Flight Test NEWS

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Stuber Announces AIAA, SFTE, and SETP Plans For Combined Testing Manual Publication

Measurement of Launch Loads on the Douglas A-4 Catapult Hook

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NATC, Flight Test Division

Recent operational experience in the U. S. Navy has evidenced a potential problem with the catapult hooks on the A-4 Skyhawk. The catapult hooks, which are underwing mounted, link the aircraft to the shipboard steam catapult through a removable cable called a bridle. Losses of three or more aircraft are thought attributable to catapult hook breakage.

In the course of qualification testing of components, the McDonnell-Douglas Company have demonstrated and cleared the catapult hooks and fittings to a life of 1200 launches in lab testing. Typically, a launch was considered to be one cycle of combined 80,000 lb axial load and 18,000 in-lb torque about the axial load axis. The torque load simulated the load caused by "unlaying" of the bridle. The fact that fleet failures had an average life of 600 launches implied that the lab tests did not adequately reproduce the service loadings.

The Naval Air Test Center was requested to instrument an A-4 aircraft and measure the actual launch loads on the catapult hooks. These tests were to be conducted on the shorebased TC-7 steam catapult at Patuxent River, Maryland. The catapult hooks were instrumented with strain gages to measure axial load, torsion about the main axis, and vertical and lateral bending in the hook shank. The aircraft was also instrumented to measure longitudinal acceleration. The hooks were lab calibrated and interaction relations determined.

The flight test program with the instrumented hooks was structured to provide a wide range of launch endspeeds and aircraft gross weights in hopes of determining the effect of both of these factors. In addition, it was planned to position the aircraft on the catapult off-center to the left and right up to 10 inches as well as on-center.

As the test program progressed, several items of note appeared. There was a distinct oscillatory vertical bending moment occurring during the launch with a frequency of approximately 2-3 Hz. This was particularly unexpected since the hook is mounted on a spherical bearing and the moments were occurring without the hook contacting its restraining stops. A second and important phenomena was a very rapid high amplitude vertical bending moment occurring within 0.02 seconds of the end of the catapult power stroke. This

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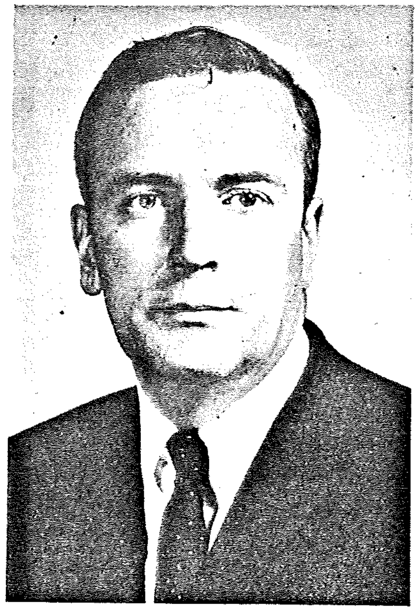

SFTE President Stuber

Patuxent River, Dec. 20, 1971 – The Society of Flight Test Engineers has been invited to join with AIAA and Society of Experimental Test Pilots representatives in a joint working group meeting to formulate and plan continued efforts in the publication of testing manuals. Mr. B. V. Stuber, SFTE President, announced that Mr. W. S. Lowe, Chairman of the AIAA Flight Testing Committee, had offered the invitation.

The working group meeting is scheduled during the AIAA 10th Aerospace Sciences Meeting, at the Town and Country Hotel in San Diego on 18 January 1972. The SETP and AIAA have already written the "Pilot's Handbook for Exploratory Flight Testing" which is to be printed this month. This handbook is written primarily for the test pilot. Mr. Stuber envisions a manual of enlarged scope to cover the flight test engineers' involvement in the planning, analysis and reporting of flight test programs.

Mr. Lowe stated, in a letter to Stuber, "We would very much appreciate discussing the affiliation of SFTE with the present SETP/AIAA group in order to present a solid professional society foundation to this continuing effort." Mr. Stuber has not yet named the SFTE representative, but reported that the Society would definitely be represented.

Holiday Greetings

Solving the Submarine Problem?

