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U.S. and U.S.S.R. Military Aircraft and Missile Aerodynamics (1970-1980)

A Selected, Annotated Bibliography

Volume I

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INTRODUCTION

The purpose of this selected bibliography is to list available, unclassified, unrestricted publications which provide aerodynamic data on major aircraft and missiles currently used by the military forces of the United States of America and the Union of Soviet Socialist Republics. Technical disciplines surveyed include aerodynamic performance, static and dynamic stability, stall-spin, flutter, buffet, inlets, nozzles, flap performance, and flying qualities. Concentration is on specific aircraft including fighters, bombers, helicopters, missiles, and some work on transports which are or could be used for military purposes. The bibliography is limited to material published from 1970 to 1980. The publications contained herein illustrate many of the types of aerodynamic data obtained in the course of aircraft development programs and may therefore provide some guidance in identifying problems to be expected in the conduct of such work. As such, this information may be useful in planning future aircraft research programs.

Although primary emphasis is placed on aerodynamic reports on specific aircraft, a limited number of more general publications are included which contain, for example, data on aircraft geometry and specifications. A few pertinent publications which address more general aeronautical topics, such as aircraft design and variable sweep, are also included. Advanced technology reports on research aircraft or paper designs are generally avoided unless the advanced technology is being investigated using an existing aircraft. Examples of this latter case include studies of two-dimensional nozzles and supercritical aerodynamics.

Considerable effort was made to survey as much relevant literature as possible from many different sources. However, an immense amount of information on the subject aircraft has been generated during the past decade. Therefore, this report contains only a partial listing of the available literature and some important papers may have been inadvertently overlooked.

Four NASA bibliographic publications (citations 134, 203, 228, and 280) which cover work published to date under the NASA Supersonic Cruise Research and other supersonic research programs are included. In addition, citation 218 summarizes many military aircraft contributions made by the NASA Langley Research Center.

Limited use is made of technical magazine articles; these publications provide some up-to-date information on current aircraft programs. A list of serial publications is provided in appendix A; these sometimes feature data reports and related articles on current aircraft. Appendix B lists a group of books covering both historical and summary information on the subject aircraft.

This report is published in three volumes because of the range of classifications: Volume I, Unclassified–Unlimited (NASA TM-81951); Volume II, Unclassified–Limited (NASA TM-83113); and Volume III, Secret (NASA TM-83114).

Persons wishing more information on specific topics or aircraft should check the reference lists in those documents described here which are pertinent to their interest. They also are urged to use the services available from NASA and/or the Defense Technical Information Center (DTIC) for computer data bank searches. Technical libraries at NASA research centers can fill such requests.

The items selected for inclusion in this bibliography are arranged chronologically by dates of publication. Author and subject indexes are found at the end of the bibliography. Airplanes, helicopters, and missiles are also indexed by names or other designations to facilitate the use of this bibliography.

In most cases, abstracts used are from the NASA announcement bulletins "Scientific and Technical Aerospace Reports" (STAR) and "International Aerospace Abstracts" (IAA). In other cases, authors' abstracts were used. License was taken to modify or shorten abstracts. If it is known that a paper has appeared in several forms, mention is made of this fact.

Identifying information, including accession and report numbers (when known), is included in the citations in order to facilitate the filling of requests for specific items. When requesting material from your library or other source, it is advisable to include the complete citation; the abstract may be omitted.

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BIBLIOGRAPHY

1 *Hollingsworth, E. G.; and *Cohen, M.: **Comparison of Wind Tunnel and Flight Test Techniques for Determining Transonic Buffet Characteristics on the McDonnell Douglas F-4 Airplane.** Presented at AIAA Aerodynamic Testing Conference, St. Louis, Mo., May 18–20, 1970. Also Journal of Aircraft, vol. 8, no. 10, Oct. 1971, pp. 757–763.

AIAA Paper 70-584 A70-29886#

This paper compares the results of experimental programs conducted to determine the transonic buffet characteristics in several wind tunnels with the results of flight by various techniques on the Model F-4 airplane. Wind tunnel tests were conducted in cooperation with NASA at Langley Research Center and at McDonnell Douglas. Wind tunnel instrumentation for buffet onset included a wing tip accelerometer, wing root strain gage, wing trailing edge pressure taps, and force data. Flight test investigation of buffet characteristics of the Model F-4 airplane was conducted under Air Force Flight Dynamics Laboratory contract. Flight test instrumentation includes wing tip and pilot seat accelerometers, wing root, aileron, and stabilator strain gages, wing trailing edge pressure taps, a boundary layer pressure rake and wing tufts. Wing leading edge maneuvering slats were also tested in the wind tunnel and in flight in an attempt to improve the maneuvering characteristics of the airplane. Results of buffet data obtained in wind tunnel and in flight with and without leading edge maneuvering slats are discussed.

*McDonnell Aircraft Corp., St. Louis, Mo.

2 **Department of Defense Model Designation of Military Aircraft, Rockets, and Guided Missiles.** (Designating and Naming Defense Equipment) (1969). Air Force Pamphlet No. 82-1; Army Pamphlet No. 700-6; NAVAIR Instruction 13100. Prepared by Aeronautical Systems Division, Wright-Patterson AFB, Ohio 45433, July 28, 1970.

LaRC requestors ask for CN-127,132.

All military aircraft of the Army, Navy, and Air Force, which are in the current inventory or in the process of entry therein, are listed in this publication. This July 1970 update is the last in this series according to information from the issuing agency.

3 *Farmer, Moses G.: **Flutter Studies to Determine Nacelle Aerodynamic Effects on a Fan-Jet Transport Model for Two Mount Systems and Two Wind Tunnels.** NASA TN D-6003, Sept. 1970, 35 pp.

N70-39907#

Low-speed flutter studies of a dynamically and elastically scaled model of a large multijet transport airplane have been conducted primarily to determine the nacelle aerodynamic effects for high-bypass-ratio fan-jet engines. Data were obtained on a vertical rod mount in two wind tunnels and on a two-cable mount in one of the tunnels. The flutter response of the model was found to be dependent on nacelle aerodynamics, engine-pylon stiffness, mount-system—wind-tunnel configuration, and mass ratio.

*NASA, Langley Research Center, Hampton, Va.

4 *Chambers, J. R.; *Anglin, E. L.; and *Bowman, J. S., Jr.: **Effects of a Pointed Nose on Spin Characteristics of a Fighter Airplane Model Including Correlation With Theoretical Calculations.** NASA TN D-5921, Sept. 1970, 59 pp.

N70-37395#

An investigation was conducted to correlate the results of theoretical spin calculations with the results of free-flight model tests for a contemporary fighter configuration. The study was designed to substantiate the theoretical methods before these methods are applied to studies of the spin and recovery characteristics of the airplane. In order to explain some of the results obtained, however, a series of wind-tunnel tests which produced significant information on the effects of a long pointed fuselage nose on spin characteristics was conducted. Various techniques employed in the study included static and forced-oscillation wind-tunnel tests, theoretical calculations, flow-visualization tests, autorotation tests, and free-spinning tests of dynamically scaled models.

*NASA, Langley Research Center, Hampton, Va.

5 *Free, F. W.: **Russian Helicopters.** Aeronautical Journal, vol. 74, Sept. 1970, pp. 767–785. Presented at the Royal Aero. Soc., Half-Day Symposium, London, England, March 11, 1970.

A70-43895

Review of the historical development of the helicopter in Russia and the technical characteristics of the current types in service. The various types of Russian helicopters developed since World War II are briefly described and characterized. Particular attention is given to Mi-8 and Mi-2 helicopters, which are described in detail in terms of their configuration, performance and handling, all weather operation, airframe, rotor and transmission system, engines, systems and equipment, and servicing and maintenance. In addition, the Ka-26 and Mi-10K helicopters are also discussed in some detail.

*British European Airways Corp., Ruislip, Middlesex, England

6 *Lee, Henry A.: **Spin-Tunnel Investigation of a 1/20 Scale Model of a Modified Straight-Wing, Twin-Boom, Counter-Insurgency Airplane.** NASA TM X-2053, Oct. 1970, 23 pp.

