed in December 1959 and was followed in December 1960 with a full scale firing of the 40,000-pound thrust chamber.[60]

Project Joshua was especially significant, for its progress indicated that the Air Force possessed an "in-house" capability to design and develop a missile propulsion system despite the adversities which beset the "in-house" effort previously mentioned in this chapter.

In 259 subscale firings through 30 June 1961, performance of Joshua almost achieved theoretical or 90 percent reliability, and six full scale firings to 1 July 1961 indicated a performance level just under a 90 percent goal established by the Directorate.[61] (End of [redacted]

Personnel Assigned 1952 - 1961

Richard F. Gompertz, as chief of the Rocket Branch in September 1950, became the first person assigned and the only individual assigned until early 1951. By 30 June 1952, Rocket Branch personnel numbered six officers, 18 airmen and 44 civilians. From that time on until 1957 there was little change in

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59. Hist of the AFFTC, Jan - Jun 1960, p. 185.
60. Interview by C V Eppley with E G Haberman, project engineer, Rocket Propulsion Div., 6593rd Test Group (Development), SSD, 4 April 1962.
61. Ibid.

the number of personnel as depicted in the following chart:

As of 30 June	Military	Civilian
1953	28	60
1954	32	82
1955	45	105
1956	9	45
1957	165	211
1958	186	386
1959	176	410
1960	371	503
1961	294	442

Personnel build-up for Air Force "in-house" missile research, development, and testing began in late 1957 and carried over into 1958 as shown. Another factor contributing to personnel increases after 1956 was the increased number of engine and missile contractors occupying newly completed facilities. Each contractor was supported by AFFTC personnel. Major contractors in 1957 were North American Aviation with the NAVAHO missile, Aerojet General with the BOMARC booster, Convair with ATLAS ICBM, and Rocketdyne with engines for the ATLAS and THOR missiles.

Cost of Operations 1952 - 1961

Prior to Fiscal Year 1960, the Directorate of Rocket Propulsion operating costs were expended in support of contractors utilizing facilities at the Directorate. Amounts expended were:

Fiscal Year	Amount	Fiscal Year	Amount
1953	$1,260,000	1957	$6,610,000
1954	1,390,000	1958	6,400,000
1955	3,300,000	1959	9,460,000
1956	5,500,000		

The Air Force began an "in-house" rocket and missile research and development program in late 1959 which reflected in Fiscal Year 1960 operating costs. Of $13,433,977 expended, $4,913,632 was spent on contractor support and $8,520,345 went towards AF "in-house" work. Approximately five million dollars of the total spent in Fiscal Year 1960 was civilian and military pay.[62]

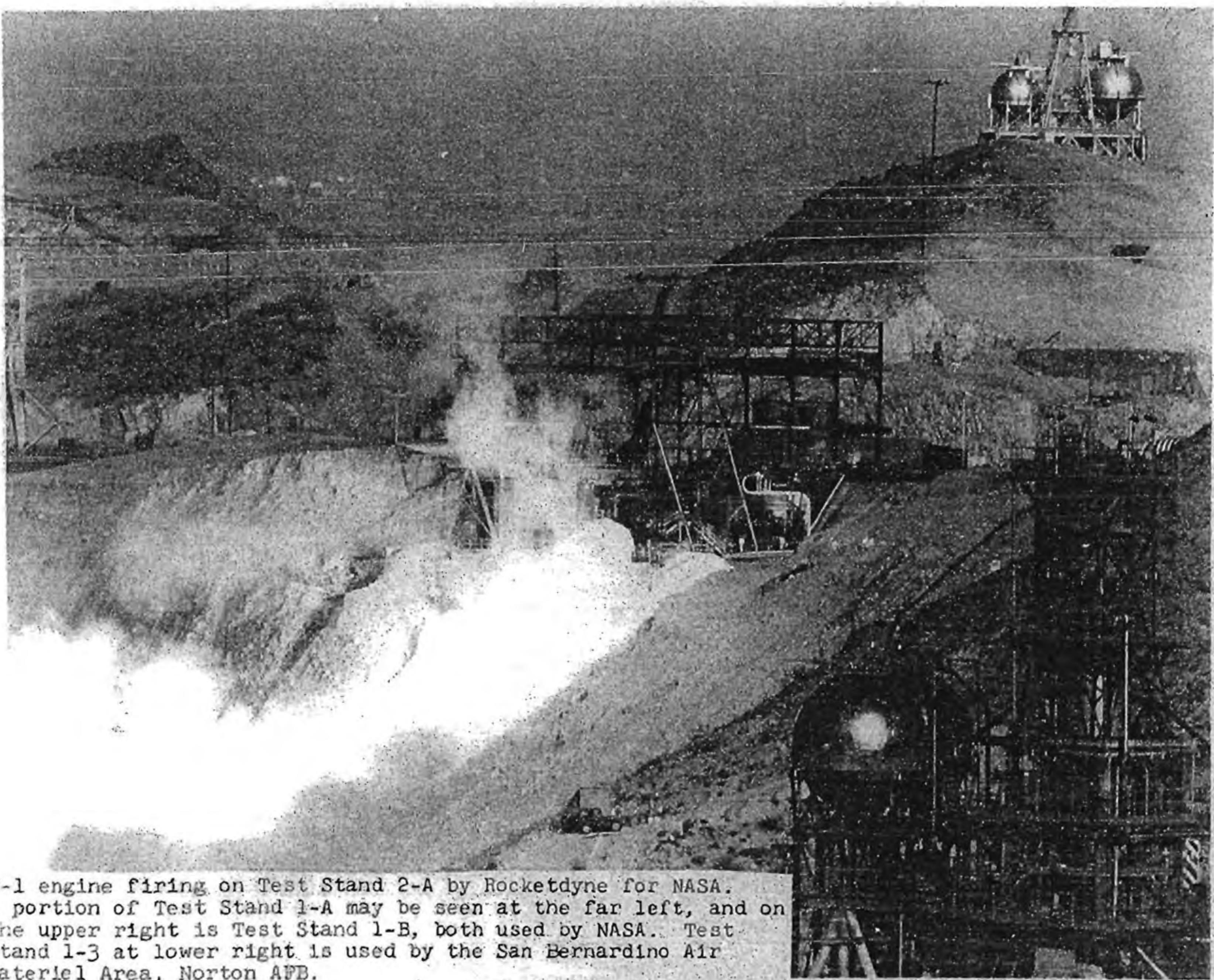
Operating costs were $16,994,693 during Fiscal Year 1961 with $5,334,432 expended in support of contractors and $11,660,261 spent for AF "in-house" effort. Military and civilian pay accounted for approximately five and one-half million dollars of the total expenditure.[63]

Expenses other than pay accrued through purchases of material and travel of personnel. It did not include cost of new facilities and modification of existing facilities.

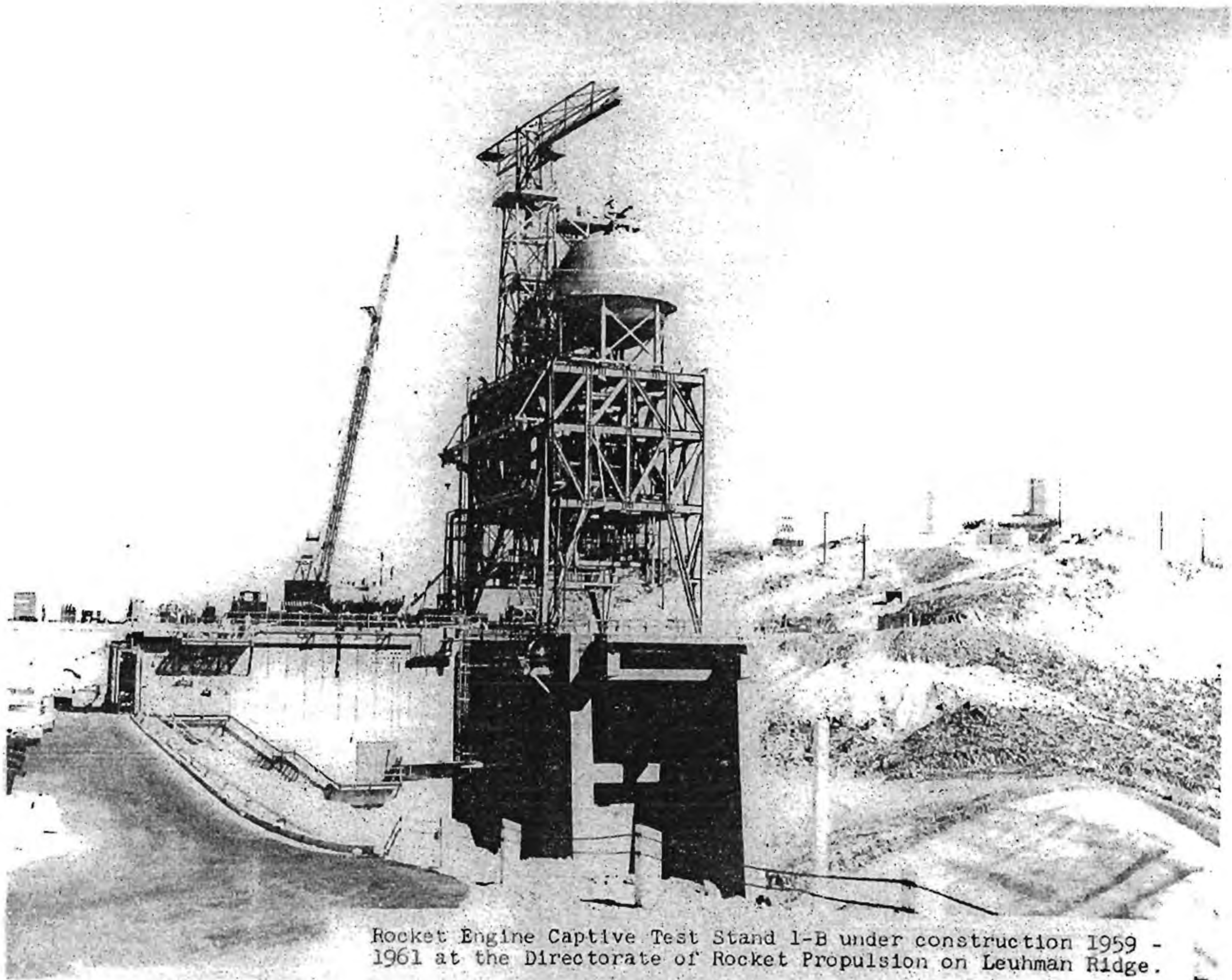
Existing Resources Summary - 1961

On 1 July 1961 when the Directorate of Rocket Propulsion was transferred from administrative management responsibility of the AFFTC to the Space Systems Division, missile test stands and

62. Extract of records maintained by the Accounting Division, DCS/Comptroller, AFFTC, by the author, Sep 1961.
63. Ibid.



F-1 engine firing on Test Stand 2-A by Rocketdyne for NASA. A portion of Test Stand 1-A may be seen at the far left, and on the upper right is Test Stand 1-B, both used by NASA. Test Stand 1-3 at lower right is used by the San Bernardino Air Materiel Area, Norton AFB.



Rocket Engine Captive Test Stand 1-B under construction 1959 - 1961 at the Directorate of Rocket Propulsion on Leuhman Ridge.

Test Stand 1-B accepted by the AF in 1961 cost $6 million to build. It was turned over to NASA for test of the 1,500,000 pound thrust Saturn F-1 engine under contract to Rocketdyne.

supporting facilities represented an investment of more than $84,000,000.[64] (See Appendix K for detailed breakdown). Missile test stands, control stations, assembly buildings, laboratories, and a liquid oxygen plant accounted for over $72,000,000 of the monetary investment while administration buildings, warehouses, communications, power, and water represented another $12,000,000. Biggest investment was reflected in 10 test stands and three control stations with each covering an investment of $1,500,000 to a high of $11,000,000 spent on Test Stand 1-A. Other than test stands and control stations, the largest investment was $4,500,000 which represented the cost of a liquid oxygen plant with a 150-ton-per-day capacity completed in July 1957.

Test Stand 1-A and its complex was badly demolished by an explosion on 27 March 1959. The ATLAS program on 1-A at the time of the accident was terminated and the Test Stand turned over to NASA along with 2-A and 1-B for test of the 1,500,000-pound thrust F-1 engine under contract to Rocketdyne. Test Stand 1-B was constructed to handle four F-1 engines or a total of 6,000,000-pounds of thrust. Construction of Test Stand 1-B began in November 1959 and the first F-1 engine captive firing followed on 10 February 1961.

Test Stand 1-1, a missile static test facility designed for testing vertically mounted, complete missile systems, had a thrust rating of 700,000 pounds. It was used in support of

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64. Hq AFFTC Long Range Plan and Program Guidance Document, 18 Mar 1961, p. 165.

ATLAS testing but was undergoing modification in 1961 for test of the NASA CENTAUR upper stage under contract with Convair. Test Stand 1-2 was also of 700,000-pound thrust capacity. However, 1-2 was equipped with an environmental test chamber capable of subjecting complete missile systems to wide variations in temperature (-35 degrees to plus 160 degrees Fahrenheit).

Test Stands 1-3, 1-4, and 1-5 were capable of withstanding thrust capacities up to 400,000, 600,000, and 400,000-pounds, respectively. All three were built for static test of vertical mounted engines. Test Stand 1-3 was equipped for two engine test positions, 1-4 could handle one, and 1-5 was modified for three test positions. Test Stand 1-3 was in the process of reliability testing of the TITAN engine, 1-4 was used in the engine reliability program for ATLAS, and Test Stand 1-5 used during THOR engine testing was now used for applied research tests of storable and cryogenic propellant engines.

Test Stand 1-21 was designed specifically for support of experimental scaled rocket engines and associated engine components. Its thrust rating was 100,000 pounds and it was capable of handling from two to six test articles. A unique feature of 1-21 was an environmental chamber capable of testing a 5,000 pound thrust engine to simulated altitudes of 125,000 feet.

Test Stand 1-40 was designed for rocket engines using pentaborane and hydrazine. It consisted of four test pads, two for 5,000-pound thrust engines each and two for 40,000-pound thrust engines each. Test Stand 1-40 was a proving ground for toxic propellants.

Control Station 1-A as the title implied was a facility for control of Test Stands 1-A, 2-A, and 1-B and for data acquisition from these stands. Control Station 1-6 performed the same function for Test Stands 1-1 and 1-2. And Control Station 1-7 performed in the same manner for Test Stands 1-3, 1-4, and 1-5.

Other facilities included Silo launch sites used in testing the Boeing MINUTEMAN and silo shops, assembly areas, and a control station; solid propellant missile test stands and a solid propellant test control room, a component test laboratory, a hazard test facility, propellant evaluation areas, spill test area, and a component processing shop.

A Directorate-operated Hydrodynamics Test Facility designed to accommodate dynamic or static tests on valves, regulators, pneumatic controls, and flow meters was included in test support facilities at the Missile Static Test Site. Protected test cells permitted use of high pressure gases and cryogenic fluids, and a water flow system provided for hydrostat checks up to 30,000 pounds per square inch. Another facility, the Laboratory Services Building, housed the

Directorate's Instrumentation Section, Photographic Section, and a Chemical and Metallurgical Laboratory.

Test support facilities also included a large industrial area. This included an extensive assembly, checkout, warehousing, and administrative complex all very essential to the Directorate in its support of various test programs. Contractors and Air Force agencies were provided with buildings, machine shops, communications service, utilities, and dining facilities. A railroad spur connected the Missile Site with the Santa Fe main line, and access roads linked with main highways in the immediate area.