High on the Navy's list of priority problems is that of ASW (anti-submarine warfare). To date the detection and localization of a submarine has proven to be a very difficult problem, indeed. However, the R & D Community may well be on the road to achieving one, or several, major breakthroughs in reaching a solution to this problem. At a recent symposium on this subject, the following valuable insights to some of these possible problem-solving techniques were presented (depending on one's discipline):

1. The Physicist's Method: Irradiate the ocean with neutrons, so that H_2O becomes ^4H_2O. Submarines will become excessively buoyant and cannot submerge. Their disposition can then be undertaken at leisure.

2. The Chemist's Method: Place in the ocean large quantities of lysergic acid. The fish population becomes terrified at the prospect of loneliness and clusters about submarines in a frenzy of affection and admiration, thereby constricting the movement of submarines to a level of ineffectuality.

3. The Engineer:s Method: Construct a large filter system having a mesh of about 8 meters and pump ocean water through it at the rate of 15×10^6 liters/day. This will recirculate the oceans daily. Because of the mesh of the filter, only the submarines will be trapped.

4. The Mathematician's Method: Construct a large Klein bottle that can contain the necessary numbers of submarines. Note that the submarines are initially outside of this bottle. However, the outside of a Klein bottle is also its inside. Therefore, the submarines are inside the bottle. (Two-dimensional submarines may be disposed of by a suitable Mobius strip.)

5. The Ballistician's Method: Equip all antisubmarine warfare ships with green paint. On detecting a submarine spread the paint over the sea surface and remain quiet. The submarine rises to investigate, but its periscope becomes covered with green paint. It therefore believes itself to be underwater and continues to rise. When it has reached a convenient altitude, shoot it down with antiaircraft fire.

6. The Economist's Solution: Induce the USA to use sea water rather than gold to support its currency. The French will immediately start to sequester it in their vaults in such quantities that by the time the supply and demand curves cross, all submarines will either be (a) aground or (b) securely locked up in French safe deposit boxes.

Contributor Anonymous

Army-Navy to Revise Helo Flying Qualities Specification

The general requirements for helicopter flying and ground handling qualities, MIL-H-8501A, will be revised. A team composed of Army Aviation Systems Command, Naval Air Systems Command, and Pacer Systems, Inc. will update the 1961 specification to reflect current requirements and capabilities. Publication date for the revised document is September 1972.

The joint group has already met and established basic philosophies. The current effort will be an interim specification to bridge the gap between the current MIL-H-8501A and the final M-H-8501C version. Compound helicopters (such as the AH-56, S-67, etc.) will not be addressed. The format will be based largely upon the fixed wing 8785B specification. Pacer Systems will be utilized to accomplish a literature search, access format, and play the "Devil's Advocate" role. The starting point for rewrite will be the unpublished Army version of MIL-H-8501B.

The U. S. Air Force has decided to apply its VTOL/STOL specification (83300) to helicopters, and is not participating in this project.

Contributed by R. L. Wernecke
NATC Patuxent River

Fairchild Reports Slight Increase

Fairchild Industries reported sales of $188,281,000 and earnings of $4,976,000 for the first nine months of 1971.

Earnings reflected a slight increase over the $4,949,000 reported for the same period a year ago, although sales declined from the $201,850,000 recorded during the first nine months of 1970.

Earnings per share remained level at $1.09 for the first nine months, unchanged from the previous year.

Commenting on recent developments, President Edward G. Uhl said that Fairchild, in anticipation of lower sales caused by continued softness of commercial airlines and aircraft markets, had instituted successful cost cutting procedures, such as reducing general, administrative, marketing and development expenses from $25 million to $[illegible] million. Furthermore, siza[illegible] savings in interest charges h[illegible] resulted from a $46 million reduction in bank loans since the beginning of the year.

Fairchild Industries yesterday announced plans to establish a new subsidiary to acquire the assets of the Swearingen Aircraft Company of San Antonio, Texas, manufacturer of the Merlin and Metro series of aircraft.

Mr. Uhl also noted that Fairchild recently was awarded an Air Force contract for 15 of its STOL Peacemaker aircraft. This is the first procurement of a military version of the commercial Fairchild Porter which the company has been building for several years. The potential for additional sales is promising.