N70-40657#

The test results indicate that the airplane will spin in the erect attitude for all loading conditions and will spin inverted only for ailerons with control settings. The optimum control technique for recovery from all spins is movement of the rudder against the spin followed about one-half turn later by neutralization of the longitudinal and lateral controls. Satisfactory emergency recoveries from spins can be obtained by the use of rockets that produce an antispin yawing moment (about the Z body axis) of at least 27,600 ft-lb for at least 4.5 seconds.

*NASA, Langley Research Center, Hampton, Va.

7 *Grafton, Sue B.; and *Libbey, Charles E.: **Dynamic Stability Derivatives of a Twin-Jet Fighter Model for Angles of Attack from -10° to 110°.** NASA TN D-6091, Jan. 1971, 36 pp.

N71-14634#

A low-speed investigation was conducted to determine the dynamic stability derivatives in pitch, roll, and yaw over an angle-of-attack range of -10° to 110° for a twin-jet swept-wing fighter model. Several frequencies and amplitudes were investigated to determine the effects of these variables on the stability derivatives. The effect of the vertical and horizontal tail, and horizontal-tail incidence on the derivatives was also evaluated. The results indicate that the model exhibited stable values of damping in pitch over the entire angle-of-attack range, but marked reductions of damping in roll were measured at the stall, and unstable values of damping in yaw were present for the very high angles of attack associated with flat spins. Either removal of the horizontal or vertical tail or full up deflection of the horizontal tail eliminated the unstable characteristics of the damping-in-yaw derivatives.

*NASA, Langley Research Center, Hampton, Va.

8 **Soviet Helicopters.** Translated into English from the Russian by the Army Foreign Science and Technology Center, Charlottesville, Va. FSTC-HT-23-1063-70, Feb. 1971, 11 pp.

AD-719585 N71-25133#

Brief descriptions are presented for the V-10(Mi-10), Ka-25K, KA-26, and KA-22 helicopters.

9 *Kilgore, R. A.: **Some Transonic and Supersonic Dynamic Stability Characteristics of a Variable-Sweep-Wing Tactical Fighter Model.** NASA TM X-2163, Feb. 1971, 44 pp.

N71-17425#

Wind-tunnel tests were made by using a small-amplitude forced-oscillation mechanism to determine the damping and oscillatory stability in pitch and in yaw and the effective-dihedral parameter at angles of attack from about -5° to 17° at Mach numbers from 0.40 to 2.50. The effect of individual model components, tail incidence, and wing-sweep angle was investigated. The data are presented without analysis.

*NASA, Langley Research Center, Hampton, Va.

10 *Burcham, Frank W., Jr.: **An Investigation of Two Variations of the Gas Generator Method to Calculate the Thrust of the Afterburning Turbofan Engines Installed on an F-111A Airplane.** NASA TN D-6297, April 1971, 30 pp.

N71-22614#

Two variations of the gas generator method for calculating the net thrust of the afterburning turbofan engines installed in an F-111A airplane are investigated. An influence coefficient study and two ground thrust tests were performed. It was found that the gas generator method can be successfully applied to an afterburning turbofan engine. At static conditions with two engines operating plus or minus 2 percent accuracy can be achieved for most power settings using either the method based primarily on nozzle total pressure and area (PTA) or the method based primarily on nozzle total temperature and weight flow (TTW). For in-flight conditions the influence coefficient results indicated that the accuracy of the TTW method was about plus or minus 3 percent, whereas the accuracy of the PTA method was about plus or minus 5 percent for a military power setting. With either calculation method, additional errors in calculated thrust of plus or minus 2 percent could result from high inlet flow distortion. If accurate thrust values are required, both thrust calculation methods should be used.

*NASA, Dryden Flight Research Center, Edwards, Calif.

11 Redemann, Hans: **McDonnell Douglas F-4E(F) Luftwaffe's Phantom II.** Flug Revue, no. 7, 1971, pp. 48–51. (In German.)

The author starts with a short development history of the F-4 Phantom and its different versions. The Phantom II was developed initially as a twin-engined two-seat long-range all-weather attack fighter for service with the US Navy, and more than ten versions of this modern and versatile weapons system have been built in the meantime. The article gives a picture of the mission capability of the German F-4E(F) and covers differences of the aircraft in comparison with the F-4E. The article closes with a description of the F-4E(F) engine, the General Electric J79-GE-17 and the weapons carrying capabilities of the aircraft. Photos, diagrams, etc. are included.

12 *Anglin, E. L.: **Static Force Tests of a Model of a Twin-Jet Fighter Airplane for Angles of Attack for -10° to 110° and Sideslip Angles from -40° to 40°.** NASA TN D-6425, Aug. 1971, 90 pp.

N71-31330#

An investigation was conducted to obtain a set of static-force-test data for use as aerodynamic inputs to theoretical spin studies. Control-effectiveness tests were made for each control individually and for a full left pro-spin combination of controls. The results are presented without detailed analysis, but are analyzed in terms of factors which would affect their applicability for use in spin theory. Several data characteristics are indicated that are deemed to be of significance with regard to their intended use in theoretical spin studies.

*NASA, Langley Research Center, Hampton, Va.

Contract 136-63-02-04

13 *Martin, Richard A.; and *Hughes, Donald L.: **Comparisons of In Flight F-111A Inlet Performance for On and Off Scheduled Inlet Geometry at Mach Numbers of 0.68 to 2.18.** NASA TN D-6490, Sept. 1971, 47 pp.

N71-33211#

Total and static pressure data from the left inlet of a prototype F-111A airplane were recorded over a large portion of the operating range during automatically scheduled and manually controlled off-schedule positioning of the two-cone compression spike. These data were used to derive inlet performance parameters which indicated that a relatively wide range in performance may be expected during normal operation. The data showed that the preset controller schedule produced nearly optimum performance. Degradation occurred during off-schedule operation. Compressor stalls due to small inlet geometry changes were found to be most likely to occur at high supersonic Mach numbers, and more range in second-cone angle was available before a compressor stall occurred with a blunt-lip cowl than with a sharp-lip cowl. Trends of total pressure recovery and distortion in flight data were similar to trends in both full-scale and 1/6-scale model data.

*NASA, Dryden Flight Research Center, Edwards, Calif.

14 *Grafton, Sue B.; *Parlett, Lysle P.; and *Smith, Charles C., Jr.: **Dynamic Stability Derivatives of a Jet Transport Configuration with High Thrust-Weight Ratio and an Externally Blown Jet Flap.** NASA TN D-6440, Sept. 1971, 82 pp.

N71-35213#

The investigation was conducted to determine the dynamic stability derivatives of an externally blown jet-flap transport configuration having clustered inboard pod-mounted engines and full-span triple-slotted flaps. The results showed that the model had positive damping in pitch, roll, and yaw up to the stall angle of attack. The application of power resulted in an increase in pitch damping at high angles of attack and a moderate increase in yaw damping for the higher flap deflections but had no consistent effects on roll damping. For a given level of total engine thrust, the damping derivatives were generally not affected by frequency or by having one engine inoperative.

*NASA, Langley Research Center, Hampton, Va.

15 *Carmichael, Julian C., Jr.; and **Ray, Edward J.: **Subsonic Characteristics of a Twin-Jet Swept-Wing Fighter Model With Leading-Edge Krueger Flaps.** NASA TM X-2325, Oct. 1971, 69 pp.

N71-36436

An investigation has been conducted at Mach numbers of 0.60 and 0.90 to determine the effects of various combinations of leading-edge Krueger flaps, inboard plain flaps, and outboard slats on the static aerodynamic characteristics of a twin-jet, swept-wing fighter-airplane model. The angle-of-attack range was varied from -2° to 24° and the angle-of-sideslip range was varied from about 4° to -15°. The results of the investigation indicated that the addition of Krueger flaps caused significant improvements in maximum lift coefficient and in drag coefficient at high lift coefficients.

*McDonnell-Douglas Corp., St. Louis, Mo.

**NASA, Langley Research Center, Hampton, Va.

16 *Reichert, G.: **Rotary Wing Aircraft.** VDI-Z, vol. 113, Dec. 1971, pp. 1404–1407.

(In German). A72-16734

Description of the special features and performances of a number of currently used helicopters. The Huey Cobra, Cheyenne, and Blackhawk fighter helicopters are cited, as well as the giant Soviet helicopter, the Mil Mi-12, and the relation between recent helicopter developments and military requirements is noted. The incompleteness of existing knowledge concerning the phenomena occurring on a helicopter is cited as a factor limiting the improvement of performance.

*Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn; Darmstadt, Technische Hochschule, Darmstadt, West Germany.

17 *Sorrells, Russell B.; and *Watson, Carolyn B.: **Aerodynamic Characteristics of a Fighter Model With a Conventional Delta Wing and a Cranked-Tip Delta Wing at Mach Numbers of 1.60 to 4.60.** NASA TM X-2457, Jan. 1972, 141 pp.

N79-75305

An experimental and theoretical investigation was made at Mach numbers of 1.60 to 4.60 to determine the longitudinal and lateral aerodynamic characteristics of a conventional and a cranked-tip delta-wing fighter with an aft horizontal tail. The investigation included the effects of pylon-mounted missiles.

*NASA, Langley Research Center, Hampton, Va.

18 ***Supercritical Wing Technology: A Report on Flight Evaluations.** NASA SP-301, 1972, 133 pp.

N77-85474

The ten papers in this compilation were presented at the NASA Symposium on "Supercritical Wing Technology: A

Progress Report on Flight Evaluations," held at the NASA Flight Research Center, Edwards, Calif., on February 29, 1972. The purpose of the symposium was to present timely information on flight results obtained with the F-8 and T-2C supercritical wing configurations, discuss comparisons with wind-tunnel predictions, and project follow-on flight programs planned for the F-8 and F-111 (TACT) airplanes.

*Papers were presented by representatives of the NASA Flight Research Center, the NASA Langley Research Center, and North American Rockwell-Columbus Division.

19 *Thompson, William C.: **Ditching Investigation of a 1/30-Scale Dynamic Model of a Heavy Jet Transport Airplane.** NASA TM X-2445, Feb. 1972, 80 pp.

N72-17005#

An investigation was made to determine the ditching characteristics of a heavy jet transport airplane. A 1/30-scale dynamic model was used for the tests which were made with the landing gear retracted and with the landing gear extended in various positions. The test results indicated that the most favorable condition for ditching is a 7° landing attitude with the flaps down 40 deg, a landing speed of 137 knots, the nose gear retracted, and the main gear fully extended. There will most likely be some damage to the fuselage bottom and most of the main landing gear will probably be torn away.

*NASA, Langley Research Center, Hampton, Va.

20 *Steinmetz, George G.; *Parrish, Russell V.; and *Bowles, Roland L.: **Longitudinal Stability and Control Derivatives of a Jet Fighter Airplane Extracted from Flight Test Data by Utilizing Maximum Likelihood Estimation.** NASA TN D-6532, March 1972, 43 pp.

N72-18013#

A method of parameter extraction for stability and control derivatives of aircraft from flight test data, implementing maximum likelihood estimation, has been developed and successfully applied to actual longitudinal flight test data from a modern sophisticated jet fighter. The results of this application establish the merits of the estimation technique and its computer implementation (allowing full analyst interaction with the program) as well as provide data for the validation of a portion of the Langley differential maneuvering simulator (DMS). The results are presented for all flight test runs in tabular form and as time history comparisons between the estimated states and the actual flight test data. Comparisons between extracted and manufacturer's values for five major derivatives are presented and reveal good agreement for these principal derivatives with the exception of the static longitudinal stability derivative $C_{m_{\alpha}}$. This particular derivative is extensively investigated by utilizing the interactive capabilities of the computer program. The results of this investigation verify the numbers extracted by maximum likelihood estimation.

*NASA, Langley Research Center, Hampton, Va.

21 *Hughes, Donald L.; and *Johnson, Harold J.: **Flight-Determined Characteristics of an Intake System on an F-111A Airplane.** NASA TN D-6679, March 1972, 66 pp.

N72-18996#

Flow phenomena of the F-111A air intake system were investigated over a large range of Mach number, altitude, and angle of attack. Boundary-layer variations are shown for the fuselage splitter plate and inlet entrance stations. Inlet performance is shown in terms of pressure recovery, airflow, mass-flow ratio, turbulence factor, distortion factor, and power spectral density. The fuselage boundary layer was found to be not completely removed from the upper portion of the splitter plate at all Mach numbers investigated. Inlet boundary-layer ingestion started at approximately Mach 1.6 near the translating spike and cone. Pressure-recovery distribution at the compressor face showed increasing distortion with increasing angle of attack and increasing Mach number. The time-averaged distortion-factor value approached 1300, which is near the distortion tolerance of the engine at Mach numbers above 2.1.

*NASA, Dryden Flight Research Center, Edwards, Calif.

22 *Kilgore, Robert A.; and *Adcock, Jerry B.: **Supersonic Aerodynamic Damping and Oscillatory Stability in Pitch and Yaw from a Model of a Variable-Sweep Fighter Airplane with Twin Vertical Tails.** NASA TM X-2555, May 1972, 41 pp.

N72-22027#

Wind-tunnel measurements of the aerodynamic damping and oscillatory stability in pitch and yaw for a 1/22-scale model of a proposed carrier-based variable-sweep fighter airplane have been made by using a small-amplitude forced-oscillation technique. Tests were made with a wing leading-edge sweep angle of 68° at angles of attack from about -1.5° to 15.5° at a Mach number of 1.60 and at angles of attack from about -3° to 21° at Mach numbers of 2.02 and 2.36. The results of the investigation indicate that the basic configuration has positive damping and positive oscillatory stability in pitch for all test conditions. In yaw, the damping is generally positive except near an angle of attack of 0° at a Mach number of 1.60. The oscillatory stability in yaw is positive except at angles of attack above 16° at Mach numbers of 2.02 and 2.36. The addition of external stores generally causes increases in both pitch and yaw damping. The oscillatory stability in pitch is reduced throughout the angle-of-attack range by the addition of the external stores. The effect of adding stores on the oscillatory stability in yaw is a function of angle of attack and Mach number. The effect of changing horizontal-tail incidence on the pitch parameters is also very dependent on angle of attack and Mach number.

*NASA, Langley Research Center, Hampton, Va.

23 *Flechner, Stuart G.; and *Patterson, James C., Jr.: **Tabulated Pressure Measurements on a Large Subsonic**

Transport Model Airplane with High Bypass Ratio, Powered, Fan Jet Engines. NASA TM X-2530, May 1972, 345 pp.

N72-24020#

An experimental wind-tunnel investigation to determine the aerodynamic interference and the jet-wake interference associated with the wing, pylon, and high-bypass-ratio, powered, fan-jet model engines has been conducted on a typical high-wing logistics transport airplane configuration. Pressures were measured on the wing and pylons and on the surfaces of the engine fan cowl, turbine cowl, and plug. Combinations of wing, pylons, engines, and flow-through nacelles were tested, and the pressure coefficients are presented in tabular form. Tests were conducted at Mach numbers from 0.700 to 0.825 and angles of attack from -2 to 4 deg.

*NASA, Langley Research Center, Hampton, Va.

24 Sevart, F. D.; Patel, S. M.; and Wattman, W. J.: **Analysis and Testing of Stability Augmentation Systems---for Supersonic Transport Aircraft Wing and B-52 Aircraft Control Systems.** Final Rept. D3-8884; NASA CR-132349, June 13, 1972, 125 pp.

N74-11809#

Testing and evaluation of stability augmentation systems for aircraft flight control were conducted. The flutter suppression system analysis of a scale supersonic transport wing model is described. Mechanization of the flutter suppression system is reported. The ride control synthesis for the B-52 aeroelastic model is discussed. Model analyses were conducted using equations of motion generated from generalized mass and stiffness data.

*Boeing Co., Wichita, Kans.

Contract NAS1-10885

25 Danfernandes, F.: **Theoretical Prediction of Interference Loading on Aircraft Stores. Part 1: Subsonic Speeds.** NASA CR-112065-1, June 1972, 91 pp.

N72-26021#

A method is developed for theoretically predicting the loading on pylon-mounted stores in subsonic compressible flow. Linear theory is used, without two-dimensional or slender body assumptions, to predict the flow field produced by the aircraft wing, nose, inlet, and pylons. The interference loading is integrated over the store length by considering the local crossflow, its axial and radial derivatives, and buoyancy. Store moment calculations under an F-4 aircraft at Mach 0.8 are compared to wind tunnel data. The method is computerized, and program user information is included.