Programs and Projects Transferred from AFFTC to SSD[65]

When the Directorate of Rocket Propulsion administrative mangement responsibility transferred from the AFFTC to the Space Systems Division (SSD) on 1 July 1961, twenty-nine programs and projects were involved in the transfer. SSD inherited technical management responsibility for nine programs which included UHF communications satellite booster development, nuclear rocket propulsion and engine research, liquid and solid rocket technology and propellant development, and gas generator development. Programs in support of the Ballistic Systems Division which required SSD participation were the ATLAS, TITAN, and MINUTEMAN ICBM tests and a valve evaluation project. In

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65. Transfer Agreement between Space Systems Division, DCAS (AFSC) and Air Force Flight Test Center (AFSC) for transfer of 6593rd Test Group (Development), 7 August 1961, Tab A, Operations, paragraph 2, Current Technical Programs. SD B in Vol 2, this hist.

support of the Aeronautical Systems Division, SSD also became responsible for providing administrative management of GAM 87A tests; IM-99, WS-202A, WS-208A, and the GAM-83B propulsion subsystems development; XLR-99 engine development for the X-15 research aircraft; attitude control rockets for the X-15; MB-1 motor support; cryogenic support equipment, hi-energy storable propellant equipment, and solid propellant handling equipment. Additionally, programs were transferred to SSD concerning Advanced Research Projects Agency (ARPA) solid propellant studies, the National Aeronautics and Space Administration (NASA) development and testing of the Rocketdyne F-1 engine for use in Project NOVA, support of NASA in the Convair portion of Project CENTAUR, and support of rocket scaling studies under the direction of the Office of Aerospace Research (OAR).

Chapter 5

DIRECTORATE OF FLIGHT TEST

The Directorate of Flight Test evolved from the 2759th Experimental Wing and 3077th Experimental Group which conducted flight testing at Edwards AFB for Air Materiel Command prior to 2 April 1951. On the latter date, Edwards AFB was transferred to the newly created Air Research and Development Command.[1] Nine days later, on 10 April 1951, the commander of Edwards AFB, Brigadier General Albert Boyd, USAF, established a Base Directorate, Experimental Flight Test and Engineering[2] and named Colonel Fred J. Ascani, USAF, as its chief.

As we have seen in Chapter 1, Air Research and Development Command established the Air Force Flight Test Center (AFFTC) on 25 June 1951.[3] In the same General Order,[4] the 2759th Experimental Wing and 3077th Experimental Group were discontinued and their personnel and equipment absorbed by the AFFTC and a new unit, the 6510th Air Base Wing. Also, the Base Directorate, Experimental Flight Test and Engineering was discontinued and the Flight Test and Development Division was established.

Colonel J. S. Holtoner, USAF, assumed command of the AFFTC on 18 February 1952 replacing General Boyd. Colonel Holtoner appointed Colonel Ascani Deputy Chief of Staff for Operations on 1 January 1953 and named Lieutenant Colonel Walter L. Moore, USAF, chief of the Flight Test and Development Division.[5] The Flight

1. Hq AMC GO 23, 30 Mar 1951.
2. Hq EAFB Organizational Directive 20-600.1, 16 Apr 1951.
3. Page 6, this history.
4. Hq ARDC GO 15, 21 Jun 1951.
5. Hq AFFTC GO 8, 31 Dec 1952.

Test and Development Division was redesignated the Directorate of Flight Test in February 1953. Colonel Horace A. Hanes, USAF, succeeded Colonel Moore as Director of Flight Test on 22 July 1953[6] and was replaced in turn by Colonel Royal N. Baker, USAF, on 5 August 1957.[7] Colonel Baker departed the AFFTC on 14 July 1960. Colonel George A. Kirsch, USAF, was named Director on 14 July[8] but reverted to his former position as Deputy Director on 31 July when Colonel Clay Tice Jr., USAF, became Director.[9] Colonel Tice was reassigned as Deputy Chief of Staff for Operations on 28 October[10] and Colonel Kirsch again became the Director until 14 November 1960 when Colonel Clayton L. Peterson, USAF, the present Director, was assigned.[11]

Mission

Mission of the Directorate of Flight Test was--as the name implied--the flight testing of aircraft, engines, and allied equipment and components along with supporting Air Force contractors who maintained facilities at the AFFTC. Specifically, the mission statement read:[12]

> Executes research, development, and related tests for experimental equipment in accordance with approved Research and Development programs. Executes flight test of adopted type aircraft, power plants, components, equipment, and accessories in accordance with approved programs. Conducts tests to determine the qualitative characteristics of production and in-service materiel. Performs engineering evaluation of deviations and changes applicable to such

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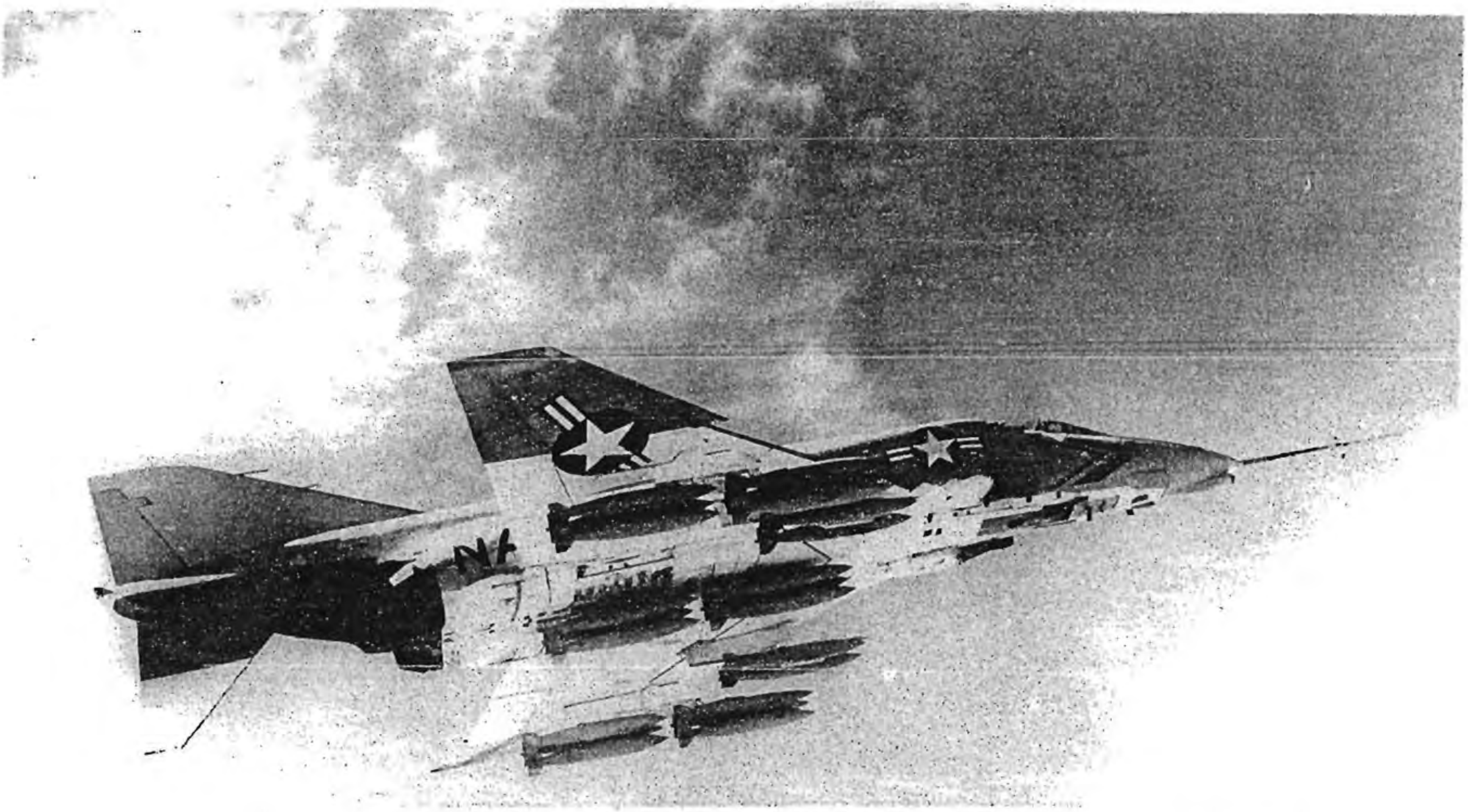
6. Hq AFFTC GO 15, 22 Jul 1953.
7. Hq AFFTC GO 15, 28 Aug 1957.
8. Hq AFFTC GO 49, 20 Jul 1960.
9. Hq AFFTC GO 51, 31 Jul 1960.
10. Hq AFFTC GO 69, 25 Oct 1960.
11. Hq AFFTC GO 71, 14 Nov 1960.
12. Hq AFFTC Organization and Functions Chart No. 20, Oct 1961. Appendix H.



Included within the mission of AFFTC are projects undertaken by other Federal departments and agencies as well as numerous industrial contractors. Pictured is the Phantom II, the Navy F4H-1F in its latest test phase with 22 - 500 pound conventional bombs. Having successfully completed all service tests, this aircraft has taken over the number one position in the Navy's stable of supersonic fighters. Equipped with two J79GE-8 General Electric engines, the Phantom II has established an impressive operational record: Sustained flight altitude of 66,443.8 ft., reached an altitude of 98,561 ft., holds the trans-continental record of 2 hr. and 47 min. plus establishment of world records on the following closed courses:

3 Kilometer --- 902.768 MPH	100 Kilometer --- 1,390.21 MPH
15/25 Kilometer --- 1,606.324 MPH	500 Kilometer --- 1,216.78 MPH

materiel, and provides technical support to the Air Force Logistics Command (AFLC), and other major commands as required. Takes action, within the scope of the AFFTC mission, to effect continuous improvement of the functional quality of materiel. Controls and operates special test programs as directed. Supports such contractor activities as may be established at the AFFTC, and administers and supervises such contractor operations as directed.

Organization

Under the Director, Colonel Peterson, the Directorate of Flight Test was organized to include a technical director, program management office, T-39 aircraft test force, B-52H aircraft test force, B-70 test force, a technical support division, flight test operations division, flight test engineering division, and headquarters squadron section of the 6512th Test Group (Aircraft). Within each of the three divisions were several operating units. The Technical Support Division was made up of an aerospace data facilities office, administration office, and seven branches: photography, instrumentation, aerospace data systems, space positioning, technical support supply, propulsion, and experimental track. Both the Propulsion Branch and the Experimental Track Branch are discussed as separate chapters (7 and 8) later in this history.

The Flight Test Operations Division was broken down into four branches, fighter operations, bomber-transport operations, special projects operations, and support projects operations. Flight Test Engineering consisted of a manned spacecraft engineering office, performance engineering branch, operational engineering branch, flight research branch, and a bioastronautics branch.

Headquarters Squadron Section, 6512th Test Group (Aircraft), was the unit organized for administering personnel assigned to the

Directorate of Flight Test and for reporting purposes. The 6512th was organized and assigned to the AFFTC 1 July 1959.[13]

Personnel

Personnel assigned to the Directorate of Flight Test on 30 June 1961 numbered 971. Of this total, 197 were officers, 241 were airmen, and 533 were civilians. A detailed breakdown by major division follows:[14]

	OFFICERS		AIRMEN		CIVILIANS	
	Auth	Asgd	Auth	Asgd	Auth	Asgd
Hqs of the Directorate and Test Forces	19	28	12	12	19	16
Flt Test Engr Div	54	54	39	37	57	59
Flt Test Oper Div	39	45	20	18	8	8
Tech Support Div	22	24	126	174	453	450
TOTALS	134	151	197	241	537	533

Facilities and Equipment

As manager of the Directorate of Flight Test, Colonel Peterson was concerned with materiel as well as manpower. The Technical Support Division represented an investment of nearly $35,000,000 in radar, timing, telemetry, data reduction, space positioning, and instrumentation equipment with additional supplies and equipage running about one-tenth annually as much as the total investment.[15] The Technical Support Division's Experimental Track Branch facility and equipment added another

13. Hq ARDC GO 60, 24 Jun 1959.
14. Extract of records (Distribution of Civilian and Military Personnel) prepared by the Manpower and Organization Div. (FTOM), DCS/Plans & Operations, AFFTC, 21 June 1961.
15. Hist of the AFFTC, Jul - Dec 1960, p. 88.

$14,000,000, the Photographic Branch equipped with cameras and allied equipment was valued at approximately $2,000,000, and resources of the Propulsion Branch exceeded $5,000,000. In fact, when facilities and resources of the Flight Test Engineering Division and the Flight Test Operations Division were added to those of the Technical Support Division, the monetary value of AFFTC facilities utilized in direct support of the flight test mission rose to nearly $75,000,000.[16]

Aircraft Flight Test Procedures

The Directorate of Flight Test substantially contributed to the missions of the AFFTC, AFSC, and the USAF during the past decade by conducting aircraft flight tests and preparing test results which vitally influenced performance, stability, control, and other engineering design changes on every aircraft from the P-80 to the B-58. However, there were many problems which had to be dealt with from time to time including one that continued to plague the Directorate. This continuing problem was the result of USAF change from Phase to Category Test Concept in 1958 that levied additional test missions and test resources requirements upon the AFFTC which were difficult if not impossible for the Directorate to meet.[17]

Prior to 1958 under the Phase I through VIII Test Concept, the Directorate determined performance, stability and control, and functionally tested individual aircraft systems and armaments. Complete strategic, tactical, and air defense weapon system tests

16. Hq AFFTC Long Range Plan and Program Guidance Document, 18 Mar 1961, p. 179.
17. Ibid, p. 178.

were conducted by other AFSC test centers. The Directorate of Flight Test functional tests of armament systems were conducted only to determine fire-out rates, bomb system accuracy and reliability, rocket system jettison reliability, and rocket or missile blast effect on launching aircraft. Only rarely was weapon system accuracy and kill potential determined.

In 1958, AFR 80-14 which outlined Phase Test procedures was revised to introduce the Category I, II, and III concept of testing. Category testing was implemented to achieve weapon system development economy through consolidation of testing, to compress development time and achieve an earlier introduction of the weapon system into the AF inventory, and to improve development effectiveness through integrated testing.

Air Force Systems Command assigned responsibility for complete Category II aircraft testing to the AFFTC by AFSCR 23-4. In April 1960, AFSC specifically included development testing of Bomb-NAV Fire Control Systems as an AFFTC responsibility. And this was the crux of the problem, for AFR 80-14 required that Category II test objectives "demonstrate in as realistic and complete an environment as practicable that the whole system is functionally operative, operationally effective, and compatible with the other systems and supporting equipment required for its operational employment". Furthermore, AFR 80-14 Category II test objectives were to "determine if the system is capable of, and suitable for, meeting the established

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requirements and design objectives". Yet AFSC directives required the AFFTC fully utilize existing resources within the AFSC to effect test economy and prevent duplication.