Also during the period, Fairchild received a new contract from the Boeing Company for continued production of wing control surfaces for 747 Superjets and won its first substantial orders for food and beverage service equipment for [illegible] new Lockheed L-1011 TriSt[illegible] aircraft.

Development of the two experimental safety automobiles

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A-4E Launch Loads

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spike was traced to the application of the Van Zelm bridle arrester. The magnitude was also found to be a function of aircraft endspeed and point of application of the Van Zelm bridle arrester. The magnitude of this bending moment, up to 32,000 in-lb at the spherical joint, was sufficiently large to have a significant effect on the hook fatigue life. It was also found that the maximum axial load of 80,000 lb was very difficult to reach and that the 18,000 in-lb "unlaying" torque was approximately double the measured values.

In an effort to learn more about the loads imposed on the A-4 catapult hook, NATC conducted further laboratory tests to define the loading mechanisms and verify the strength of the hook in bending.

The tests were conducted on an A-4E catapult hook that was restrained by a representative wing fitting with ball joint. The wing fitting was held in a Douglas fixture which simplified attachment to the loading machine. The axial load was applied to the hook by a typical bridle fitting swagged on a 5 foot length of cable. The freedom afforded by the ball joint, cable, and fitting allowed the system to align itself properly short of the hook hitting its stops. Vertical bending moments were introduced by applying normal loads to the bridle fitting at the Van Zelm lanyard shackle with a hydraulic jack.

The catapult hook was instrumented with strain gages to measure axial load and vertical bending moment at one station only. The axial gages were calibrated in the Southwark Emery tension machine to 80,000 lb. The vertical bending gages were dead weight calibrated to 7,000 in-lb. This calibration limit was used because of weight basket limitations. Since the calibration was linear, up and down loading, extrapolation was used where required.

The test program was begun by applying various bending loads up to 5,000 lbs. in combination with various axial loads up to 20,000 lb. The purpose of this exercise was to establish procedures for attaining desired axial and bending loads simultaneously. This was a problem because the axial and bending loads were both applied through the same fitting. Consequently, each load directly affected the other. The process which worked best was one of diminishing incremental loads applied alternately for desired axial and bending loads. It would require considerable refinement to use this system for fatigue loadings. An alternate load path arrangement would be desirable.

In another series of loadings, the axial load was maintained at some nominal value while the vertical bending load was increased until the hook was just short of contacting the fitting.

It was found that bending moments up to 2,200 in-lbs. were measured without being in contact with a stop. The maximum bending moment occurred at a value of lanyard load well below that required for stop contact. The source of the resisting moment and its nature were not determined. However, the laboratory achievement of this bending moment should serve to verify the