*General Dynamics, Electrodynamics Division, Pomona, Calif.

Contract NAS1-10374

26 *Danfernandes, F.: **Theoretical Prediction of Interference Loading on Aircraft Stores. Part 2: Supersonic Speeds.** NASA CR-112065-2, June 1972, 95 pp.

N72-26022#

A method is developed for theoretically predicting the loading on pylon-mounted stores in supersonic flow. Linear theory is used, without two dimensional or slender body assumptions, to predict the flow field produced by the aircraft wing, nose, inlet, and pylons. Aircraft shock wave locations are predicted, and their effect on the flow field is included through a transformation of the aircraft geometry. The interference loading is integrated over the store length by considering the local crossflow, its axial and radial derivatives, and buoyancy. Store moment calculations under an F-4 aircraft at Mach 1.2 are compared to wind tunnel data. The method is computerized, and program user information is included.

*General Dynamics, Electrodynamics Division, Pomona, Calif.

Contract NAS1-10374

27 *Danfernandes, F.: **Theoretical Prediction of Interference Loading on Aircraft Stores. Part 3: Programmer's Manual.** NASA CR-112065-3, June 1972, 114 pp.

N72-26023#

A FORTRAN program is described for predicting interference loading on aircraft stores. An analysis of the program is presented from a programmer's point of view, including program organization, subroutine explanations, and FORTRAN variable definitions. This information is intended for use in any program modification, extension, or troubleshooting efforts. This manual is supplementary to the separately documented program theory and user information.

*General Dynamics, Electrodynamics Division, Pomona, Calif.

Contract NAS1-10374

28 *Lamb, Milton; and *Spearman, M. Leroy: **Additional Study of Fixed-Wing Twin-Vertical-Tail Fighter Model Including the Effects of Wing and Vertical-Tail Modifications.** NASA TM X-2619, Aug. 1972, 59 pp.

N79-74731

An investigation has been conducted in the Langley Unitary Plan wind tunnel over the Mach number range from 1.70 to 4.63 to determine the effect of larger vertical tails and increased wing span on the longitudinal and lateral aerodynamic characteristics of a fixed-wing twin-inlet fighter model having a horizontal tail and twin vertical tails. Previous data for the basic model, the model with wing end plates, and the model with a modified fuselage are presented with the data of the present study to provide comparisons of the longitudinal and lateral aerodynamic characteristics for the various configurations.

*NASA, Langley Research Center, Hampton, Va.

29 *Parrish, Russell V.; and *Steinmetz, George G.: **Lateral Stability and Control Derivatives of a Jet Fighter Airplane Extracted from Flight Test Data by Using Maximum Likelihood Estimation.** NASA TN D-6905, Sept. 1972, 51 pp.

N72-31013#

A method of parameter extraction for stability and control derivatives of aircraft from flight test data, implementing maximum likelihood estimation, has been developed and successfully applied to actual lateral flight test data from a modern sophisticated jet fighter. This application demonstrates the important role played by the analyst in combining engineering judgment and estimator statistics to yield meaningful results. During the analysis, the problems of uniqueness of the extracted set of parameters and of longitudinal coupling effects were encountered and resolved. The results for all flight runs are presented in tabular form and as time history comparisons between the estimated states and the actual flight test data.

*NASA, Langley Research Center, Hampton, Va.

30 *Grafton, S. B.; and *Anglin, E. L.: **Dynamic Stability Derivatives at Angles of Attack From -5^{o} to 90^{o} for a Variable-Sweep Fighter Configuration With Twin Vertical Tails.** NASA TN D-6909, Oct. 1972, 52 pp.

N72-32044#

An investigation was conducted in the Langley full-scale tunnel to determine the dynamic stability derivatives in pitch, roll, and yaw over an angle-of-attack range of -5 deg to 90 deg for a variable-sweep fighter configuration with twin vertical tails. The study consisted of forced-oscillation tests of a 1/10-scale model of the airplane at a Reynolds number of 0.4 million based on the reference wing mean aerodynamic chord. Tests were conducted for wing sweep angles of 22 deg, 35 deg, 50 deg, and 68 deg, and the effects of the vertical and horizontal tails, wing leading-edge slats, nose-mounted canards, and frequency of the oscillation were also evaluated.

*NASA, Langley Research Center, Hampton, Va.

31 *Greer, H. D.: **Summary of Directional Divergence Characteristics of Several High-Performance Aircraft Configurations.** NASA TN D-6993, Nov. 1972, 63 pp.

N73-10033#

The present paper summarizes the high-angle-of-attack characteristics of a number of high-performance aircraft as determined from model force tests and free-flight model tests and correlates these characteristics with the dynamic directional-stability parameter. This correlation shows that the dynamic directional-stability parameter correlates fairly well with directional divergence. Data are also presented to show the effect of some airframe modifications on the directional divergence potential of the configuration. These results show that leading-edge slats seem to be the most effective airframe modification for reducing or eliminating the directional divergence potential of aircraft with moderately swept wings.

*NASA, Langley Research Center, Hampton, Va.

32 *Spearman, M. Leroy; and *Collins, Ida K.: **Aerodynamic Characteristics of a Swept-Wing Cruise Missile at Mach Numbers from 0.50–2.86.** NASA TN D-7069, Nov. 1972, 40 pp.

N73-10002#

An investigation has been made in the Mach number range from 0.50 to 2.86 to determine the longitudinal and lateral aerodynamic characteristics of a cruise missile having a 58^{o} swept wing and conventional aft tails. Such a vehicle might be applicable to missions such as surface- or air-launched tactical or strategic missiles, unmanned reconnaissance, or countermeasure decoys.

*NASA, Langley Research Center, Hampton, Va.

33 **Fluid Dynamics of Aircraft Stalling.** Advisory Group for Aerospace Research & Development, AGARD-CP-102, Papers presented at the Fluid Dynamics Panel Specialist's Meeting, Lisbon, Portugal, April 25–28, 1972, 342 pp.

N73-14998#

The proceedings of a conference on the fluid dynamics of aircraft stalling are presented. The subjects discussed are: (1) two dimensional laminar separation bubbles, (2) turbulent boundary layers flow, (3) aerodynamics of high lift airfoil systems, (4) low speed stalling of wings with high lift devices, (5) stall characteristics of various military aircraft, and (6) airflow separation and buffet onset during fighter aircraft maneuvers. Individual titles are N73-14999 through N73-15020.

34 *Anderson, Charles A.: **Stall/Post-Stall Characteristics of the F-111 Aircraft.** In "Fluid Dynamics of Aircraft Stalling," AGARD-CP-102, (N73-14998), Paper No. 18, Nov. 1972, 9 pp.

N73-15013

The stall/post-stall characteristics of the F-111 aircraft are described. The characteristics have been defined on the basis of wind tunnel tests, free-flight model tests, radio controlled drop model tests, analytical analysis, and flight tests. The extent of each type of testing is discussed and a summary of the results is presented. A discussion of the regression techniques used to obtain aerodynamic derivatives in the high angle of attack simulator is included.

*General Dynamics Corp., Convair Aerospace Division, Ft. Worth, Texas

35 *Bore, Cliff L.: **Post-Stall Aerodynamics of the Harrier GR1.** In "Fluid Dynamics of Aircraft Stalling," AGARD-CP-102, (N73-14998), Paper No. 19, Nov. 1972, 7 pp.

N73-15014

The post-stall aerodynamics of the Harrier GR1 aircraft are discussed. The requirement to achieve high usable lift coefficients during maneuvering at subsonic speeds, without incurring a weight penalty for leading edge devices is described. The resulting characteristics of boundary layer separation after buffet onset are analyzed. The effects of arrays of fences and vortex generators are examined.

*Hawker Siddeley Aviation, Ltd., Kingston upon Thames, England.

36 *Wimpress, John K.: **Predicting the Low Speed Stall Characteristics of the Boeing 747.** In "Fluid Dynamics of Aircraft Stalling," AGARD-CP-102, (N73-14998), Paper No. 21, Nov. 1972, 9 pp.