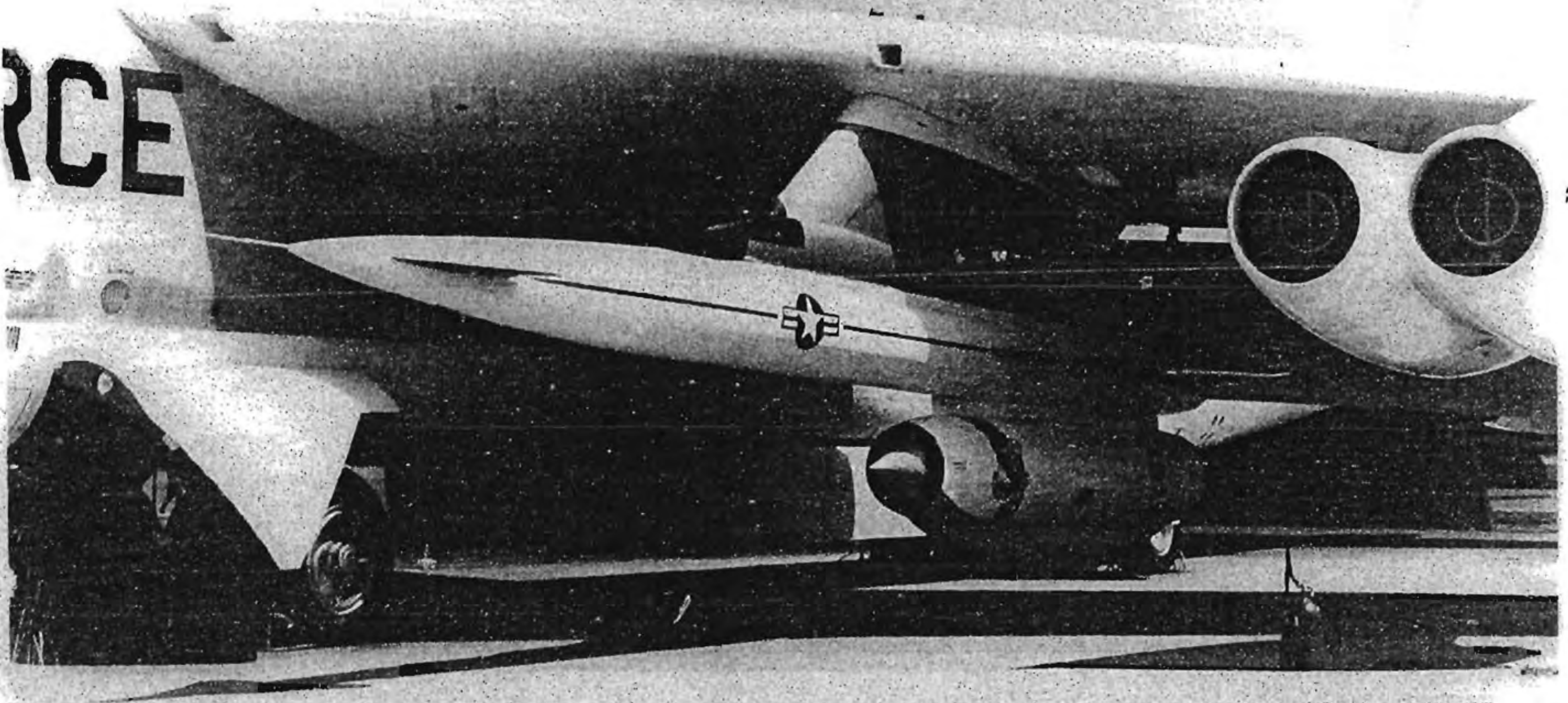
Obviously the AFFTC Directorate of Flight Test could not conduct integrated weapon system Category II tests with the present guided aircraft missile mission assigned to Air Proving Ground Command and the guided aircraft rocket mission assigned to the Air Force Missile Development Center.[18]

When concurrent or subsequent tests on the same weapon systems were conducted at and by other AFSC Centers, AFR 80-14 development objectives of economy, time compression, and integrated testing were negated. Moreover, this division of manned weapon system test responsibility among AFSC Test Centers relegated the Directorate of Flight Test to functional weapon system tests at the AFFTC the same as before revision of AFR 80-14 in 1958. About the only way the Directorate of Flight Test could accomplish its mission and achieve AFR 80-14 objectives was for AFSC to assign the complete manned weapon system test mission to the AFFTC along with necessary supporting resources.

Aircraft In A Test Status

On 30 June 1961 the Directorate of Flight Test possessed 41 aircraft. But only 12 of the 41 were in a test status and two of the 12 were B-52 carrier aircraft for the X-15 rocket research airplane.[19] Of the remainder, 23 were used for test support and

18. Ibid.
19. AFFTC Assigned Aircraft Inventory, 30 Jun 1961. SD C in Vol 2, this hist.



B-52G/GAM-77 combination mated for ground firing of the GAM-77 engine. Photo by Boeing Airplane Co.

six were in storage. The ten aircraft in a test status were a JTB-47B (B-58 escape capsule), YRB-58 (ejection tests), YRB-58 (Category II Performance with a two component pod), NB-58A (proficiency), JF-100D (Optimum flap position and 335 gallon tank test) JTF-102A (pressure suit & accessories test, X-15 physiological package, oxygen component data, & Douglas A3D target), JH-43B (Category II performance and stability and control), YT-38 (barrier development), YT-38 (Category II performance), and a T-39A (Category II systems evaluation). A report of completed projects follows.

B-52G/GAM-77 Category II Tests

Captain Charles F. G. Kuyk Jr., USAF, project pilot, and Captain Charles W. Nyquist, USAF, project engineer, conducted a Category II performance and stability and control evaluation of the B-52G/GAM-77 weapon system at Edwards AFB between 26 March and 7 June 1960. Test aircraft was B-52G USAF S/N 58-0224, and 17 flights totaling 102 hours and 20 minutes were required to complete the test program. ARDC Test Directive 60-41 established the test program.

([redacted]) Purpose of the test was to define performance of the B-52G/GAM-77 combined weapon system and to determine the effect of GAM-77 missiles on the stability and control characteristics of the B-52G airplane. GAM-77 "Hound Dogs" were supersonic guided aircraft missiles externally carried by and air-launched from pylons installed under each wing of B-52's between the inboard nacelle and the fuselage. Carrier aircraft were equipped to control and monitor missile operation prior to launch. Fuel was supplied to the missile from the B-52 fuel system during the missile's captive flight.

Test personnel determined maximum range of the test B-52 with a GAM-77 under each wing was nine percent less than that of a B-52G without missiles. This determination was made with missile engines operating at maximum continuous power and the B-52 traveling Mach .76 and 35,000 feet altitude. When the missile engines were at idle the combined weapon systems range dropped 10 percent under that of a non-missile carrying B-52, and when missile engines were left windmill the range dropped 11 percent.[20]

Project personnel also found, at a gross weight of 485,000 pounds, take-off ground roll required by the B-52G using water and maximum allowable GAM-77 thrust augmentation was 6,920 feet or 14 percent less roll than required without missile thrust augmentation. Stability and control of the B-52G was essentially unchanged by addition of GAM-77 missiles. However, during high speed flight at low altitude, elevator effectiveness and response were marginal and elevator control forces were heavy. Elevator effectiveness was low compared to horizontal stabilizer trim effectiveness, and this created a potential severe mistrim hazard at high airspeeds and during go-arounds or touch-and-go landings. In fact, precise control of the B-52G during low altitude flight at airspeeds in excess of 325 knots was possible

20. Hq AFFTC-TR-60-74: B-52G/GAM-77 Category II Performance, Stability and Control Tests, Jan 1961. SD I in Vol 2, this hist.

only in smooth air.[21]

Aerial refueling characteristics of the B-52G/GAM-77 combined weapon system were also evaluated to the maximum allowable in-flight gross weight of 488,000 pounds. Without the additional thrust of two GAM-77 missile engines at 31,500 feet altitude the B-52 seemed to "hang" in the tanker downwash when moving into the contact position. With missile engines operating at maximum continuous power, however, power control was satisfactory for accomplishing refueling.[22] (End of [redacted])

B-58A Heavy Weight Take-off Refusals

Eleven tests were accomplished at Edwards AFB between 25 October and 1 December 1960 to obtain refused take-off performance data for inclusion in the B-58A Flight Manual. Test goals were to demonstrate a take-off refusal at the design brake limit speed (speed at which 18 million foot-pounds of energy is absorbed by each brake), and to determine and demonstrate an optimum take-off refusal technique for B-58A aircraft. Other test objectives were aimed at disclosing tire, wheel, and brake energy design capabilities and to investigate and develop an optimum aerodynamic braking technique.

Authority for these tests was ARDC Test Directive 58-6. First Lieutenant Robin K. Ransone, USAF, was project engineer, and Major Fitzhugh L. Fulton Jr., USAF, was project pilot. B-58A USAF S/N 58-1020 was used for refused take-off testing.

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21. Ibid, p. 45.
22. Ibid, p. 31.

Because of the hazardous nature of this type testing, boiler plate metal guards were installed over the main gear wheels to protect the B-58 from tire and wheel fragments. Also, fuse plugs were installed designed to melt at 430 degrees Fahrenheit to deflate the tires. To provide an additional margin of safety, fuel tanks less the 4,000 pound capacity reservoir were ballasted with water and only the pilot was aboard the B-58 during test runs.[23]

The highest brake energy level demonstrated in the program was a take-off refusal which generated almost 17 million of the maximum allowable 18 million foot-pounds of energy in each brake. Although brake shuttle valves failed which caused minor wheel fires at the end of this run, tires, wheels, and brakes functioned close to design capabilities.

Minimum stopping distances for speeds under the brake limit speed (maximum speed from which the take-off may be refused using full brake capacity throughout the deceleration) were obtained by maximum use of the mechanical brakes and drag chute with the B-58 in a three point attitude.[24] Test personnel noted when refused take-off speeds exceeded brake limit speeds, aerodynamic braking (aircraft nose up) was effective in decelerating the airplane to brake limit speed and should be used in conjunction with the aircraft drag chute. But aerodynamic braking was no substitute for wheel braking and should be used only to decrease aircraft speed to brake limit speed.

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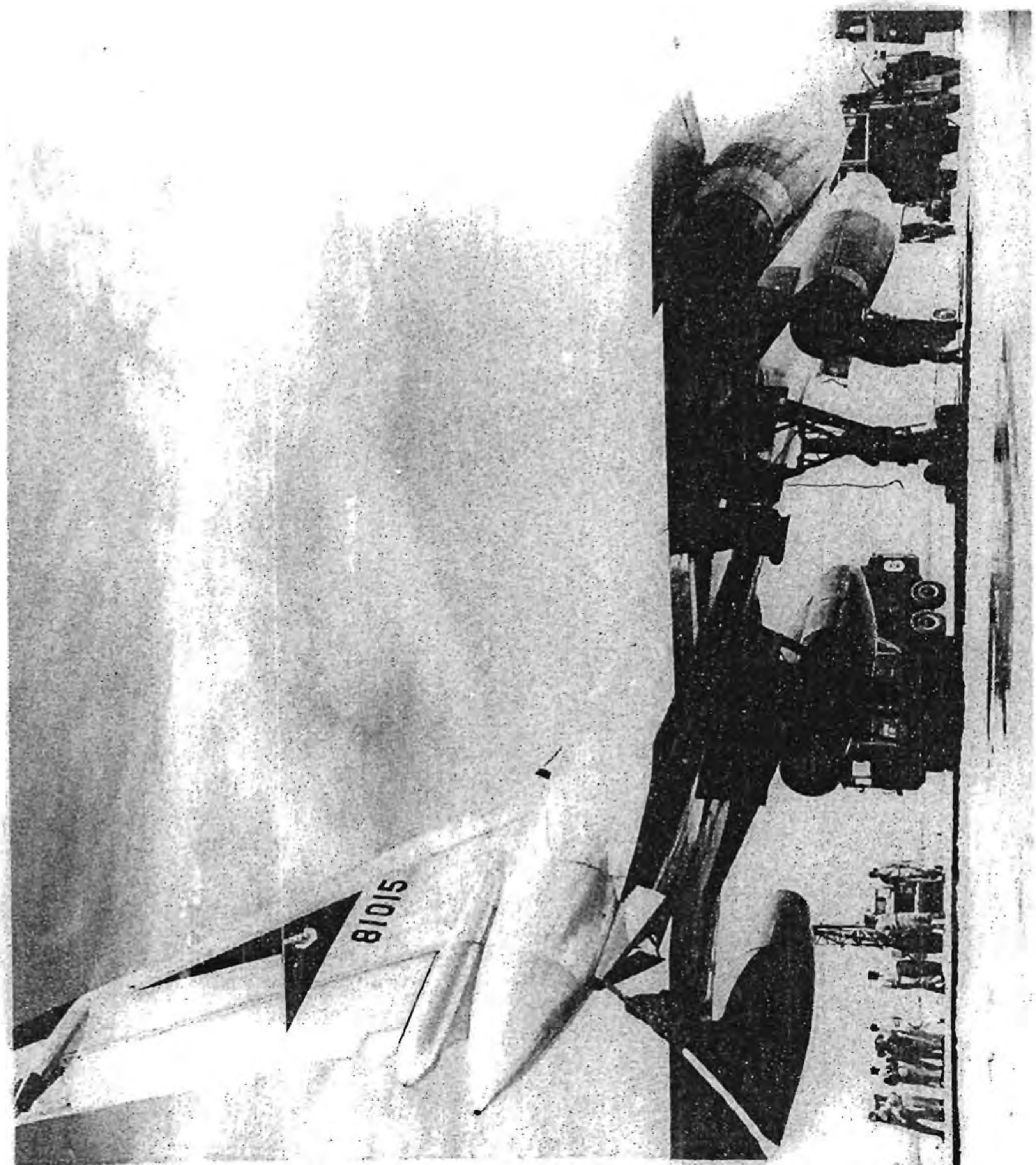
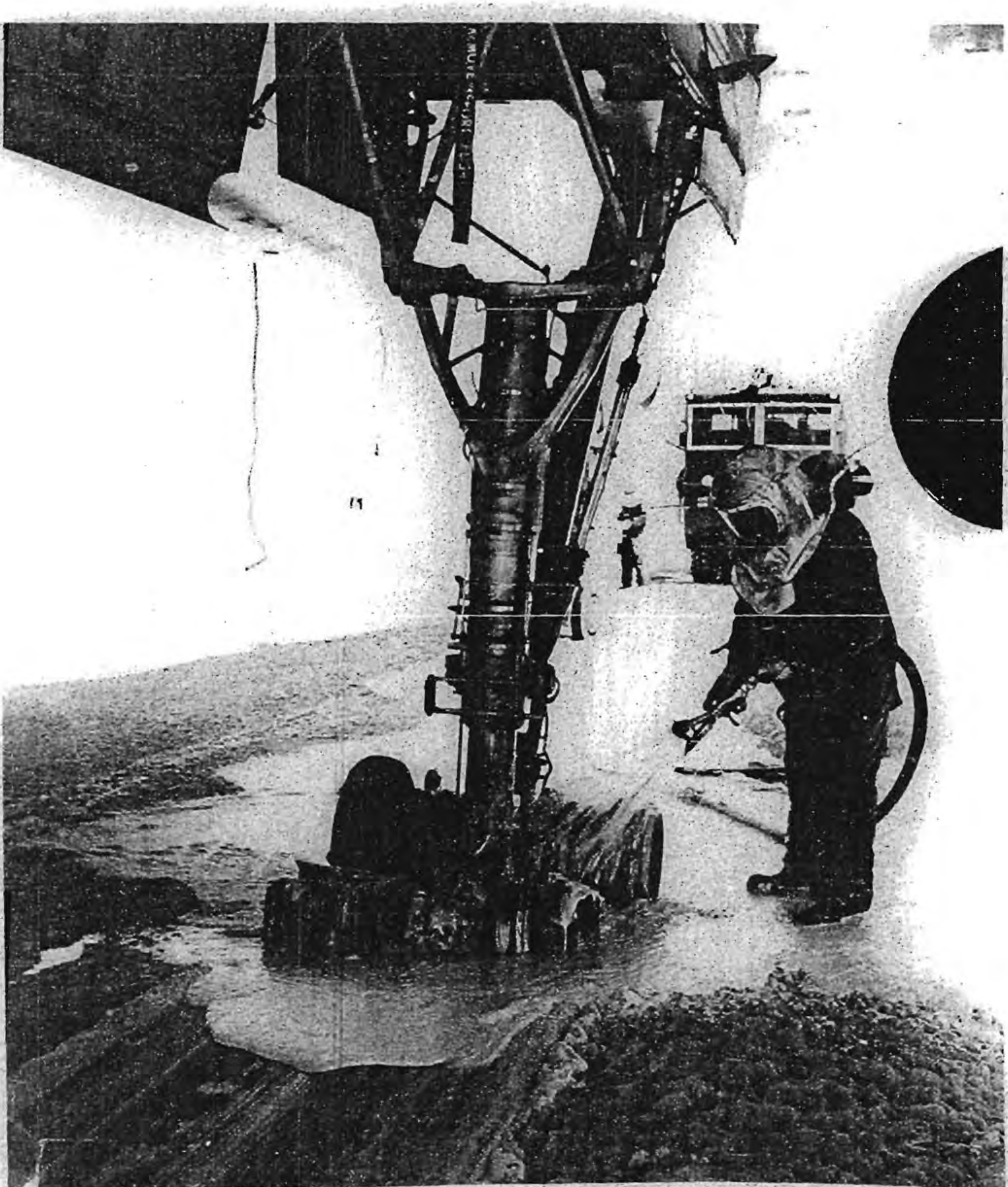
23. Hq AFFTC-TR-61-14: B-58A Heavy Weight Take-off Refusals, Aug 1961, p. 1. SD J in Vol 3, this hist.
24. Ibid.