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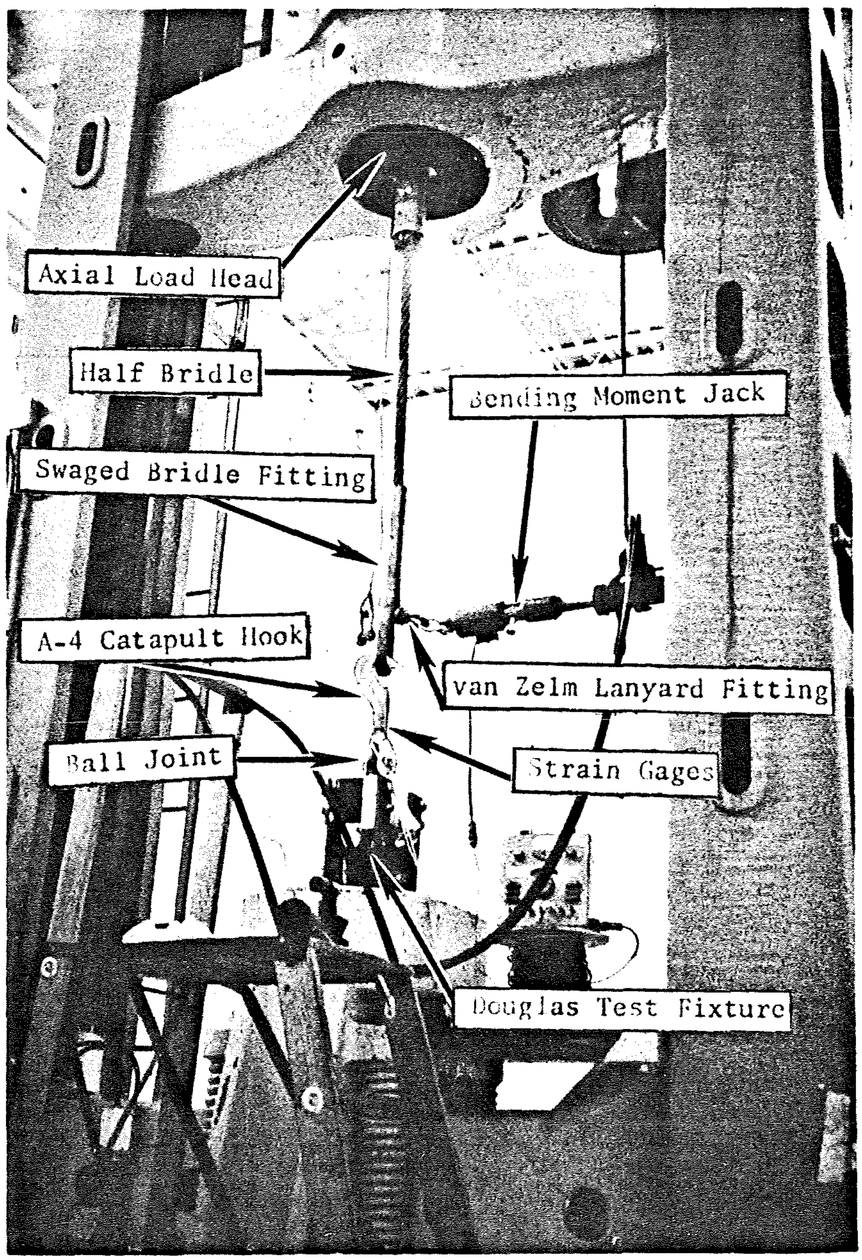

A-4E Catapult Hook Undergoing NATC Lab Tests.

A-4E Launch Loads

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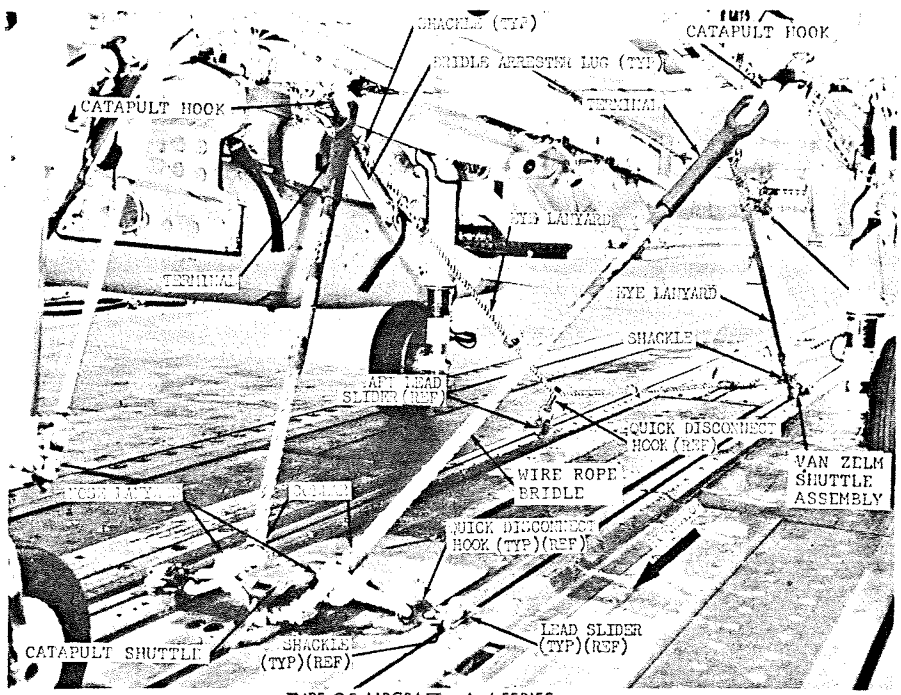
existence of vertical bending moments observed in the early and middle phases of actual catapult launches. From the laboratory data, it also appears quite reasonable that bending moments of 3,500 in-lb. at axial loads of 75,000 lb. are valid conditions for a test point.