N73-15016

The pre-flight estimates for the Boeing 747, based on wind tunnel data obtained at a Reynolds Number of approximately 1 million, are presented. These test results were adjusted to full scale flight values using correlation factors developed from other Boeing transport airplanes. As an independent check, high lift data were obtained in a pressurized wind tunnel up to a Reynolds Number of 7.5 million and extrapolated to the full scale value of 40 million. Flight results show that the correlation factors were moderately successful in predicting stall speeds. Also, extrapolating the pressure tunnel data to full scale Reynolds Numbers predicted the flight value of maximum lift coefficient with reasonable accuracy. The wind tunnel data at all Reynolds Numbers predicted satisfactory handling characteristics throughout the stall that were confirmed during flight testing.

*The Boeing Company, Seattle, Wash.

37 *Butkewicz, Peter J.: **On Airflow Separation and Buffet Onset During Fighter Aircraft Maneuvering.** In "Fluid Dynamics of Aircraft Stalling," AGARD-CP-102, (N73-14998), Paper No. 22, Nov. 1972, 10 pp.

N73-15017

An experimental flight test program was sponsored to determine the buffet characteristics of four high performance aircraft. The aircraft were flown in transonic maneuvers encountering conditions of buffeting onset through heavy buffeting. The aircraft were instrumented with accelerometers, wing root strain gages, wing static pressure taps, and one wing was tufted for flow visualization photographs. The aircraft were flown in the baseline configuration as well as with various deflections of leading and trailing edge flaps. The results of the flight test program, the effects of mechanical high lift devices on buffet, and some wind tunnel/flight test correlations are presented.

*Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio

38 *Ray, Edward J.; and *McKinney, Linwood W.: **Maneuver and Buffet Characteristics of Fighter Aircraft.** In "Fluid Dynamics of Aircraft Stalling," AGARD-CP-102, (N73-14998), Paper No. 24, Nov. 1972, 10 pp. (NASA TN D-7131 is based on this paper and is No. 47 in this bibliography.)

N73-15019

The emphasis of the present studies was placed on the high subsonic and transonic characteristics of fighter aircraft and the factors affecting aerodynamic boundaries, such as maximum obtainable lift, buffet onset, pitchup, "wing rock," and "nose slice." Investigations were made using a general research configuration which encompassed a systematic matrix of wing design parameters. These results emphasized the sensitivity to section and planform geometry at the selected design point. The incorporation of variable-wing-geometry devices in the form of leading-edge slats or flaps was shown in a number of flight and wind-tunnel studies to provide controlled flow over a wide range of flight conditions and substantial improvements in maneuver capabilities. Additional studies indicated that the blending of a highly swept maneuver strake with an efficient moderately swept wing offers a promising approach for improving maneuver characteristics at high angles of attack without excessive penalties in structural weight.

*NASA, Langley Research Center, Hampton, Va.

39 *Burris, W. R.; and *Lawrence, J. T.: **Aerodynamic Design and Flight Test of U.S. Navy Aircraft at High Angles of Attack.** In "Fluid Dynamics of Aircraft Stalling," AGARD-CP-102, (N73-14998), Paper No. 25, Nov. 1972, 10 pp., 10 refs.

N73-15020

The aerodynamic design, engineering development, and flight testing of naval aircraft at high angles of attack are discussed. The flight regime beginning with buffet onset and proceeding up through departure from controlled flight is investigated. Post-stall gyrations and spin recovery are analyzed. The importance of the design process for low speed flight stability is emphasized.

*Naval Air Systems Command, Washington, D.C.

40 *Monta, William J.: **Supersonic Aerodynamic Characteristics of an Air-to-Air Missile Configuration with Cruciform Wings and In-Line Tail Controls.** NASA TM X-2666, Dec. 1972, 140 pp.

N78-75313

A wind-tunnel investigation has been conducted to determine the static aerodynamic characteristics of an air-to-air missile configuration with trapezoidal wings and in-line delta tail controls. The configuration had a fineness ratio of 18 and was tested over a Mach number range from 1.50 to 4.60 for angles of attack from about -4° to 40°. A large and a small model were utilized in order to encompass the entire angle-of-attack range, and the tests were conducted basically at unit Reynolds numbers of 9.8×10^6 and 6.6×10^6 per meter, respectively.

*NASA, Langley Research Center, Hampton, Va.

41 *Lamb, Milton; *Spearman, M. Leroy; and *Tudor, Dorothy H.: **Aerodynamic Characteristics at Mach Numbers from 1.60 to 4.63 of a Variable-Sweep Fighter Model With Wing Sweep Angles of 44° and 71°.** NASA TM X-2662, Dec. 1972, 126 pp.

N79-76850

An experimental investigation has been made in the Langley Unitary Plan wind tunnel over the Mach number range from 1.60 to 4.63 to determine the longitudinal and lateral aerodynamic characteristics of a variable-sweep airplane model with wing sweeps of 44° and 71°. A theoretical study was made over the same Mach number range to determine the zero-lift drag corrections necessary to correct the wind-tunnel data to full-scale for a hypothetical airplane.

*NASA, Langley Research Center, Hampton, Va.

42 *Hughes, Donald L.: **Pressures and Temperatures on the Lower Surfaces of an Externally Blown Flap System During Full-Scale Ground Tests.** NASA TN D-7138, Jan. 1973, 34 pp.

N73-14984#

Full-scale ground tests of an externally blown flap system were made using the wing of an F-111B airplane and a CF700 engine. Pressure and temperature distributions were determined on the undersurface of the wing, vane, and flap for two engine exhaust nozzles (conical and daisy) at several engine power levels and engine/wing positions. The tests were made with no airflow over the wing. The wing sweep angle was fixed at 26 deg; and the angle of incidence between the engine and the wing was fixed at 3 deg; and the flap was in the retracted, deflected 35 deg, and deflected 60 deg positions. The pressure load obtained by integrating the local pressures on the undersurface of the flap, F sub p was approximately three times greater at the 60 deg flap position than at the 35 deg flap position. At the 60 deg flap position, F sub p was between 40 percent and 55 percent of the engine thrust over the measured range of thrust. More than 90 percent of F sub p was contained within plus or minus 20 percent of the flap span centered around the engine exhaust centerline with both nozzle configurations. Maximum temperatures recorded on the flaps were 218 C (424 F) and 180 C (356 F) for the conical and daisy nozzles, respectively.

*NASA, Dryden Flight Research Center, Edwards, Calif.

43 *Ray, Edward J.; and **Hollingsworth, E. G.: **Subsonic Characteristics of a Twin-Jet Swept-Wing Fighter Model with Maneuvering Devices.** NASA TN D-6921, Jan. 1973, 292 pp.

N73-15988#

An investigation has been conducted at Mach numbers ranging from 0.06 to 0.94 to determine the effects of various combinations of leading-edge slat devices on the static aerodynamic characteristics of a twin-jet swept-wing fighter model. The study also included a determination of the effects of wing leading-edge droop, trailing-edge chord-extensions, wing fences, and wing-planform and camber modifications. The angle-of-attack range generally extended from about minus 2 deg to 24 deg and the sideslip angles ranged from about -6 deg to -13 deg.

*NASA, Langley Research Center, Hampton, Va.
**McDonnell Douglas Corp., St. Louis, Mo.

44 *Monta, William J.: **Aerodynamic Characteristics at Mach Numbers from 1.50 to 2.87 of a Dogfight Missile Configuration with Cruciform Cranked Wings and Trapezoidal Tail Controls.** NASA TM X-2771, March 1973, 59 pp.

N80-72278

A wind-tunnel investigation has been conducted to determine the static stability and control characteristics at supersonic speeds of a cruciform missile configuration having cranked wings and in-line trapezoidal tail controls. The tests were conducted in the Langley Unitary Plan wind tunnel at Mach numbers from 1.50 to 2.87. The angle of attack was varied from about -6° to 34° at sideslip angles of 0° and 3° for roll orientations of 0°, 22.5°, and 45°. The effects of tail deflections to provide pitch, roll, and yaw control were also investigated.

*NASA, Langley Research Center, Hampton, Va.

45 *Ayers, Theodore G.: **A Wind-Tunnel Investigation of the Application of the NASA Supercritical Airfoil to a Variable-Wing-Sweep Fighter Airplane.** NASA TM X-2759, July 1973, 266 pp.