B-58A USAF S/N 58-1015 after landing on 15,000-foot runway at Edwards AFB 13 April 1960 with seven of eight tires blown on right main landing gear. Seven tires blew on take-off during heavyweight performance test. Major Fitzhugh Fulton, AFFTC test pilot, elected to land on foamed runway rather than bail-out.



Close-up of B-58A USAF S/N 58-1015 right main gear after successful emergency landing 13 April 1960 at the AFFTC.

It was also determined during these tests that the B-58 should be taxied clear of the runway before coming to a complete stop after a refused take-off because of the rapid onset of brake fusion.[25] The procedure recommended was to slow the aircraft to about 10 knots then taxi off the runway and allow the aircraft to stop without further use of brakes.

Non-frangible Wheel Development for B-58 Aircraft

Airman First Class James A. Ford was project engineer and Major Fulton project pilot for 15 taxi runs and a take-off and landing at Edwards AFB using B-58 USAF S/N 55-0662 with a special non-frangible wheel assembly on the left main landing gear. This test was authorized by ARDC Test Directive 58-6. Purpose of the test was to develop a non-frangible wheel configuration for B-58 aircraft capable of performing under maximum gross weight hot day take-off conditions with blown tires. The test was accomplished from 21 December 1960 through 28 February 1961.

On several occasions in the past during B-58 operations at maximum gross weight, tire failure occurred which resulted in the wheel load being carried by the frangible outer wheel rims. These rims disintegrated and rim fragments inflicted serious damage to pods and aircraft.[26] Purpose of the non-frangible wheel was to provide a "third-tire" by means of a solid metal center flange between the dual main gear wheels on which to roll in the event of tire failure during take-off or landing.

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25. Ibid, p. 17.
26. Hist of the AFFTC, Jul - Dec 1960, p. 114.

Development work and dynamometer testing began in 1960 at wheel manufacturing facilities and a series of tests to confirm the feasibility of B-58 operation on a metal flange without support from pneumatic tires was conducted at the AFFTC in September 1960.[27] But soft metals of these initial center flange wheels permitted considerable deformation prior to center flange wheel failure. Ductile metals of aluminum alloy were investigated and proved more resistant to fragmentation. During tests of the aluminum alloy center flanges, however, it was found that wheel loads developed in the early stages of tire failure sufficient to destroy wheel bearings and bearing web supports. Cause of bearing and bearing web support failure was determined to originate from an unbalanced condition of the wheel assembly as the tire carcass tore from its bead bundles.[28] This in turn created flat spots in the center wheel flange which overloaded the wheels and caused the wheel bearings to fail. These conditions were corrected during November and December 1960 and another series of tests was undertaken on 21 December 1960.

In the new tests it was demonstrated by a take-off and landing that the latest wheel configuration was suitable for emergency take-off in the event of tire failure. Test personnel noted that since the non-frangible center wheel possessed an

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27. A letter report presenting the results of this test was submitted to the B-58 Weapon System Project Office (WSPO), Wright-Patterson AFB by the AFFTC Directorate of Flight Test on 24 Oct 1960.
28. Hq AFFTC-TR-61-33: Development of the Non-frangible Wheel for B-58 Aircraft, June 1961. SD K in Vol 3, this hist.

inherent skid capability which was compounded by the B-58 anti-skid device, and since the non-frangible center flange was proven capable of carrying the B-58 weight safely, any take-off should be continued where tires are blown in excess of 100 knots.[29] The tests also proved that concrete runways were not damaged by the non-frangible wheel. Rough runway test data up to 120 knots ground speed indicated about one-half the structural capability of the wheel. On runways of comparable roughness, therefore, it was unlikely that loads in excess of the wheels capability would occur up to the maximum gross weight - hot day take-off speed.[30]

Tests of a C-130B Modified for Satellite Recovery

Between 23 December 1960 and 3 February 1961, the AFFTC Directorate of Flight Test conducted a limited performance, stability and control, and structural demonstration flight test on JC-130B USAF S/N 57-0526 at Edwards AFB. Seventeen flights totaling 49 hours and 10 minutes were flown for these tests. Mr. Charles O. Johnson was the stability and control engineer, First Lieutenant James L. Wendland, USAF, was the performance engineer, and Captain Robert R. Heaton, USAF, was the JC-130B project pilot.

Purpose of the test was to determine the effect of satellite recovery modification on cruise performance and handling characteristics of the JC-130B and to demonstrate structural integrity

29. Ibid, p. 23.
30. Ibid, p. 22.

of the modified airplane to 80 percent of design limit load conditions. The JC-130B used for testing was a C-130B modified to locate and recover re-entering satellites. It was equipped with a large direction finder on top of the forward fuselage and the aircraft cargo area contained satellite recovery gear.

Tests disclosed the JC-130B range was approximately 3.5 percent less than that of the C-130B.[31] Test personnel recommended the same cruise speed for the JC-130B as that of the C-130B but noted it required five percent more power to maintain the JC-130B cruise speed due to its modifications.

Loads which resulted in an aircraft center of gravity position of 32.5 percent or greater produced light longitudinal forces in all configurations. With center of gravity aft as far as 37.5 percent (MAC) Mean Aerodynamic Chord, the aircraft was stable in all configurations except recovery. Also, left roll tendencies were present during accelerated stalls at the aft center of gravity loading with the flaps down.

Generally, however, stability and control characteristics of the JC-130B were much like those of the C-130B[32] within the normal center of gravity envelope.

Tests personnel also conducted a variety of maneuvers to demonstrate the JC-130B to 80 percent of the limit for C-130B

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31. Hq AFFTC-TR-61-13: Limited Performance, Stability and Control, and Structural Demonstration Tests of a C-130B Modified for satellite Recovery, Apr 1961, p. 11. SD L in Vol 3, this hist.
32. Ibid, p. 18. For details of the C-130B, see Hist of the AFFTC, Jan - Jun 1960, p. 120.

aircraft. Maneuvers performed either met or exceeded the limits defined by structures personnel[33] with no structural damage to the aircraft.

T-33A Performance Evaluation

Mr. W. G. Schweikhard and Captain Thomas P. Stafford, USAF, both of the USAF Experimental Flight Test Pilot School, were project engineer and project pilot for a T-33A performance evaluation at Edwards AFB between 3 December 1960 and 17 January 1961. Sixteen flights for 28 hours and 30 minutes were flown with T-33A-5 USAF S/N 52-9846 and two additional flights for three hours and 15 minutes were flown with T-33A USAF S/N 51-8954 to complete the test. Purpose of the test was to evaluate the performance of a representative T-33A aircraft with an average thrust engine and to determine the cause for variation in performance between aircraft. The T-33A performance evaluation actually stemmed from the belief that the Flight Manual was no longer valid since T-33 aircraft engines had been in service for so many years they presumably suffered from thrust deterioration.

Results disclosed with few exceptions that the test data and the Flight Manual data compared favorably. Take-off data in the Flight Manual was 16 to 24 percent optimistic while descent data was about 75 percent pessimistic.[34] Flight Manual cruise and climb performance compared favorably with test data at low altitudes, but was slightly above those achieved during the test

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33. Ibid, p. 26.
34. Hq AFFTC-TR-61-22: T-33A Performance Evaluation, May 1961. SD M in Vol 3, this hist, p 5 and 15.

at high altitudes. Test results also indicated the greatest cause of engine thrust deterioration was not service life but the broad thrust limits permitted after overhaul of an engine, and to variations of trim revolutions per minute (rpm) in flight.[35]

While the T-33 performance evaluation was underway, Sacramento Air Materiel Area requested test personnel conduct an investigation of the Flight Manual sideslip restriction on the T-33 when carrying a travel pod. When full rudder sideslips in both the power approach and cruise configurations disclosed no adverse effects from the travel pod, test authorities recommended sideslip restrictions for T-33's with travel pod be the same as for T-33's with tip tanks installed.[36]

T-37B Category II Performance Test

Category II tests were conducted on T-37B USAF S/N 60-00079 at Edwards AFB between 24 October 1960 and 3 January 1961 to obtain data for the Flight Manual and to compare performance with the T-37A. Project engineer was First Lieutenant Forrest W. Worthington, USAF, and project pilot was Captain Emil Sturmthal, USAF. Twenty-five flights totaling 36 hours were made to complete the test.

Manufactured by the Cessna Aircraft Company, the T-37B was a low-wing jet trainer of all-metal construction and side-by-side seating. Power was provided by two Continental J69-T-25 turbojet engines rated at 1,025 pounds of thrust each uninstalled. This trainer was equipped with a two-position speed

35. Ibid, p. 17.
36. Ibid, p. 22.

brake, spoilers for artificial stall warning, thrust attenuators to divert the engine thrust in order to provide an increased approach angle for landing, a jettisonable clamshell canopy, and ejection seats. Main differences between the T-37B and T-37A were an increase in rated thrust from 920 to 1,025 pounds per engine and an increase of 347 pounds in design gross weight.[37]

Performance of the T-37B was improved over that of the T-37A. Take-off performance, initial rate of climb, ceilings, and maximum level flight speeds were increased significantly. Single engine performance improvement also added considerably to aircrew safety particularly during traffic pattern flight. Handling characteristics were about the same as those of the T-37A, and ground handling control during normal and fast-cornering turns was excellent (using nose wheel steering only).

The one major deficiency, unsatisfactory braking, noted during testing of the T-37A was still present in the T-37B. Simultaneous operation of both brake pedals resulted in abbreviated or interrupted braking with no way of determining which brake would become effective first. Braking action feel was like that of the T-37A, almost lacking until the brakes were pumped rapidly several times. Poor brake action caused some directional over-controlling when brakes and nose wheel steering were used in ground taxi operations.[38]

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37. Hq AFFTC-TR-61-16: T-37B Category II Performance Test, Apr 1961, p. 1. SD N in Vol 3, this hist. For purposes of comparing the T-37B and T-37A, see Hist of the AFFTC, Jul - Dec 1956, p. 49.
38. Ibid, p. 7.

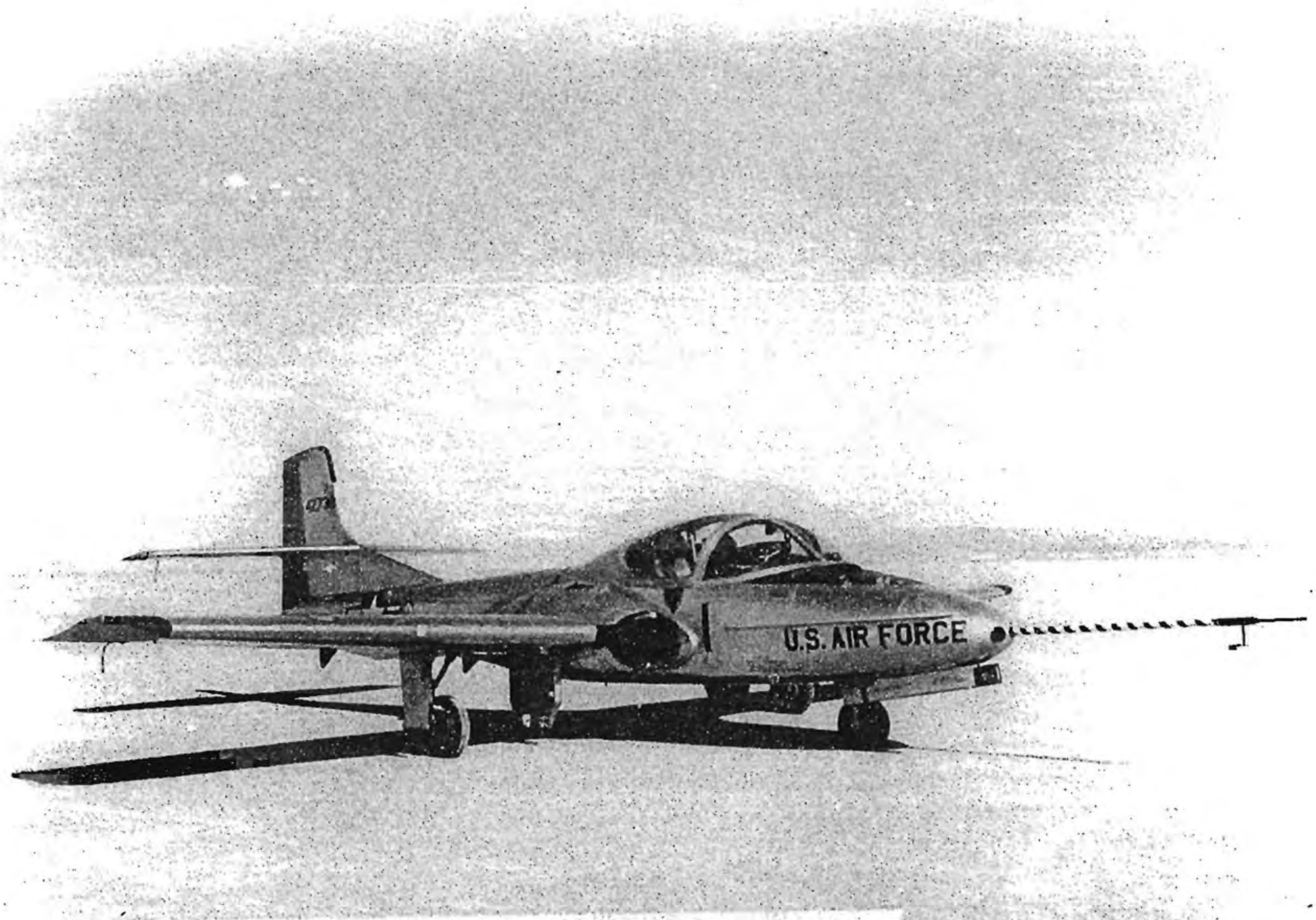
T-37B Spin Evaluation

A spin program was conducted on TB-37B USAF S/N 60-0331 at the AFFTC between 13 September and 20 October 1961. Eighteen flights for twenty-two hours and thirty minutes were required to accomplish 270 spins. Two Air Training Command pilots and one Cessna pilot participated in the spin program along with AFFTC pilots, Major Walter F. Daniel and Captain William J. Knight. Either Daniel or Knight was in the aircraft on all flights. A production T-37B was used for the test, and with the exception of a cockpit mounted camera no instrumentation was installed. Test objectives were to conduct an analysis of the Flight Manual spin procedures and determine if a more simplified spin recovery method could be developed.

Test personnel found the three recovery procedures listed in the Flight Manual for normal, accelerated, and inverted spins gave positive recovery for the respective type spin under all conditions. Further tests disclosed, however, that there was a single recovery procedure for all three types of spins under all conditions.

The one procedure which would recover the T-37B from any spin under all conditions required the pilot to neutralize the rudders and move the stick full aft (aileron neutral) and hold. Over 100 spins of all types were tested using this procedure with the following results:[39]

39. FTC-TDR-61-59: T-37B Qualitative Spin Evaluation, November 1961, p. 4. SD 0 in Vol 3, this hist.



A Cessna built T-37 low-wing jet trainer with side-by-side seating is shown on Rogers Dry Lake.

During an inverted spin, recovery was made within one-half turn. In an accelerated spin the controls were neutralized as soon as rotation stopped and recovery was made from the ensuing dive. When rotation continued the pilot could determine the T-37 was in an erect normal spin since it could not spin inverted or accelerated with the controls held as prescribed. Next the pilot determined the T-37 direction of rotation and applied full rudder opposite to this direction. One turn later, he moved the stick full forward and as the T-37 nose pitched down he relaxed forward pressure. As soon as rotation stopped, the controls were neutralized and recovery made from the ensuing dive.