It is thought that the bending moments during mid-stroke are caused by the introduction of a concentrated moment at the juncture of the bridle fitting and catapult hook. The concentrated moment is the result of a change in aircraft attitude during the catapult stroke and the inability of the bridle fitting to rotate in the hook throat due to the extremely high Hertzian stresses at the juncture. This moment is balanced by the cable tension and a slight change in the elevation of the catapult hook above or below the original equilibrium position. The effect of the mid-stroke bending moment is thought to be of limited significance.

In the actual catapult tests, bending moments of 18,000 in-lb. were recorded during the final phase of the launch. One source of conjecture on the validity of this data concerned the strength of the hook in bending. In an effort to validate this data, the hook was loaded in the laboratory to bending moments of 18,000 in-lb. with combined axial loads of 5,000 and 10,000 lb. At the completion of the tests, there was no observed deformation or other damage to the hook or fitting. The required lanyard load to produce the 18,000 in-lb. bending moment varied from 5,000 to 7,000 lb. When considered with the lanyard geometry on the actual installation, the loads are in good agreement with catapult data. This test series verified the strength of the hook to withstand the loads measured on the catapult. On this basis, it appears that test conditions of 18,000 in-lb. with axial loads of 10,000 lb. or less are realistic.

The high bending moments encountered at the end of the power stroke were found to be directly related to the Van Zelm brake application point. The earlier the brake was applied, the higher bending moment. It became clear that with early brake application,



TYPE OF AIRCRAFT - A-4 SERIES
TYPE OF BRIDLE - FORGED EYE
APPLICABLE TYPE(S) OF BRIDLE ARRESTER SYSTEM(S) -
MK 2 - MOD 0, MK 2 - MOD 2, MK 4 - MOD 1, MK 4 - MOD 2
TYPE OF CATAPULT - STEAM

A-4 Catapult Hook-up.

there was still a significant bridle load from the catapult shuttle on the hook and that the bridle and bridle arrester lanyard combined to give a very high net down load on the hook. This down load was sufficient to force the hook rapidly against its down stops. The resulting impact load as the hook hit its stops aggravated the peak bending moment considerably. The instrumentation showed that there was sufficient energy stored in the hook from bending after impact, that after the bridle was shed from the hook at the end of the power stroke, the hook rebounded alternately against its upper and lower stops as many as six times. While this number is not significant in itself, it is indicative of the abuse to which the hook was being subjected. A direct result of this finding has been a program to more easily and accurately set the application point of the Van Zelm bridle arrester to keep this point as late as possible without excessive runout of the bridle arrester after the power stroke. This work on the Van Zelm brake is still in progress at NATC, Patuxent River, Maryland.

As another result of the flight and laboratory tests at NATC, McDonnell Douglas has been contracted to conduct further tests on the A-4 series catapult hooks. These new tests, expected to begin in Spring, 1972, will now include bending moments up to 18,000 in-lb measured at the midpoint of the shank along with combined axial load and torsion. These tests, part of the Service Life Extension Program (SLEP), should help to extend the carrier operational life of the A-4 Skyhawk with a high degree of confidence in the "advertised" fatigue life.

"The Flight Test Engineer's Creed."

"The aeroplane does do these things, and if the theory does not give warranty for the practice, then it is the theory which is wrong."

JOHN WILLIAM DUNNE
April 1913

Jet Ranger II Certified At 3200 Pounds

Bell Helicopter Jet Ranger II (Model 206B) featuring the new 400 SHP Allison 250-C20 engine has been certified by the Federal Aviation Administration (FAA) for 3200 pounds gross weight, an increase of 200 pounds.