N78-73075#

An investigation was conducted in the Langley 8-foot transonic pressure tunnel and the Langley Unitary Plan wind tunnel to evaluate the effectiveness of three variations of the NASA supercritical airfoil as applied to a model of a variable-wing-sweep fighter airplane. Wing panels incorporating conventional NACA 64A-series airfoil with 0.20 and 0.40 camber were used as bases of reference for this evaluation. Static force and moment measurements were obtained for wing leading-edge sweep angles of 26°, 33°,

39^o, and 72.5^o. Fluctuating wing-root-bending-moment data were obtained at subsonic speeds to determine buffet characteristics. Subsonic data were also obtained for determining the effects of wing transition location and spoiler deflection. Limited lateral directional data are included for the conventional 0.20 cambered wing and the supercritical wing.

*NASA, Langley Research Center, Hampton, Va.

46 *Burcham, Frank W.; *Hughes, Donald L.; and *Holzman, Jon K.: **Steady-State and Dynamic Pressure Phenomena in the Propulsion System of an F-111A Airplane.** NASA TN D-7328, July 1973, 99 pp.

N73-29806#

Flight tests were conducted with two F-111A airplanes to study the effects of steady-state and dynamic pressure phenomena on the propulsion system. Analysis of over 100 engine compressor stalls revealed that the stalls were caused by high levels of instantaneous distortion. In 73 percent of these stalls, the instantaneous circumferential distortion parameter, k_θ, exhibited a peak just prior to stall higher than any previous peak. The k_θ parameter was a better indicator of stall than the distortion factor, k_d and the maximum-minus-minimum distortion parameter, d, was a poor indicator of stall. Inlet duct resonance occurred in both F-111A airplanes and is believed to have been caused by oscillations of the normal shock wave from an internal to an external position. The inlet performance of the two airplanes was similar in terms of pressure recovery, distortion, and turbulence, and there was good agreement between flight and wind-tunnel data up to a Mach number of approximately 1.8.

*NASA, Dryden Flight Research Center, Edwards, Calif.

47 *Ray, Edward J.; *McKinney, Linwood W.; and **Carmichael, Julian C.: **Maneuver and Buffet Characteristics of Fighter Aircraft.** NASA TN D-7131, July 1973, 16 pp. (Based on a paper given at the AGARD Specialists' Meeting on Fluid Dynamics of Aircraft Stalling, Lisbon, Portugal, April 26–28, 1972, which is No. 38 in this bibliography.)

N73-25999#

Recent research efforts in the improvement of the maneuverability of fighter aircraft in the high-subsonic and transonic speed range are reviewed in the present paper with emphasis on the factors affecting aerodynamic boundaries, such as maximum obtainable lift, buffet onset, pitchup, "wing rock," and "nose slice." The investigations were made using a general research configuration which encompassed a systematic matrix of wing-design parameters. These results illustrated the sensitivity of section and planform geometry to a selected design point. The incorporation of variable-geometry wing devices in the form of flaps or leading-edge slats was shown to provide controlled flow over a wide range of flight conditions and substantial improvements in maneuver capabilities. Additional studies indicated that the blending of a highly swept maneuver strake with an efficient, moderately swept wing offers a promising approach for improving maneuver characteristics at high angles of attack without excessive penalties in structural weight.

*NASA, Langley Research Center, Hampton, Va.
**McDonnell Douglas Corp., St. Louis, Mo.

48 *Thor, Wayne A.: **An Investigation of the Rolling Stability Derivatives of a T-Tail Fighter Configuration at High Angles of Attack.** Society of Flight Test Engineers 4th Annual Symposium Proceedings. 5 pp. in "Flight Testing Today – 1973." Las Vegas, Nev., Aug. 21–23, 1973, A74-34852#. Also: Society of Flight Test Engineers, Journal, vol. 1, Jan. 1979, pp. 21–25.

A79-50165

High angle-of-attack rolling stability tests for a T-tail fighter in a wind tunnel indicate that the roll damping drops off abruptly and the roll-induced yaw increases negatively when the angle of attack on a model with a clean wing increases. Wing fences, slats and strakes produce a favorable effect on the roll damping and adverse yaw. Wing fences appear to be the simplest effective aerodynamic modification for increasing the roll damping at high angles of attack without degrading the longitudinal characteristics. Wing tip end plates, on the other hand, decreased the roll damping at angles of attack below the stall.

*U.S.A.F.—Aeronautical Systems Division, Wright-Patterson AFB, Ohio

49 *Putnam, Terrill W.: **Investigation of Coaxial Jet Noise and Inlet Choking Using an F-111A Airplane.** NASA TN D-7376, Aug. 1973, 32 pp.

N73-28989#

Measurements of engine noise generated by an F-111A airplane positioned on a thrust measuring platform were made at angles of 0 deg to 160 deg from the aircraft heading. Sound power levels, power spectra, and directivity patterns are presented for jet exit velocities between 260 feet per second and 2400 feet per second. The test results indicate that the total acoustic power was proportional to the eighth power of the core jet velocity for core exhaust velocities greater than 300 meters per second (985 feet per second) and that little or no mixing of the core and fan streams occurred. The maximum sideline noise was most accurately predicted by using the average jet velocity for velocities above 300 meters per second (985 feet per second). The acoustic power spectrum was essentially the same for the single jet flow of afterburner operation and the coaxial flow of the nonafterburning condition. By varying the inlet geometry and cowl position, reductions in the sound pressure level of the blade passing frequency on the order of 15 decibels to 25 decibels were observed for inlet Mach numbers of 0.8 to 0.9.

*NASA, Dryden Flight Research Center, Edwards, Calif.

50 *Eckert, W. T.; and **Maki, R. L.: **Low-Speed Wind-Tunnel Investigation of the Longitudinal Characteristics of a Large-Scale Variable Wing-Sweep Fighter Model in the High-Lift Configuration.** NASA TM X-62244, Aug. 1973, 85 pp.

N73-31940#

The low-speed characteristics of a large-scale model of the U.S. Navy/Grumman F-14A aircraft were studied in tests conducted in the Ames Research Center 40- by 80-Foot Wind Tunnel. The primary purpose of the program was the determination of lift and stability levels and landing approach attitude of the aircraft in its high-lift configuration. Tests were conducted at wing angles of attack between minus 2 deg and 30 deg with zero yaw. Data were taken at Reynolds numbers ranging from 3.48 million to 9.64 million based on a wing mean aerodynamic chord of 7.36 ft. The model configuration was changed as required to show the effects of glove slat, wing slat leading-edge radius, cold flow ducting, flap deflection, direct lift control (spoilers), horizontal tail, speed brake, landing gear and missiles.

*NASA, Ames Research Center, Moffett Field, Calif.
**Army Air Mobility Research & Development Lab., Moffett Field, Calif.

51 *Eckert, W. T.; and **Maki, R. L.: **Low-Speed Wind-Tunnel Investigation of the Lateral-Directional Characteristics of a Variable Wing-Sweep Fighter Model in the High-Lift Configuration.** NASA TM X-62306, Oct. 1973, 35 pp.

N74-12714#

The low-speed characteristics of a large-scale model of the F-14A aircraft were studied in tests conducted in the Ames Research Center 40- by 80-Foot Wind Tunnel. The primary purpose of the present tests was the determination of lateral-directional stability levels and control effectiveness of the aircraft in its high-lift configuration. Tests were conducted at wing angles of attack between minus 2 deg and 30 deg and with sideslip angles between minus 12 deg and 12 deg. Data were taken at a Reynolds number of 8.0 million based on a wing mean aerodynamic chord of 2.24 m (7.36 ft). The model configuration was changed as required to show the effects of direct lift control (spoilers) at yaw, yaw angle with speed brake deflected, and various amounts and combinations of roll control.

*NASA, Ames Research Center, Moffett Field, Calif.
**Army Air Mobility Research & Development Lab., Moffett Field, Calif.

52 *Hayes, R. D.: **Application of Advances in Structures and Materials to the Design of the YF-17 Airplane.** Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16–18, 1971, 8 pp.

SAE Paper 730891 A74-17534

A review of the structural design and material selection in the YF-17 airplane is presented. Emphasis is placed on the choice of those design concepts and materials that are unique, and the effect on these choices of the prototyping philosophy is described. Special emphasis is placed on the use of graphite materials, but the use of other nonmetallic materials and the considerations involved in the selection of metallic alloys and heat treatments are also discussed.