At the tests conclusion, it was pointed out by the AFFTC pilots that the single recovery procedure was not a "cure-all" but a method prescribed to lessen the chances of a pilot becoming confused and applying the wrong controls. Yet it was noted that if a pilot were to apply the wrong controls even with the single recovery procedure, the T-37 could still be "spun in".

T-38A Category II Systems Evaluation

Category II systems evaluation test of the T-38A airplane equipped with YJ85-GE-5 engines was conducted at the AFFTC from 6 May 1960 through 2 February 1961 using seven aircraft and 1,200 hours of flying time. The T-38 was one of the first airplanes to be tested entirely under the integrated contractor/Air Force category test system. Headquarters Air Research and Development Command T-38 Joint Test Directive Number 58-14, 17 December 1958, was the test program authority. AFR 80-14 was used as a guide to prepare the test plan and the plan was coordinated with Air Training Command, the prime using command, to assure test planning was consistent with intended aircraft employment. This test was given an ARDC priority of 1-B and a precedence rating of V-70 under the development plan for Support System T-38A. The T-38 supersonic trainer was Air Force System 420L.[40] Aircraft used in the test were:

USAF S/N	Date of Arrival	Number of Flights	Total Test Time	Date of Last Flight
59-1594	6 May 60	231	242:35	2 Feb 61
59-1595	6 Jun 60	169	184:05	2 Feb 61
59-1597	25 Aug 60	177	218:45	2 Feb 61
59-1598	31 Aug 60	176	218:10	2 Feb 61
59-1599	28 Sep 60	108	128:40	2 Feb 61
59-1600	9 Nov 60	80	89:45	2 Feb 61
59-1601	17 Oct 60	100	121:10	2 Feb 61

Test aircraft maintenance was performed jointly by AFFTC and Air Training Command using AFFTC facilities. Air Training Command (ATC) support included 79 maintenance personnel.

Mr. Robert C. Tucker was the AFFTC project engineer and Major Swart H. Nelson, USAF, was the AFFTC project pilot. Objectives of the test program were to complete a functional and operational evaluation of the T-38 airplane to determine its suitability, capability, and compatibility in meeting design requirements. This type test provided early detection of system discrepancies, reliability, and maintainability data, and demonstrated the aircraft as a system including its aerospace ground equipment. Familiarization, training, and on-the-job experience for using command personnel were secondary objectives of

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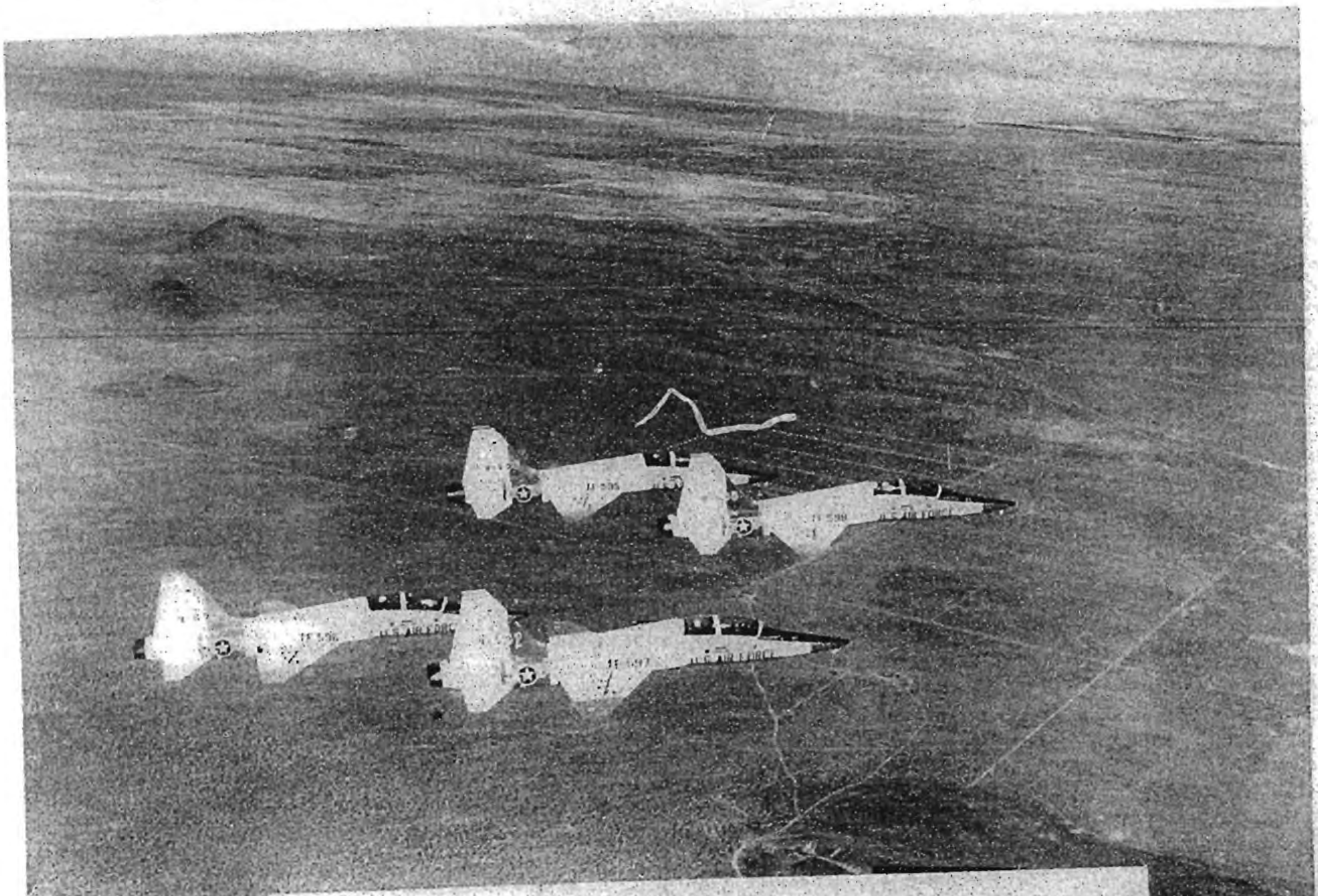
40. Hq AFFTC-TR-61-21: T-38A Category II Systems Evaluation Test, July 1961, p. 1. SD W in Vol 4, this hist.



Norair built T-38 Talon trainers in flight over the Mojave Desert. Category I and II tests were conducted at the AFFTC in 1960 and 1961.

the test program.

The T-38 was a two place tandem supersonic trainer manufactured by the Norair Division of the Northrop Corporation. Its mission was to accomplish all phases of basic pilot training. Test aircraft basic weight was 7,500 pounds with an internal usable fuel capacity of about 3,750 pounds. The T-38 was equipped with a full power irreversible control system, conventional ailerons and rudder, and an all movable horizontal tail. Two independent hydraulic systems powered all flight control surfaces. Stability augmentation was provided about the pitch and yaw axes to aid inherent aerodynamic damping. All three axes of the flight control system were trimmable in flight. In addition, the T-38 was equipped with hydraulically activated speed brakes from the underside of the fuselage and electrically operated, trailing edge, plain landing flaps.

Two YJ85-GE-5 engines powered the T-38 aircraft. The YJ85-GE-5 engine was a compact, lightweight, afterburning, turbojet engine with an eight stage axial flow compressor coupled directly to a two stage turbine. It incorporated a through flow, annular type combustion system, variable-inlet guide vanes, and controlled compressor interstage air bleed valves. It was rated at a static uninstalled gross thrust of 3,600 pounds.

Category II results proved beyond doubt that the T-38 trainer was well suited for its mission. It possessed excellent handling qualities, maneuver and stall characteristics were good, maximum speed was in the low supersonic range, and climb performance was comparable to modern fighters. Test pilots noted the cockpit was confortable, well arranged, and provided good visibility.

However, there were a few deficiencies to be corrected. Major problem areas compromising the mission of the T-38 were airframe mounted gear box service life (25 hours),[41] nose wheel shimmy, and engine overspeed induced by fuel control malfunction. These problems were under investigation, but were not fully solved.

AFFTC and ATC pilots flew an ATC training profile series and found the aircraft to be compatible with all missions except closed pattern landings. The exception was created by the flap motor duty cycle which permitted one landing each five minutes while the aircraft could be landed every three minutes from a closed pattern.[42]

Other deficient areas of the T-38 included a high failure rate of oxygen regulators, overly critical canopy rigging which caused loss of a canopy in flight,[43] high failure rate of fuel flow indicators and the gyro compass due to an incompatibility with aircraft electrical power, malfunctioning main landing gear strut seals, numerous main landing gear tire failures, and inadequate afterburner relight capability at altitude. Engine performance was marginal during the first half of the test

41. Ibid, p. 47.
42. Ibid, p. 75.
43. Ibid, p. 23.

program and engine parts failed at an unacceptable rate.[44] Engine overspeed was also common, and one engine--S/N 230150--was destroyed when the compressor blew apart during a sudden uncontrolled overspeed.[45] Aircraft USAF S/N 58-1197 was severely damaged by the engine explosion, however, this aircraft was not a Category II Systems Evaluation test airplane. Analysis of compressor parts by General Electric indicated the engine reached over 130 percent speed before destruction occurred. Cause of overspeed was believed to be contamination lodging in the engine main fuel controls.

Over 60 percent of the maintenance support went for power plant 50 hour inspection and unscheduled engine maintenance. Near the end of the test program, only 25 maintenance manhours were required per flying hour. This was such a significant improvement over the program average that test personnel recommended increasing the airframe inspection interval to 100 hours on test aircraft to be used in Category III testing.[46]

T-38A Category II Stability and Control Tests

Stability and control tests of the T-38A were performed by the AFFTC on contractor maintained aircraft which were used concurrently by the contractor in Category I tests. The Category II stability and control test program began on 22 February and was completed 16 December 1960 at Edwards AFB. Test aircraft

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44. Ibid, p. 32.
45. Ibid, p. 33.
46. Ibid, p. 75.

were USAF S/N 58-1192 and 58-1195. Seventeen flights were flown for stability and control purposes for a total 13 hours and 48 minutes. Captain William A. Lusby, Jr., USAF, was project engineer and Captain Norris J. Hanks, USAF, was the project pilot. Prime objectives of the AFFTC Category II test was to obtain quantitative data on stability and control handling characteristics of the T-38 in the flight envelope not tested during Category I testing, evaluate changes resulting from recommendations made during Category I tests, and more thoroughly investigate areas previously tested. Norair and Air Force pilots participated in the contractor's Category I program and the AFFTC Category II tests.

Stability and control characteristics were termed satisfactory throughout the flight envelope. However, longitudinal control response was sensitive at high speeds and slow at airspeeds below 220 knots.[47] Although the aircraft was found safe to fly with or without stability augmentation, damping of longitudinal disturbances with the pitch damper inoperative was low and military specifications could not be met in almost all flight conditions below 30,000 feet altitude.[48] Damper systems provided adequate damping at all airspeeds and slightly excessive damping longitudinally at low airspeeds. All in-flight directional, lateral-directional, and lateral characteristics were satisfactory.

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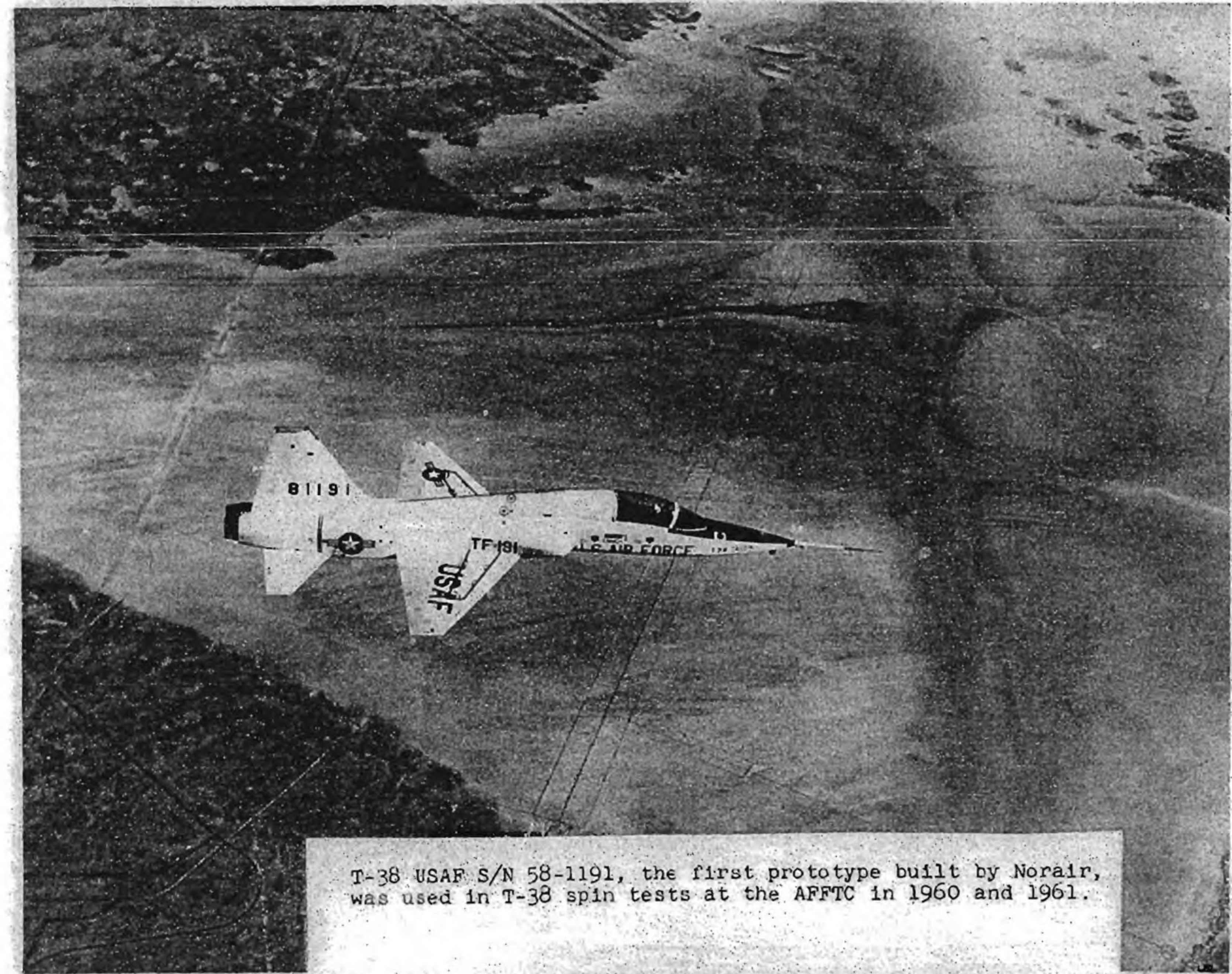
47. Hq AFFTC-TR-61-15: T-38A Category II Stability and Control Tests, August 1961, p. 8. SD V in Vol 4, this hist.
48. _Ibid_, p. 12.



T-38 USAF S/N 58-1191, the first prototype built by Norair, was used in T-38 spin tests at the AFFTC in 1960 and 1961.

Nose wheel steering response was low near neutral. This condition necessitated excessive rudder pedal movements while taxiing and occasionally caused over-control on take-off. But release of nose wheel steering would correct this deficiency.[49]

Category II test results indicated undesirable features noted during Category I tests were either improved or corrected. The T-38A aircraft evaluated during the AFFTC Category II stability and control program revealed the airplane to be an excellent trainer for pilot transition into high performance jet aircraft.[50] Its simplicity was conducive to transition and its performance handling permitted Century Series simulation and development of correct pilot technique. Visibility from both the front and rear seat during all phases of flight presented no problems, and the rear seat (instructor position) afforded complete control over most normal and emergency procedures.