Use of the 400 SHP Allison engine derated to 317 SHP and 270 SHP, takeoff and maximum continuous respectively, allows the Model 206B to operate with full loads at much higher altitudes and temperatures than the presently certified Model 206A with the 250-C18 engine.

Special attention was given to increasing gross weight and performance characteristics at a minimum of cost. This allows the operator to purchase a Model 206B at little initial cost over the Model 206A, or to convert a Model 206A to a Model 206B at a minimum of cost. In addition to holding cost at a minimum, center of gravity limitations, rpm and airspeed limitations were established to allow the helicopter to operate under a variety of loading configurations, yet give the customer a relatively low vibration ride while operating at maximum gross weight.

These aims have been accomplished in the Model 206B, and the aircraft should prove to be a reliable, economical helicopter that can carry more pounds a given distance in less time and with no increase in direct operating cost over the presently certified Model 206A with the Model 250-C18 engine.

Contributed by David Gastinger
Flight Test Engineer
Bell Helicopter Co.

Fairchild

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which Fairchild is building for the Department of Transportation is on schedule. The first one will be delivered in late December of this year, and the company's opportunity to win a follow-on contract for 12 more safety cars appears excellent, Mr. Uhl said.

Navy "AIMS" Testing

AIMS is an acronym for Air Traffic Control Radar Beacon System (ATCRBS), Identification Friend or Foe (IFF), and Mark XII Systems. ATCRBS is used to provide reporting (Mode C and 4069 codes, identification and position reporting (Mode 3/A)) to the Federal Aviation Administration (FAA) and military ground stations. IFF is a general class of "L" band equipment which provides range, azimuth, and identity of aircraft to ground stations. The Mark XII system is capable of operating on Mode 4 (crypto, secure mode, military only).

On 29 April 1965 the FAA notified the public of plans for the development and improvement of the National Aerospace System and alerted users to proposed airborne equipment requirements. The proposal discussed, among other items, the ATCRBS requirements. An FAA Notice of 5 March 1969 stated that by 1 January 1973 all aircraft operating in controlled airspace at and above 10,000 feet mean sea level, and in terminal airspace within which transponders are required, must have ATCRBS installed.

There are approximately 60 models of Navy aircraft which must be tested and evaluated for AIMS compatibility. Two or three aircraft of each model are required for approximately three weeks each for testing. All Navy AIMS test and evaluation is conducted at the Naval Air Test Center, Patuxent River, Maryland, under the direction of the Naval Air Systems Command.

The testing involves two basic types: (1) Pre-AIMS testing is required to determine the static pressure position errors of the basic aircraft without AIMS equipment, and (2) Post-AIMS testing to investigate the ability of the AIMS installation to perform within the AIMS specifications under aspects of the aircraft operating envelope. In order to retrofit all necessary aircraft by the deadline of 1 January 1973, the test and evaluation of all Navy aircraft was to be completed by 1 January 1972.

With the advent of more and more air traffic in our National airspace, it is imperative that tighter control be maintained to insure the safety of air travelers. Some of the benefits to be derived from the AIMS concept are:

(1) Enhance safety due to increased flexibility and reliability of aircraft identification and tracking;
(2) Improve safety by automatically displaying aircraft altitude to the controller;
(3) Reduce volume of communications between controller and pilots;
(4) Improve utilization of airspace by providing controllers with continuous altitude data on climbing or descending aircraft;
(5) Increase the effectiveness of the air traffic controller by permitting him greater selectivity in viewing targets in or near the airspace under his jurisdiction; and
(6) Reduce the number of advisories and traffic avoidance vectors required in the provision of radar traffic information and vectoring service.

Technical Papers Available

In response to inquiries from the Los Angeles Chapter, the Publications Committee announced that technical symposium papers will be available individually at a cost of $1.00. This applies to papers presented at both the first and second symposiums. The committee emphasized that it would prefer selling the papers in complete sets. Mr. R. B. Siegel is the contact at the National Headquarters address.

The Naval Air Test Center completed the Phase I Navy Preliminary Evaluation of the F-14 at Grumman's Calverton test facility on December 18, 1971. NATC pilots flew 39 flights for 73.9 hours during the evaluation.

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