*Northrop Corp., Los Angeles, Calif.

53 *Gilbert, William P.; *Nguyen, Luat T.; and *Van Gunst, Roger W.: **Simulator Study of Applications of Automatic Departure- and Spin-Prevention Concepts to a Variable-Sweep Fighter Airplane.** NASA TM X-2928, Nov. 1973, 84 pp.

N80-72268

An investigation has been conducted on the Langley differential maneuvering simulator to evaluate the application of several automatic departure- and spin-prevention concepts to a variable-sweep fighter configuration. Included were departure-prevention concepts for prevention of loss of control and spin-prevention concepts which allowed departure from controlled flight but prevented developed spins. The study used low Reynolds number, low Mach number, and aerodynamic data derived from wind-tunnel tests. Representative air-combat maneuvers were employed as pilot tasks for the evaluations. Results of the study showed that although the basic airplane exhibited well-behaved low g stall characteristics, maneuvers at higher g levels at high angles of attack resulted in control-induced departures from controlled flight. The spin-prevention concepts effectively prevented the developed spin and thereby improved flight safety but did not provide improvements in tactical effectiveness. The several departure-prevention concepts studied included angle-of-attack limiting, centering of the lateral stick at high angles of attack, aural warning tones, interconnection of lateral control with the rudder and washing out of differential tail control at high angles of attack, and provision for special high angle-of-attack stability augmentation. A combination of the control interconnect scheme and the high angle-of-attack stability augmentation scheme allowed the airplane to be used to its fullest extent without loss of control.

*NASA, Langley Research Center, Hampton, Va.

54 *Lamb, Milton: **Effects of Simulated Damage on Stability and Control Characteristics of a Fixed-Wing Twin-Vertical-Tail Fighter Model at Mach Numbers from 2.50 to 4.63.** NASA TM X-2815, Nov. 1973, 127 pp.

N80-72274

An experimental investigation has been conducted in the high Mach number test section of the Langley Unitary Plan wind tunnel over the Mach number range from 2.50 to 4.63 to determine the effect of simulated damage on the longitudinal and lateral aerodynamic characteristics of a fixed-wing twin-inlet fighter model having an aft horizontal tail and twin vertical tails. Damage was simulated on the wing, horizontal tail, and one of the vertical tails. The results are presented in figure form.

*NASA, Langley Research Center, Hampton, Va.

55 Geddes, J. P.: **The Light-Weight High-Performance YF-17.** Interavia, vol. 28, Dec. 1973, pp. 1315–1318.

The USAF outlined clear design objectives of the light-weight fighter, based on a 'day fighter,' i.e., one that would operate in clear weather, usually under visual flight rules. The emphasis in performance is on transonic maneuverability. The aircraft is a twin-engined single seat model with a hybrid wing planform, set at mid-fuselage position. Distinguishing features are the large bubble cockpit, angled twin vertical tails set well forward of the large horizontal tail, and long leading edge extensions or strakes extending over the nostril engine inlets. The main design objective for the flight control system on the YF-17 was to provide a basic aerodynamic design that is stable and spin resistant without stability augmentation. The structure of the design is largely conventional.

56 *Mach, W.: **Earthbound Missiles.** VDI-Z, vol. 115, no. 18, Dec. 1973, pp. 1466–1470. (In German).

A74-18183

A general survey concerning the missiles available to the U.S. and the USSR is presented, taking into account new developments which increase the range, efficiency, and accuracy of the missiles. Details regarding ground-to-ground missiles are discussed together with ground-to-air missiles, air-to-air missiles, air-to-ground missiles, and missiles for special missions. Attention is given to advantages and applications of remotely piloted vehicles.

*Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany

57 *MacWilkinson, D. G.; *Blackerby, W. T.; and *Paterson, J. H.: **Correlation of Full-Scale Drag Predictions with Flight Measurements on the C-141A Aircraft. Phase 2: Wind Tunnel Tests Analysis, and Prediction Techniques. Vol. I: Drag Predictions, Wind Tunnel Data Analysis and Correlation.** Final Rept. LG73ER0058-Vol. 1; NASA CR-2333, Feb. 1974, 166 pp.

N74-18679#

The degree of cruise drag correlation on the C-141A aircraft is determined between predictions based on wind tunnel test data, and flight test results. An analysis of wind tunnel tests on a 0.0275 scale model at Reynolds number up to 3.05 × 1 million/MAC is reported. Model support interference corrections are evaluated through a series of tests, and fully corrected model data are analyzed to provide details on model component interference factors. It is shown that predicted minimum profile drag for the complete configuration agrees within 0.75% of flight test data, using a wind tunnel extrapolation method based on flat plate skin friction and component shape factors. An alternative method of extrapolation, based on computed profile drag from a subsonic viscous theory, results in a prediction four percent lower than flight test data.

*Lockheed-Georgia Co., Marietta, Ga.

Contract NAS1-10045

58 *MacWilkinson, D. G.; *Blackerby, W. T.; and *Paterson, J. H.: **Correlation of Full-Scale Drag Predictions with Flight Measurements on the C-141A Aircraft: Phase 2: Wind Tunnel Tests, Analysis, and Prediction Techniques. Vol. 2: Wind Tunnel Tests and Basic Data.** Final Rept. LG73ER0058-Vol. 2; NASA CR-2334, Feb. 1974, 187 pp.

A research program has been conducted to determine the degree of cruise drag correlation on the C-141A aircraft between predictions based on wind tunnel test data, and flight test results. Information is presented on the wind tunnel test program and basic aerodynamic data on the C-141A wind-tunnel model used in the correlation studies.

*Lockheed-Georgia Co., Marietta, Ga.
Contract NAS1-10045

59 *Taillon, Norman V.: **Flight-Test Investigation of the Aerodynamic Characteristics and Flow Interference Effects About the Aft Fuselage of the F-111A Airplane.** NASA TN D-7563, Feb. 1974, 77 pp.

N74-18657#

Static pressure measurements were made on the aft fuselage of an F-111A airplane to determine local flow characteristics and engine/airframe interaction effects. Data were obtained over the Mach number range from 0.5 to 2.0. Aspiration effects associated with low ejector nozzle expansion ratios reduced the local pressure coefficients particularly on the interfairing but also extending to the trailing edge of the nacelle. The presence of afterbodies also affected the behavior of the air flowing into and about the ejector nozzle. Pressures about the aft fuselage were improved by an increase in primary nozzle area at a supersonic speed. A comparison of wind-tunnel and flight-test results showed generally good agreement, although there was a large disparity in pressure level about the ejector nozzle. However, the shape of the data curves and the local flow behavior were basically similar.

*NASA, Dryden Flight Research Center, Edwards, Calif.

60 *Abel, I.; and *Sanford, M. C.: **Status of Two Studies on Active Control of Aeroelastic Response at NASA, Langley Research Center.** In AGARD Active Control Systems for Load Alleviation, Flutter Suppression, and Ride Control. March 1974; pp. 23–48; also NASA TM X-2909, 1973.

N74-25553#

The application of active control technology to the suppression of flutter was successfully demonstrated during two recent studies in the Langley transonic dynamics tunnel. The first study involved the implementation of an aerodynamic-energy criterion, using both leading- and trailing-edge controls, to suppress flutter of a simplified delta-wing model. Use of this technique resulted in an increase in the flutter dynamic pressure of approximately 12 percent for this model at a Mach number of 0.9. Analytical methods used to predict the open- and closed-loop behavior of the model are also discussed. The second study, which is a joint effort with the Air Force Flight Dynamics Laboratory, was conducted to establish the effect of active flutter suppression on a model of the Boeing B-52 Control Configured Vehicle (CCV). Some preliminary results of this study indicate significant improvements in the damping associated with the critical flutter mode.

*NASA, Langley Research Center, Hampton, Va.

61 *Spearman, M. Leroy; and *Sawyer, Wallace C.: **External Store Effects on the Stability of Fighter and Interceptor Airplanes.** NASA TM X-71935, March 1974, 28 pp.

N74-20658#

The purpose of this paper is to consider some criteria for external carriage of missiles for fighter aircraft intended for aerial combat missions and for fighter-interceptor missions. The mission requirements discussed include the short-range fighter-interceptor, the short-range interceptor, the medium-range interceptor, and the long-range interceptor. Missile types considered to be compatible with the various point mission designs include the short-range missile, the medium-range missile, and the long-range missile. From the study, it appears that point mission design aircraft can be arranged in such a way that the required external-store arrangement will not impair the stability of the aircraft. An extensive reference list of 109 documents on NASA external store research is included.