T-38 Spin Evaluation

Spin tests were also conducted as part of the joint AFFTC/contractor Category I of the T-38A airplane. The test program, initiated at Edwards AFB on 20 April 1960 and completed on 5 April 1961, consisted of 108 contractor flights for 95 hours and 34 AFFTC flights for 27 additional hours. The first prototype aircraft (S/N 58-1191) was used in this program and was modified to include a 25.6 foot diameter spin recovery parachute. Other modifications included strengthening the aft fuselage with

49. Ibid, p. 19.
50. Ibid, p. 18.

external fittings and installation of a test nose boom. Purpose of the AFFTC test was to determine spin entry, spin, and spin recovery characteristics of the T-38. First flight by the AFFTC was 19 August 1960. Captain Lusby was the project engineer and Major Nelson and Captain Hanks were project pilots.

Early in the test program it was determined that T-38 spin modes included an unstable inverted mode, a continuing oscillatory erect mode, and a continuing erect smooth flat mode. However, the aircraft only rarely spun inverted and would not sustain an inverted spin for more than two turns.[51] Investigations also revealed that the T-38 would not enter a continuing spin except following an abrupt application of aft stick at close to maximum possible rates. In addition, it was learned early in the spin test program that double engine flame-outs could be expected while spinning.

Immediate corrective procedure for all out-of-control gyrations was to neutralize and release all controls. Recovery for the inverted spin was to neutralize and release all controls and wait for the spin to break or convert to an erect spin, then apply and hold full rudder against the spin with the stick full back and as much aileron with the spin as could be held. Project pilots noted inverted spin recovery was positive and fast, but recovery from an erect spin--either oscillatory or smooth and flat--could not be assured.[52] Recovery from oscillatory spins

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51. Hq AFFTC-TR-61-31: T-38 Spin Evaluation, Aug 1961, p. 10. SD X in Vol 4, this hist.
52. Ibid, p. 12.

was possible in from two to eight turns providing the engines did not flame-out and hydraulic pressure to the control system was not lost.[53] With these findings at hand, project personnel warned that intentional spins in the T-38 should be prohibited and such an entry be made in the Flight Manual.[54]

T-38A Flameout Evaluation

A brief T-38A flame-out evaluation was conducted by the AFFTC at Edwards AFB as a result of a request from the Aeronautical Systems Division T-38A Project Office to develop a landing pattern for emergency landing with both engines flamed out. Nine flights with nine hours and 45 minutes flying time made up the program. First flight was 8 March 1961 and the last was performed on 6 April 1961. Mr. Robert W. Sudderth was project engineer and Captain Hanks was project pilot.

To reduce costs of the program, four precautionary tests were accomplished with a production airplane equipped with J or production engines. Double engine out landings were made with a Norair bailed airplane S/N 58-1191 equipped with a battery powered hydraulic backup system and YJ or prototype engines.

From this short experience, test personnel determined it was not advisable to make a flamed out landing with the T-38A. However, it was noted that should a deadstick landing capability be required then a battery powered hydraulic backup pump should be installed in the T-38.[55]

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53. Ibid, p. 14.
54. Ibid, p. 18.
55. Hq AFFTC-TR-61-48: T-38A Flameout Evaluation, Sep 1961. SD V in Vol 4, this hist.

Although the test was exceptionally brief, project pilots determined that airstart with both engines flamed out was satisfactory at the recommended glide speed of 220 knots to about 5,000 feet altitude. Below 5,000 feet, 240 knots was required to assure an airstart. Moreover, it was determined that flight control response in a double engine flameout was adequate for glides to proper altitudes or glides to unpopulated areas for ejection.

Category II T-38A Engine Evaluations

Three types or models of engines were evaluated as a follow-on program to the T-38A Category II systems test which was conducted at the AFFTC under ARDC Joint Test Directive 58-14. One was the improved YJ85-GE-5, another was the production J85-GE-5, and still another was the modified J85-GE-5. Captain Thomas H. Hobbs, USAF, was project engineer and Major Nelson was the project pilot.

The first test began 1 February 1961 on the improved YJ85-GE-5 engine and was completed 2 March 1961. Objective of the program was to prove the flight reliability of improved YJ engines and to determine the reliability of the J engine configuration as early as possible. Two YJ85-GE-5 engines were assembled for the test using YJ and J engine parts. Engines with serial numbers 230-133 and 230-167 were tested with the first used 23 hours and 35 minutes in flight and the second 29 hours and 40 minutes. Tests included stall approaches, afterburner lights and blowouts, evaluations of fuel control modifications for preventing engine overspeed, and an accumulation of operating time on installed

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overspeed governors. These were the problem areas noted during the AFFTC Category II systems evaluation.

Prior to the test, engine flameouts during stall approaches were common on the YJ engine between 35,000 and 25,000 feet altitude and speeds from 130 to 175 knots with the throttle at "idle". General Electric indicated an increased minimum fuel schedule would correct this condition and the AFFTC engine evaluation proved the fix successful.[56] Modifications to the YJ engine afterburner did not improve the engine relight capability, but did improve afterburner operation to a point where it would operate to 50,000 feet. Before modification, reliable afterburner relights were not possible above 32,000 feet altitude.[57] The engine overspeed problem which resulted from engine vibration setting up a resonant condition of the main fuel control metering valve spring and allowed the fuel schedule to shift (creep) forward was apparently solved by insertion of metering valve springs and trim bellows, for project pilots experienced no difficulty from overspeed in climbs to 50,000 feet.[58]

Four engines were flown during the production J85-GE-5 engine evaluations accomplished from 10 February through 1 May 1961 at the AFFTC. Air Training Command aircraft USAF S/N 59-1603 and 59-1605 were utilized for this evaluation and engine S/N E230-189, E230-190, E230-191, E230-192, and E230-194 were

56. Hq AFFTC-TR-61-54: Category II YJ and J85-GE-5 Engine Follow-on Evaluations, Oct 1961, p. 1. SD Z in Vol 4, this hist.
57. Ibid, p. 2.
58. Ibid.

test items. Engine S/N E230-194 was not flown but used for parts to keep the other four in operation.

After 288 hours* of test operation, AFFTC project personnel concluded that the J85 engine was quite an improvement over the YJ85. Ground operation of the J was satisfactory, problems of engine stall and flameout with the engine at "idle" had been corrected, and engine airstarts were successful below 29,000 feet at 13 percent or higher windmill revolutions per minute. But there still remained several problem areas to be corrected. High altitude, low airspeed airstarts required as much as one minute or more to complete, afterburner nozzle response during an afterburner light was too slow, and revolutions per minute drifted excessively on climbs or dives in military power. Additionally, engine bearing seals, fuel nozzles, combustion liners, afterburner fuel pumps, and first stage turbine nozzles all exhibited various deficiencies.[59]

In view of the results of the J85-GE-5 production engine evaluation, the General Electric Company instituted a flight test and engineering program (Operation Nutcracker) to improve operation of the engine. Following the General Electric flight test program, six demonstration flights totaling six hours and 45 minutes were flown between 15 and 22 May 1961 by six different Air Training Command and AFFTC pilots to evaluate the fixes incorporated in a modified production J85-GE-5 engine.

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* S/N E230-189 (100:15), 190 (77:15), 191 (44:35), 192 (66:40).

59. Hq AFFTC-TR-61-54: Category II YJ and J85-GE-5 Engine Follow-on Evaluations, Oct 1961, p. 1. SD Z in Vol 4, this hist.

These pilots determined that modifications on the production engine improved significantly the afterburner light and airstart envelopes over the standard J engines tested previously. Afterburner lights were possible to 220 knots at 50,000 feet and to 180 knots at 40,000 feet. Below 40,000 feet, the afterburner capability was satisfactory throughout the airframe envelope. Airstart was raised 2,000 to 3,000 feet and was satisfactory at 30,000 feet altitude for all airspeeds above 200 knots.[60] Although the pilots held the modified engine in high praise, a new deficiency appeared seemingly as a result of these modifications. Pilots now experienced an engine stall and flameout when they moved the throttle from cruise power settings to military or afterburner while under cruise flight conditions. This problem received prompt attention by the Aeronautical Systems Division (ASD) T-38A Project Office and General Electric. The AFFTC was notified by ASD that a new compressor which was expected to eliminate the difficulty was undergoing test at General Electric in September 1961.[61]

F-104D High Density Fuel Range Test

Captain Theodore C. Freeman, USAF, and Captain Albert H. Crews, USAF, were project engineer and project pilot respectively to determine range increase of an F-104D when using HTF 59-24 High Density Fuel rather than JP-4. This test was performed at the AFFTC using F-104D USAF S/N 57-1314 and required 26 flying

60. Ibid, p. 19.
61. Ltr, Hqs AFFTC (FTFED) to Hist Div (FTNH), Subj: Inclusion of Project Office Comments. Appendix L.

hours. The first flight was performed on 14 June 1961 under ARDC Test Directive 60-65.

A production F-104D sufficiently instrumented to obtain level flight performance data was used for this test. One of two standard direct current powered engine ignition systems was replaced by a high energy alternating current system to insure ground and in-flight starts under cold atmospheric and fuel temperature conditions. Also, two 175-gallon tip tanks were fitted to the aircraft to provide 1,012 gallons of fuel, and the main fuel control on the engine was modified slightly to meter the HTF 59-24 High Density Fuel.

Test results indicated a 14.6 percent or 110 nautical miles range increase by use of HTF 59-24. Maximum range was achieved by making a military power climb to cruise altitude of 30,000 feet and maintaining a speed thereafter of 515 knots. Range was 865 nautical miles with HTF 59-24 and 755 nautical miles with JP-4 under the same conditions.[62]

Avrocar Flight Evaluation

On 4 April 1960 and 9 June 1961, a limited qualitative evaluation was conducted on the performance, stability and control of Avrocar, U. S. Army VZ-9AV, at the contractor facility, Avro Aircraft Limited, Malton, Ontario, Canada. AFFTC personnel making the evaluation was First Lieutenant Wallace H. Deckert, USAF, project engineer, and Major Walter J. Hodgson, USAF, project pilot.

62. FTC-TDR-61-62: F-104 High Density Fuel Range Test, Jan 1962, p. 12. SD P in Vol 3, this hist.

The Avrocar, a ground effect vehicle, was manufactured for the Army under USAF Contract AF 33(600)-3796. It was an unconventional aircraft with a circular planform. Take-off gross weight was 5,680 pounds which included 840 pounds of fuel and a pilot. Avrocar was powered by three Continental J69-T-9 engines each rated at 927 pounds static sea level thrust. Together, the engines acted as a gas generator to drive a centrally located turborotor. Air flowed from the turborotor through radial ducts and exhausted out through various combinations of annular nozzles and jets depending on the flight regime.

Avrocar was equipped with a focussing ring control system for hovering flight during the first evaluation on 4 April 1960. Modifications were undertaken in 1961 to add a separate control system for transition and high speed flight. The second evaluation on 9 June 1961 was performed to determine if the changes effected the aircraft in its hovering and low speed regime.

Deckert and Hodgson found the addition of a high speed control system produced an adverse affect upon performance and control of the avrocar during hovering and low speed flight.[63] Maximum airspeed dropped from 30 to 20 knots and ground cushion instability occurred at a lower height (anything over 1½ feet). When the avrocar was flown over irregular terrain and a large ditch during the test, there was some evidence of an underpowered condition and a major problem from recirculating debris

63. FTC-TDR-61-56: Avrocar Flight Evaluation, Jan 1962, p. 12. SD Q in Vol 3, this hist.

(grass, dust, water, and sand). Correction of these problems along with modifications to the control system and the propulsion system was to be made before a ground effect transition into high speed flight could be demonstrated.

S-62A Helicopter Evaluation

From 19 through 21 September 1960, five test flights for a total 10 hours were flown with a commercial model S-62A helicopter at the AFFTC to determine its general flight characteristics. Mr. Kenneth R. Ferrell was project engineer and Captain Paul J. Balfe, USAF, was project pilot.

Manufactured by the Sikorsky Aircraft Division of United Aircraft Corporation, the S-62A was powered by a single General Electric T-58 gas free turbine engine. Basic weight of the aircraft was 5,032 pounds with a useful load capability of 2,468 pounds. The S-62A was essentially an improved amphibious, turbine powered model of the H-19 helicopter using many of the same dynamic components.

In the five flight ten hour test, AFFTC personnel found the S-62A possessed good flying qualities. Sideward and rearward flight characteristics were excellent. Controllability was acceptable about all axis and the plane was easy to fly. Major shortcomings in flying qualities were high pedal forces and poor dynamic lateral directional stability during climb.[64]

64. Hq AFFTC-TR-61-8: Limited Stability and Control Evaluation of the S-62A Helicopter, Mar 1961, p. 15. SD R in Vol 3, this hist.

YHC-1A Flight Evaluation

Flight evaluation of YHC-1A U.S. Army S/N 58-5514 was performed by the AFFTC at the Vertol Division of Boeing Airplane Company, Philadelphia, Pennsylvania, between 28 June and 7 July and 4 and 10 September 1960. Twenty-five flights for a total 22 hours and 35 minutes were required to evaluate general flying qualities of the helicopter. Mr. Charles C. Crawford was project engineer and Major Hodgson was project pilot.

Three YHC-1A helicopters were built for the Army and featured rear ramp loading and the capability of carrying 26 passengers and a crew of three or 15 litter patients, two medical attendants, and a crew of three. The YHC-1A was the second model of the Vertol 107 series. It was a twin turbine, tandem rotor (two 3-bladed rotors), tactical transport. Two General Electric T58-GE-6 free turbine engines rated at 1,050 shaft horsepower at sea level powered the YHC-1A. Design gross weight was 15,550 pounds.

The YHC-1A according to test personnel was an advance in the art of helicopter design because of its good handling qualities, positive dynamic stability, and low vibration levels at high speed. These attributes coupled with its rear ramp loading, two-engine reliability, easy access for maintenance, high ratio of cargo volume to airframe volume, and adequate weight lifting ability made the YHC-1A one of the most operationally suited helicopters ever tested by the AFFTC.[65]

Major features of the YHC-1A which were not much desired by test personnel included a reliance on the stability augmentation system (SAS) for stability and control, inability to use full engine power because of transmission torque limits (1700 shaft horsepower at 258 rotor revolutions per minute), and a slow beep trim rate. Also, there was an excessive revolutions per minute droop during power application which could lead to loss of generator output and a dual stability augmentation system malfunction. In all, 15 recommendations were offered by AFFTC personnel to increase the YHC-1A operationally.[66]

H-43B Modified Empennage Evaluation

A limited comparative evaluation of rotor blade-to-tail clearance and stability and control of a production H-43B and one with a modified empennage (vertical stabilizers lowered 14 inches and equipped with 10 inch frangible fiberglas tips) was conducted by the AFFTC during June through August 1960. Flights were made at the AFFTC and at the Kaman Aircraft Corporation facility in Bloomfield, Connecticut, 21 at the AFFTC for 15 test hours on 58-1849 to obtain baseline date on handling qualities of H-43B's with the original empennage and 11 at Bloomfield for 12 hours and 30 minutes on 59-1548 with a modified empennage. Project engineer was Mr. Ferrell and project pilot was Captain Jimmie S. Honaker, USAF.

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65. Hq AFFTC-TR-61-1: YHC-1A Flight Evaluation, Feb 1961, p. 31. SD S in Vol 3, this hist.
66. Ibid, p. 32.

The H-43B modified empennage was developed to correct rotor blade-to-tail interference which resulted in aircraft grounding and suspension of Category II testing on 4 May 1960.[67] Ferrell and Honaker determined the modifications increased the blade to tail clearance sufficient to make interference very remote. Flying qualities of the helicopter with modified empennage were acceptable for service use as long as the directional stability augmentation system was operating at the optimum setting used by the project test pilot. However, Honaker advised that the H-43B should not be flown except for flight test or pilot familiarization with an instructor pilot aboard when the directional stability augmentation system was not working.[68] For static directional stability was poor during autorotation with the directional stability augmentation system working and completely unsatisfactory with it inoperative.

Additional stability and control deficiencies were pointed out by test personnel that were particularly apparent in low level operations. But these deficiencies notwithstanding, the test disclosed the modified H-43B was a much improved helicopter for rescue work at high altitudes.

YHU-1B Category I Tests

Category I performance, stability and control tests were conducted on YHU-1B S/N 58-2078 at the AFFTC from 5 October to 1 November 1960 to determine if the helicopter met performance

67. See p. 126 and 127, Hist of the AFFTC, Jul - Dec 1960, for a discription of the H-43B and a report of incidents.
68. Hq AFFTC-TR-60-21 Addendum I: H-43B Modified Empennage Evaluation, May 1961, p. 18. SD T in Vol 4, this hist.

guarantees. Eighteen flights were made for 24 hours and 40 minutes total flight time. Captain John F. Westphal, USAF, was project engineer and Captain Balfe was project pilot.

The YHU-1B was a single lifting rotor helicopter with a conventional tail rotor manufactured by Bell Helicopter Company, Fort Worth, Texas. Power was supplied by a Lycoming T-53-L-5 gas turbine engine rated at 960 shaft horsepower on take-off. Engine fuel control was trimmed for the test program so the engine would produce 1,100 horsepower, the same as production model YHU-1B's. Design gross weight was 6,600 pounds.

Flying qualities of the helicopter were termed very good and considerably improved over earlier HU-1 series. The YHU-1B met all contractor guarantees for range, hover, cruise speed, and service ceiling. When compared to the HU-1A, the YHU-1B was improved in altitude performance, cruise speed, range, and load carrying ability. But fuel capacity at 165 gallons was a little short for flights under instrument conditions.[69]

Universal Aerial Refueling Production System Suitability Test With F-100 Aircraft

The AFFTC originally tested the Universal Aerial Refueling (UAR) System for F-100 aircraft from 27 May to 4 August 1960.[70] Prototype equipment was used for the test with the idea that a brief follow-on test would be conducted when a production model UAR package became available. Fletcher Aviation Corporation,

69. Hq AFFTC-TR-61-39: YHU-1B Category I Performance, Stability and Control Tests, July 1961, p. 14. SD U in Vol 4, this hist.
70. Hist of the AFFTC, Jul - Dec 1960, p. 130.

manufacturer of the UAR, partially modified the original test item to bring it closer to production configuration and the AFFTC new series of tests began 20 October and ended on 1 November 1960.

Test authority was ARDC message RDRTT-1-1-4-5-E, 1 April 1960, and confirmed by ARDC Test Directive 60-102. Local test authority was AFFTC Project Directive 60-156, 5 April 1960. Mr. Laurence P. Colburn was project engineer and Captain Hanks the project pilot. Their object was to evaluate operational suitability and maintenance requirements of the new UAR production package, investigate discrepancies noted in the original test program, and select a final drogue configuration for the F-100.

Drogues tested were the Fletcher Aviation Corporation (FAC), Dalmo-Victor, "Martini", and the winglet. Tests proved the UAR package satsifactory for operational use except for drogue-stabilator clearance. Stabilator and drogue damage was held to a minimum by cycling the drogue in the optimum 250 to 275 knot indicated airspeed range. The "Martini" drogue was found to be unstable without arm weights, would not blossom fully when arm weights were used, and was unsatisfactory generally. Tests of the Dalmo-Victor and winglet disclosed these drogues to be the most suited for operational use in the UAR with extension and retraction in the 250 to 275 knot range for optimum stabilator clearance.[71]

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71. Hq AFFTC-TR-60-69: Universal Aerial Refueling Production System Suitability Test with F-100 Aircraft, December 1960, p. 29. SD BB in Vol 4, this hist.

The Arresting Cable Pop-Up Device

Purpose of the prototype Arresting Cable Pop-Up Device tests at the AFFTC was to investigate feasibility of a pop-up device to engage unmodified aircraft as well as aircraft equipped with arresting hooks. ARDC Test Directive 60-86 authorized this test which began in September and ended in December 1960. AFFTC project engineer was Mr. Frank N. Lucero.

The system used for this test was an engaging device which pneumatically ejected a pendant cable from a trough in the runway to an engagement point on a moving aircraft. It was installed in an inactive runway at Edwards AFB by Research Incorporated, Hopkins, Minnesota. Research Incorporated also designed, maintained, operated, and calibrated the pop-up device. The AFFTC managed the test and provided engineering responsibility, maintained the BAK-6/F27A absorber, and furnished test aircraft and pilots. Wright Air Development Division furnished a liaison engineer for technical assistance.

An F-84G, F-100A, and a B-47 were the aircraft used to conduct this investigation. Forty-six engagements were completed at speeds from 11 to 164 knots true ground speed. All but six were successful. Three unsuccessful engagements were the result of switch mats not being actuated by the aircraft nose wheel, one was due to an improper control panel setting, and one occurred with two 275 gallon midwing tanks attached to the F-100A. The remaining failure was incurred by attempts to engage the B-47 rear main landing gear which was later determined to be impossible.

Aircraft main gear engagements were demonstrated with the F-100A up to 143 knots and were limited only at this speed by the strength of the runway pendant cable attached to BAK-6/F27A absorber. Engagements of a hook attached aft of the main gear were completed up to 164 knots. Aircraft damage on the F-84G and F-100A was a few dents caused by the cable, but the B-47 main gear engagement attempt resulted in extensive wheel door damage.[72] However, tests proved the pop-up device would engage either the main landing gear of most jet aircraft or a short hook attached to the underside of the fuselage behind the main gear.

Analytical Investigation of the Effects of Vertical Wind Gradients on High Performance Aircraft

Mr. Vincent A. Grosso, an Aeronautical Research Engineer with the Flight Test Engineering Division, Directorate of Flight Test, AFFTC, prepared a report for wind correction during aircraft flight test. Grosso noted in flight testing high performance aircraft, the rate of change of specific energy was used as a measure of performance capability. Vertical wind gradients effected this parameter and caused performance to be improved or degraded when flights were made in their presence. When flight test data was gathered under such conditions, the information obtained had to be corrected for the vertical wind gradient effect if a general

72. Hq AFFTC-TR-61-17: The Arresting Cable Pop-Up Device, April 1961, p. 28. SD CC in Vol 4, this hist.

comparison of day to day test results were to be made on a standard basis. Grosso defined a vertical wind gradient as the rate of change of the horizontal component of wind velocity as a function of altitude. He said an aircraft would experience a gradient effect if it was climbing in any wind condition where the wind was fixed in magnitude but changing in direction, fixed in direction but changing in magnitude, and changing in magnitude and direction.[73]

The report prepared by Grosso illustrated the importance of wind gradient effects and discussed a convenient and accurate means of correction. Pertinent equations of motion were derived and solved on an IBM 704 digital computer programmed to calculate the performance of a hypothetical Mach two airplane flying a particular altitude - true airspeed profile, both in the presence and absence of vertical wind gradients. The derived correction equation was then applied to the calculated climbs obtained under the gradient conditions. Corrected climbs which resulted were then compared to the no wind climbs obtained directly from the computer. From this and other comparisons, an evaluation of the accuracy of the derived correction equation was obtained. The end result was an extremely accurate method of correcting for the effects of vertical wind gradients providing reliable wind information was available.[74]

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73. Hq AFFTC-TR-61-11: Analytical Investigation of the Effects of Vertical Wind Gradients on High Performance Aircraft, Mar 1961, p. 1. SD AA in Vol 4, this hist.
74. Ibid.

Chapter 6

THE X-15 RESEARCH AIRCRAFT PROGRAM

This was a joint National Aeronautics and Space Administration/ Air Force/Navy project. Its beginning may be traced back to June 1952 when the National Advisory Committee for Aeronautics (NACA), forerunner of the National Aeronautics and Space Administration (NASA), began studies of space flight to determine methods of exploring problems attendant to space flight.[1] By 1954 NACA identified its technical areas of concern. Included were high temperature structures, hypersonic aerodynamics, stability and control, and pilotage. It was now necessary to determine the extent to which an advanced research aircraft could contribute to solution of problems already identified.

NACA studies disclosed that development of a manned vehicle to explore identifiable problems was wholly feasible. In consequence on 9 July 1954, NACA presented a proposal for a cooperative X-15 project to the Air Force and Navy. A memorandum of understanding was completed and signed in December 1954 which gave NASA technical direction of the project with advice and assistance coming from a "Research Airplane Committee" composed of representatives of the Air Force, NASA, and Navy.[2] Administration of the design and contruction phases were assigned to the Air Force.

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1. Hist of WADC, 1958, Supplemental Vol III, Development of the X-15 Research Aircraft 1954 - 1959, p. 1.
2. Ibid, p. 9.

Bell, Douglas, North American, and Republic bid to build the bird.[3] North American Aviation, Incorporated, won the competition in September 1955 and later was awarded a contract to build three aircraft (USAF Serial Numbers 56-6670, 56-6671 & 56-6672). The X-15 research vehicle was to be air-launched and propelled by a 57,000 pound thrust rocket engine developed under separate contract by the Reaction Motors Division, Thiokol Chemical Corporation.[4] However, two XLR-11 engines, each the same as the single engine used in X-1 rocket research aircraft but modified to develop 8,000 pounds thrust each instead of 6,000 as in the X-1's, were scheduled for use in X-15 aircraft initial powered flights giving the advantage of a tried and proven rocket engine for early flights and to allow development time for the XLR-99. Reaction Motors was also manufacturer of XLR-11 engines.

Edwards AFB was selected as the location where the X-15 flight program would be conducted and the first X-15 arrived by truck at the AFFTC on 17 October 1958 from the North American Aviation facility in Inglewood, California.[5] In the meantime, two B-52's (NB-52A USAF S/N 52-003 and NB-52B USAF S/N 52-008) had been modified to carry the X-15 to altitude.

For many months prior to delivery of the X-15 to the NASA/AF/Navy Joint Test Force at Edwards AFB engineers were

3. Ibid, p. 16.
4. Ibid, p. 21.
5. History of the AFFTC, Jul - Dec 1958, p. 169.

preparing a flight program for the aircraft equipped with dual XLR-11 engines. Three major areas for the program were (1) prelaunch covering ground support equipment requirements, mating with the B-52, servicing, preflight check list, and other operational items; (2) powered flights of the X-15, and (3) recovery of the X-15 including range requirements, emergency operation, and landings.[6] Maximum use was made of analog and digital computers to predict the X-15 flight envelope and a six-degree-of-freedom analog simulator of North American was used to determine pilot techniques necessary to reach maximum speed and altitude and to define range requirements for each flight.

As finally conceived, the flight test program consisted of two phases: Phase I, contractor demonstration flights, and Phase II, NASA/AF/Navy Joint Test Force flights. All flights from the first captive on 10 March 1959 through Flight Number 56 on 15 December 1960 have been reported in AFFTC semiannual histories. Logs were kept also recording data which were pertinent to each flight.[7] Flight Number 54 on 6 December 1960 by North American test pilot Scott Crossfield in X-15 USAF S/N 56-6671 equipped with the XLR-99 engine completed the North American Aviation contractor demonstration program.

NASA pilot John B. McKay was up for his second familiarization flight on 11 January 1961 in X-15 USAF S/N 56-6670

6. History of the AFFTC, Jul - Dec 1960, p. 67.
7. Flight Log #1, X-15 Program. Appendix B.

equipped with dual XLR-11 engines, but cancelled to a captive flight four minutes prior to launch when an X-15 auxiliary power unit failed. McKay was rescheduled on 1 February and made an uneventful powered flight. Major Robert M. White, USAF, using the same X-15 on 7 February pushed the small engines to a maximum speed of 2,275 miles per hour. This was the fastest speed ever achieved with an X-15 powered by dual XLR-11 engines and was accomplished while simulating a flight pattern to be used later with the X-15 equipped with the larger XLR-99 engine. Following the flight by Major White on 7 February, X-15 USAF S/N 56-6670 was returned to North American Aviation for modification and installation of the XLR-99 engine.[8]

Review of X-15 Flights With Dual XLR-11 Engines

Major White's flight on 7 February 1961 completed the flight program for X-15's equipped with dual XLR-11 engines. Accomplishments in the two year span since the first captive flight on 10 March 1959 were too numerous to detail herein[9] However, areas in which major achievements and investigations of the X-15 made initially included aerodynamic and systems checks, compatability of the B-52 carrier aircraft and the X-15, functional checks of subsystems to 45,000 feet altitude, and systems and subsystems operational checks at various altitudes to 38,000 feet.

8. Hist of Flight Test Engineering Div., Directorate of Flight Test, AFFTC, Feb 1961
9. See Appendix B and semiannual histories of the AFFTC since January 1959 for details of each flight.

When North American Aviation, the contractor, and their test pilot, Scott Crossfield, felt that all was ready for free flight (glide) the X-15 was launched from its carrier B-52 aircraft on 8 June 1959 to check flight characteristics of the rocket research airplane. Next came the first powered flight by Crossfield on 17 September 1959 which proved the capabilities of dual XLR-11 engines to power the X-15 for preliminary investigations and pilot familiarization. During all the captive and glide and powered flights of the X-15, both NASA and the AFFTC supported North American Aviation in data gathering activities.

Of particular import, the third powered flight by North American Aviation using X-15 USAF S/N 56-6671 on 5 November 1959 failed to achieve its objectives. One of eight chambers in the two XLR-11 engines exploded at ignition following launch from the B-52 carrier. With a fire in the lower engine area, Crossfield jettisoned his fuel and made an emergency landing on Rosamond Dry Lake instead of Rogers Dry Lake. The fuselage ruptured just aft of the pilot compartment when the X-15 landed.

NASA test pilot Joe Walker made a flight in the X-15 on 25 March 1960 to inaugurate the NASA/AF/Navy flight test program. By mid-1960, North American Aviation flights as well as NASA/AF/Navy pilot familiarization flights were revealing considerable data such as ballistic control system information, biomedical data (helmet versus suit pressure and suit versus cockpit pressure), and stability, control, and performance characteristics. Each flight by August 1960 also was expanding the X-15 speed and altitude envelopes. Then, on 4 August 1960, Joe Walker piloted X-15 USAF S/N 56-6670 to Mach 3.31 or 2,196 miles per hour--the fastest speed ever attained in a manned aircraft. Maximum altitude attempts followed and on 12 August 1960 Major White shot X-15 USAF S/N 56-6670 up to 136,500 feet altitude, a height which was to stand as the maximum achieved in an X-15 equipped with dual XLR-11 engines. Major White also raised the maximum speed using the same X-15 with dual XLR-11 engines to 2,275 miles per hour on the 7 February 1961 flight mentioned previously.

All of these flights were providing valuable stability information which was telemetered back to ground stations. Moreover, aerodynamic heating data was obtained during Joe Walker's flight of 4 August 1960. Aerodynamic heat build-up investigations continued thereafter with the X-15 held at Mach 3 or better for sustained periods.

For the remainder of the XLR-11 equipped X-15 flight program, familiarization flights for other X-15 pilots occupied the majority of the program. Pilots other than Joe Walker, Major White, and Scott Crossfield were Major Robert A. Rushworth, USAF; Commander Forrest S. Petersen, USN; and John B. McKay and Neil A. Armstrong both of NASA. Important investigations included biomedical monitoring of pilots, X-15 stability, control, and performance characteristics, aerodynamic and structural heating, and flight characteristics of the X-15 hypersonic flow direction sensor (sometimes referred to as "Q-Ball" and "hot nose")--an air direction indicator developed by the Nortronics Division, Northrop Corporation. Q-Ball was designed to aid the pilot in atmosphere exit and reentry. It was shaped similar to a ballistic nose cone and mounted in front of the X-15 replacing the needle-like nose of earlier flights.

Two of the most significant areas of bioastronautic or biomedical monitoring of the X-15 program involved the pilot's personal equipment and the capability of medically monitoring the pilot during flight. The MC-2 full pressure suit, a product of the David Clark Company, was the first operational full pressure suit used in a flight demonstration program of a rocket research aircraft. It was specifically designed to facilitate in-flight medical monitoring of the pilot.

Telemetered physiological data was received on the ground and recorded on board an aircraft for the first time in the United States during an X-15 flight in early May 1960.[10] Since one of the research objectives of the X-15 program was to obtain quantitative physiological data during flight, respiratory rates and heart rates were quantitatively recorded during the next 12 months. Review of the data collected disclosed that no physiological barrier to manned space flight existed.

10. Hq AFFTC TN-61-4: Biomedical Monitoring of the X-15 Program, May 1961. Prepared by Lt Col Burt Rowen, USAF, MC, Chief, Bioastronautics Branch, AFFTC. SD "H" in Vol 2, this hist.

NASA/AF/Navy X-15 Flights with the XLR-99 Engine

From the 7 February 1961 flight of Major White in X-15 USAF S/N 56-6670, only X-15 USAF S/N 56-6671 equipped with the larger XLR-99 engine was used until 30 June 1961. Major White attempted the first NASA/AF/Navy X-15 flight with the XLR-99 engine on 21 February 1961. But he lost his cabin pressure and cancelled the flight three minutes prior to launch. In a second attempt on 24 February, Major White again cancelled, this time just two minutes prior to launch, when a malfunction occurred in the stable platform system. Major White finally achieved success on 7 March when he completed the first NASA/AF/Navy X-15 flight with an XLR-99 engine. He attained 2,905 miles per hour with an engine burning time of 125 seconds at 75,000 feet altitude. Maximum altitude was 77,000 feet and maximum temperature measured during aerodynamic heating was 675 degrees Fahrenheit.[11]

Joe Walker of NASA attempted a maximum altitude flight on 21 March but cancelled due to an electrical failure between the X-15 and the B-52 carrier aircraft. Major John E. Allavie, USAF, pilot of the B-52, elected to land the B-52 carrying the X-15 without jettisoning the X-15's fuel load since he thought take-off for a second try of the mission would occur within a reasonable time. When landing, the B-52 brake parachute deployed but disintegrated. Major Allavie applied heavy braking which caused a fire in the B-52's wheel carriage but the fire was quickly

11. Flight Log #2, X-15 Program. Appendix B.

extinguished and there were no casualties.

This flight of 21 March was reset for 30 March with Walker again at the controls of the X-15. Launch was made without incident and Walker went on to achieve a new maximum speed of Mach 3.95 or 2,756 miles per hour by holding the XLR-99 engine to 75 percent full throttle for 79 seconds. Walker zoomed the aircraft to a new maximum altitude of 169,600 feet following engine burn-out and he experienced a weightless condition for approximately two minutes. Hottest temperature recorded on the X-15's surfaces was 530 degrees Fahrenheit. Also, the newly developed AP/22S-2 full pressure suit was worn for the first time during an X-15 Flight.[12]

Major White on 21 April was next to pilot the X-15. He launched at 45,000 feet and dropped to 37,000 feet in 30 seconds before the engine ignited. Using full power for 67 seconds at 79,000 feet, Major White attained a speed of Mach 4.62 or 3,074 miles per hour. Tail surfaces of the X-15 registered 657 degrees Fahrenheit during the speed run. Maximum altitude was 105,000 feet with the pilot going weightless for 60 seconds.

Walker attempted another flight on 19 May, but cancelled two seconds prior to launch when his radar beacon went out, an auxiliary power unit failed, and cabin pressure difficulties arose.[13] Walker's next try on 25 May was successful. He hit a

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12. Hist of Flight Test Engineering, Directorate of Flight Test, AFFTC, Mar 1961.
13. Interview by author with Mr. Richard J. Harer, Manned Spacecraft Office, Flight Test Engineering Div., Directorate of Flight Test, AFFTC, 13 Mar 1962.

new maximum speed of 3,307 miles per hour (Mach 4.9) at 90,000 feet while using 73 seconds of 87 seconds engine burning time.

Major White was up again on 20 June, but this flight was cancelled nine minutes before launch due to a malfunctioning auxiliary power unit. White was rescheduled and successfully flew on 23 June. At an altitude of 97,170 feet and the engine on full throttle for 75 seconds burning time, Major White pushed the X-15 to Mach 5.3 (3,603 miles per hour). Highest altitude during the flight was 107,700 and maximum temperature or heat on surfaces of the X-15 was 830 degrees Fahrenheit. Velocity on this flight was 5,285 feet per second.[14]

North American Aviation returned X-15 USAF S/N 56-6672 on 15 June from their factory in Inglewood to their flight test facility at the AFFTC. This airplane had been undergoing modification and repair since it was severely damaged by explosion on 8 June 1960 during an XLR-99 engine ground test firing at the AFFTC.[15] By 30 June 1961, all three X-15's were equipped with XLR-99 engines. Number one (56-6670) was up 36 times with 21 successful powered flights, Number two (56-6671) was up 33 times with 17 successful powered flights, and Number three (56-6672) was never flown. Fiscal Year 1961 AFFTC X-15 support of NASA was $569,000.[16]

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14. Hist of the Flight Test Engineering Div., Directorate of Flight Test, AFFTC, Jun 1961.
15. Hist of the AFFTC, Jan-Jun 1960, p. 93 and 161.
16. C-82 Report, DCS/Comptroller, AFFTC. Program Structure 605A was changed to 653A in the fourth quarter of FY-61.

Future Plans for the X-15

The X-15 program for the future will be oriented toward continuing research investigations in flight characteristics at high angles of attack, aerodynamic heating, reaction controls, adaptive control system performance, display, and energy management.[17] In the latter case, the goal was to provide a working on-board display for the pilot's use in selecting his landing site. Determination of flight characteristics at high angles of attack, in the range of 15 to 25 degrees, were required before attempting flights above the 250,000 feet X-15 design altitude.

Future altitude exploration flights above 250,000 feet (probably in 1962) were planned to acquire information up to 400,000 feet at speeds of 2,000 to 5,500 feet per second. Of major interest in this phase of the program will be such piloting aspects as display, guidance, precision of control, and bioastronautics. The ultimate operational goal of in-flight biomedical instrumentation was to enable a flight surgeon to observe a pilot's physiological condition on a real-time console on the ground. Such a display panel would present in the most useable form items that would best indicate the pilot's physiological status plus the cockpit environment. Then if

17. NASA News Release 32-61, 22 Nov 1961. Prepared from a presentation at the Third X-15 Conference at Edwards AFB, 20 - 21 Nov 1961 given by Paul F. Bikle, Director of the NASA Flight Research Center and Lt Col Edwin F. Pezda, USAF, X-15 Project Office, AFSC, Wright-Patterson AFB. Referred to hereinafter as NASA News Release 32-61.

any portion of the X-15 cockpit environmental systems were producing adverse physiological effects without the pilot taking corrective action, appropriate direction could be made from the ground to correct the condition.[18]

When programs already planned were completed, follow-on programs would explore areas partially investigated previously. Numerous space experiments have been proposed which would make use of the X-15 as a test bed to obtain information at altitudes from 150,000 feet to 350,000 feet. Proposals received were evaluated and the extent to which additional follow-on experiments would extend the program will be decided by the Research Airplane Committee. Completion of the current X-15 research program would carry it well into 1963.[19]

18. AFFTC-TN-61-4: Biomedical Monitoring of the X-15 Program, May 1961. SD "H" in Vol 2, this hist.
19. NASA New Release 32-61.

Chapter 7

AIRCRAFT ENGINE DEVELOPMENT AND TESTING

Manned and unmanned aircraft propulsion systems were the responsibility of the Propulsion Branch,[1] Technical Support Division, Directorate of Flight Test. The Propulsion Branch was located in Building Number 3800 which was completed in December 1955 at a cost of $829,000.[2] In addition, a gas turbine engine overhaul shop was enhanced in 1956 by acquiring a metallurgical laboratory under Contract AF-04-(611)-2854 favoring the Red Diamond Construction Company, Inglewood, California.[3] This facility supported evaluation of new gas turbine power plants and related components. Evaluation included disassembly, repair, and re-assembly of engines and accessories, an engineering analysis of deficiencies, and recommendations for product improvement. Equipment and facilities in the overhaul shop included an X-ray laboratory for testing engine fuel and oil accessories, gas turbine rotor balancing machines, magnaflux and zyglo inspection equipment, and ten engine repair and assembly bays capable of accommodating 30-foot engines weighing up to 10,000 pounds.

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1. The Power Plant Branch was renamed Propulsion Branch, 6 Sep 1960. AFFTC Organization and Functions Chart No. 21 B, 6 Sep 1960.
2. Extract of Real Property Records, Civil Engineering Div., 6510th ABG, AFFTC, by MSgt Chas Eppley, 22 May 1960. Building 3800 was built by McDonald Bros., under Contr No. DA-04-353-Eng-2290. McDonald finished Contract in two increments--the first in Jan 1954 ($372,000) and the second in Dec 1955 ($457,000).
3. Interview by MSgt Charles Eppley with Custodian, Real Prop Records, Civ Engr Div, 6510th ABG, AFFTC, 23 May 1961.

In 1958, four huge engine test cells were added to the Propulsion Branch complex under Contract Number DA-04-353-Eng-4691 at $4,120,000 in favor of Shaw, Estes and Associates, Dallas, Texas.[4] The test cell unit contained four individual cells which supported ambient static testing of turbojet (three cells) and turboprop (one cell) engines having a maximum of 50,000 pounds thrust or 25,000 horsepower respectively.

Finally, an X-15 rocket engine overhaul and test facility costing $490,000 was added to the Propulsion Branch in February 1960.[5] It was not adjacent to the Propulsion Branch complex like all previous additions, but was located about a mile away on Rogers Dry Lake for easy access by X-15 aircraft and carrier B-52's. Shop facilities, a test stand, and fuel storage tanks used in testing XLR-11 and XLR-99 rocket engines were the main items of the X-15 rocket engine overhaul area. The test stand which could support engine testing either installed in aircraft or removed had a maximum thrust capacity of 100,000 pounds.

4. Extracted by MSgt Chas Eppley from records maintained by the Corps of Engrs. Negotiations were finalized on 29 June 1956 and work started on 28 Jul 1956. Face value of the Contract was $4,120,000 to build four inclosed type cells accoustically treated to reduce intake and exhaust noises. Construction services included fully instrumented control rooms, installation of mechanical equipment, pressure systems, and electrical items. Actual cost was $4,421,356.
5. P. J. Walker Construction Co. received Contract Number AF-04-(611)-3003 on 27 Feb 1958 to build $318,000 (actual cost over $400,000) worth of facilities in addition to items added by North American Aviation, Inc. Interview by MSgt Chas Eppley with Glenn Felix, Asst Ch, Propulsion Branch, 23 May 1961.

Mission of the Propulsion Branch was to evaluate rocket and gas turbine engines through static test firing, disassembly, and inspection, and to initiate recommendations for engine design changes. Specifically, the Propulsion Branch was responsible for engineering evaluation and functional development of prototype and new production aircraft rocket and gas turbine engines being flight tested at the Air Force Flight Test Center (AFFTC).[6] Propulsion Branch personnel also provided and operated facilities for development, testing, and repair of flight test rocket and gas turbine engines, including support of contractors. In addition, the Propulsion Branch accomplished testing after minor repair of gas turbine engines in AFFTC support aircraft.

Otha J. Clark was chief of the Propulsion Branch. His assistant was Glenn S. Felix, who was also acting chief project engineer following the departure in December 1960 of chief project engineer Captain George W. Watts, USAF. Felix was relieved as acting chief project engineer on 9 July 1961 by Donovan L. Teegarden who was assigned as chief project engineer.[7]

Personnel authorized on 30 June 1961 were two officers, 23 airmen, 14 graded Air Force employees, and 82 wage board. One officer, 25 airmen, 13 graded, and 83 wage board were assigned.[8] Their workload was generated primarily from processing 155 gas turbine engines and 70 propulsion system test

6. Hq AFFTC Organization and Functions Chart Nr. 21, 10 Jul 61.
7. Interview by MSgt Charles V. Eppley with Mrs. McCampbell, Secretary, Propulsion Branch, AFFTC, 13 Nov 61.
8. Ibid.

stand (PSTS) rocket engine firings for the six months ending 30 June 1961. Processing of gas turbine engines was defined as any maintenance, overhaul, and test; and could be any one, any combination, or all three.

X-15 Rocket Engine Testing

In the previous AFFTC history, a complete report was made on the development of Reaction Motors Division XLR-99 rocket engine for the X-15 rocket research aircraft.[9] It was noted that the third and final North American Aviation contractor demonstration flight of the X-15 using XLR-99 Serial Number 103 went off on schedule 6 December 1960 with three successful inflight restarts made by contractor test pilot, Scott Crossfield.[10] First powered X-15 flight in the Air Force/NASA/Navy flight research program using the XLR-99 rocket engine was made on 7 March 1961.[11] In all, nine flights were attempted until 30 June but only five attempts resulted in successful powered flights. However, it was important to note that none of the cancellations was due to XLR-99 rocket engine failures.[12]

Besides the five X-15 powered flights with the XLR-99 engine, 70 propulsion system test stand XLR-99 engine runs were performed. As mentioned in the previous AFFTC history, XLR-99-RM-1 engine Serial Number 101 which arrived at the Center

9. Hist of the AFFTC, Jul - Dec 61, p. 150.
10. Ibid, p. 160.
11. X-15 Flight Log #2, Hq AFFTC, 7 Feb 61. Appendix B, this hist.
12. Ibid.

Propulsion Branch 6 June 1959 for use as a ground test engine only was suspended from further testing when a large crack opened in its thrust chamber.[13] Overhaul was accomplished and seven runs followed in January 1961 to check repairs and evaluate a North American Aviation prime system modification. Modified production isolator mounts were then installed on the engine and six more ground test runs in February were made to investigate a vibration problem. During these runs also, modified helium flow restrictors were evaluated and flight missions with extended hold periods were simulated.[14] Following final shutdown on the last run a cooling tube in the thrust chamber throat was found cracked. The tube was repaired by a NASA welder under the guidance of a Reaction Motors Division welding engineer. After welding the tube, the thrust chamber throat area was experimentally patched with Rokide applied by a plasma arc process to determine if a permanent fix were possible. Ten propulsion system test stand ground test runs were made in March 1961 using XLR-99 Serial Number 101 to complete North American Aviation rocket engine ground test objectives. After removal of engine Serial Number 101 from the propulsion system test stand, it was given a 30-minute periodic inspection and equipped with a provision for 30 percent thrust operation.

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13. Hist of the AFFTC, Jul - Dec 61, p. 160.
14. Hist of the Propulsion Branch, Tech Supp Div, Dir of Flight Test, Hq AFFTC, Feb 61, p. 3. In files of the AFFTC Historical Branch.

Thirteen propulsion system test stand firings were accomplished using XLR-99 Serial Number 103. Eleven ground test firings were made to evaluate installation of a new thrust chamber following the third XLR-99 equipped X-15 contractor demonstration powered flight on 6 December 1960 when the original thrust chamber was cracked.[15] Number 103 was delivered to NASA in March 1961 as a serviceable spare. But it returned to the Propulsion Branch in April for further ground testing when it was determined that the validity of the mixture ratio data on the engine was questionable. This doubt arose when the Propulsion Branch found during calibration of all propulsion system test stand instruments that the test stand fuel flowmeter was mechanically damaged.[16] The deficiency was corrected and two more test stand firings were made with engine 103 before delivering it to NASA for installation in X-15 Number 66671 (#2).

XLR-99-RM-1 rocket engine Serial Number 106 was received by the Propulsion Branch from Reaction Motors Division during March and ground fired six times prior to 30 June. Four field acceptance tests were fired before turning the engine over to NASA as a serviceable flight engine for installation in X-15 Number 66671 (#2). When an engine malfunction shutdown occurred

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15. Hist of the AFFTC, Jul - Dec 61, p. 160.
16. Hist of the Propulsion Branch, Tech Supp Div, Dir of Flight Test, Hq AFFTC, Apr 61, p. 3. In files of the AFFTC Historical Branch.