*NASA, Langley Research Center, Hampton, Va.

62 *Fink, D. E.: **YF-17 Evolved From Previous Data Base — Northrop Trainer/Fighter Prototype.** Aviation Week and Space Technology, vol. 100, April 15, 1974, pp. 46–47, 49–51.

Northrop's YF-17 twin-engine twin-tail lightweight fighter, designed for high maneuverability on the basis of advanced aerodynamic techniques developed by the company to meet basic air combat requirements, is examined. The design is based on experience obtained with the T-38 Talon trainer, the F-5 fighter and trainer series, and the P-530 Cobra fighter. The principal design characteristics of the craft — developed with emphasis on climb, acceleration, and turning rate in the Mach 0.9 to 1.5 range — are discussed and illustrated.

63 *Redd, L. T.; *Gilman, J., Jr.; **Cooley, D. E.; and ***Sevart, F. D.: **Wind-Tunnel Investigation of a B-52 Model Flutter Suppression System.** Presented at the AIAA/ASME/SAE 15th Structures, Structural Dynamics, and Materials Conference, Las Vegas, Nevada, April 17–19, 1974. Revision July 1974. Published in Journal of Aircraft, vol. 11, no. 11, Nov. 1974, pp. 659–663.

AIAA Paper 74–401 A74-26700#

Flutter modeling techniques have been successfully extended to the difficult case of the active suppression of flutter. This has been demonstrated in a joint USAF/NASA/Boeing (Wichita Div.) study. The demonstration was conducted in the NASA Langley transonic dynamics tunnel using a 1/30-scale, elastic, dynamic model of a Boeing B-52 Control Configured Vehicle (CCV). The results from the study show that with the flutter suppression system operating there is a substantial increase in the damping associated with the critical flutter mode. The results also show good correlation between the damping characteristics of the model and airplane.

*NASA, Langley Research Center, Hampton, Va.
**U.S.A.F. Flight Dynamics Lab., Wright-Patterson AFB, Ohio
***Boeing Co., Wichita, Kan.

64 **Two Decades of the Twenty-One.** Air Enthusiast International, May 1974, pp. 226–232.

LaRC requestors ask for CN-151167

The evolutionary process by which the MiG-21 (FISHBED-N) has evolved, from the first large-scale production circa 1959 series MiG-21F (FISHBED-C), is well documented in this article.

The MiG-21 is unquestionably the world's most widely-used fighter. In the 15 years that have elapsed since this small warplane first entered the inventory of the V-VS it has been continuously refined and modified; its operational repertoire has been progressively expanded and its armament and avionics have been steadily upgraded. The dual-role production variants of the seventies retain little more than the basic configuration of the unsophisticated day fighter of the MiG-21's infancy, and the evolutionary process can today be described in greater detail than hitherto. The development of the MiG-21 was first described in detail in the August 1971 issue and should be considered as an updating of previously-published information.

65 *Grafton, S. B.; *Chambers, J. R.; and *Coe, P. L., Jr.: **Wind-Tunnel Free-Flight Investigation of a Model of a Spin-Resistant Fighter Configuration.** NASA TN D-7716, June 1974, 76 pp.

N74-26443#

An investigation was conducted to provide some insight into the features affecting the high-angle-of-attack characteristics of a high-performance twin-engine fighter airplane which in operation has exhibited excellent stall characteristics with a general resistance to spinning. Various techniques employed in the study included wind-tunnel free-flight tests, flow-visualization tests, static force tests, and dynamic (forced-oscillation) tests. In addition to tests conducted on the basic configuration tests were made with the wing planform and the fuselage nose modified. The results of the study showed that the model exhibited good dynamic stability characteristics at angles of attack well beyond that for wing stall. The directional stability of the model was provided by the vertical tail at low and moderate angles of attack and by the fuselage forebody at high angles of attack. The wing planform was found to have little effect on the stability characteristics at high angles of attack. The tests also showed that although the fuselage forebody produced beneficial contributions to static directional stability at high angles of attack, it also produced unstable values of damping in yaw. Nose strakes located in a position which eliminated the beneficial nose contributions produced a severe directional divergence.

*NASA, Langley Research Center, Hampton, Va.

66 *Reubush, David E.; and *Mercer, Charles E.: **Exhaust-Nozzle Characteristics for a Twin-Jet Variable-Wing-Sweep Fighter Airplane Model at Mach Numbers to 2.2.** NASA TM X-2947, June 1974, 135 pp.

N74-28524#

A wind-tunnel investigation has been conducted to determine the exhaust-nozzle aerodynamic and propulsive characteristics for a twin-jet variable-wing-sweep fighter airplane model. The powered model was tested in the Langley 16-foot transonic tunnel and in the Langley 4-foot supersonic pressure tunnel at Mach numbers to 2.2 and at angles of attack from about -2° to 6°. Compressed air was used to simulate the nozzle exhaust flow at values of jet total-pressure ratio from approximately 1 (jet off) to about 21. Effects of configuration variables such as speed-brake deflection, store installation, and boundary-layer thickness on the nozzle characteristics were also investigated.

*NASA, Langley Research Center, Hampton, Va.

67 *Petroff, D. N., **Scher, S. H.; and ***Cohen, L. E.: **Low Speed Aerodynamic Characteristics of a 0.075-Scale F-15 Airplane Model at High Angles of Attack and Sideslip.** NASA TM X-62360, July 1974, 118 pp.

N78-10019#

A 0.075 scale model representative of the F-15 airplane was tested in the Ames 12 foot pressure wind tunnel at a Mach number of 0.16 to determine static longitudinal and lateral directional characteristics at spin attitudes for Reynolds numbers from 1.48 to 16.4 million per meter (0.45 to 5.0 million per foot). Angles of attack ranged from 0 to +90 deg and from -40 deg to -80 deg while angles of sideslip were varied from -20 deg to +30 deg. Data were obtained for nacelle inlet ramp angles of 0 to 11 deg with the left and right stabilators deflected 0, -25 deg, and differentially 5 deg and -5 deg. The normal pointed nose and two alternate nose shapes were also tested along with several configurations of external stores. Analysis of the results indicate that at higher Reynolds numbers there is a slightly greater tendency to spin inverted than at lower Reynolds numbers. Use of a hemispherical nose in place of the normal pointed nose provided an over correction in simulating yawing moment effects at high Reynolds numbers.

*NASA, Ames Research Center, Moffett Field, Calif.
**NASA, Langley Research Center, Hampton, Va.
***ARO, Inc., Moffett Field, Calif.

68 *Graves, Ernald B.; and *Fournier, Roger H.: **Stability and Control Characteristics at Mach Numbers from 0.20 to 4.63 of a Cruciform Air-to-Air Missile with Triangular Canard Controls and a Trapezoidal Wing.** NASA TM X-3070, July 1974, 235 pp.

N74-33432#

Investigations have been conducted in the Langley 8-foot transonic pressure tunnel and the Langley Unitary Plan wind tunnel at Mach numbers from 0.20 to 4.63 to determine the stability and control characteristics of a cruciform air-to-air missile with triangular canard controls and a trapezoidal wing. The results indicate that canards are effective in producing pitching moment throughout most of the test angle-of-attack and Mach number range and that the variations of pitching moment with lift for trim conditions are relatively linear. There is a decrease in canard effectiveness with an increase in angle of attack up to about Mach 2.50 as evidenced by the beginning of coalescence of the pitching-moment curves. At a Mach number above 2.50, there is an increase in effectiveness at moderate to high angles of attack. Simulated launch straps have little effect on the lift and pitch characteristics but do cause an increase in drag, and this increase in drag induces a rolling moment at a zero roll attitude where the straps cause an asymmetric geometric shape. The canards are not suitable devices for roll control and, at some Mach numbers and roll attitudes, are not effective in producing pure yawing moments.

*NASA, Langley Research Center, Hampton, Va.

69 *Buckner, J. K.; and *Webb, J. B.: **Selected Results from the YF-16 Wind Tunnel Test Program.** Presented at the 8th AIAA Aerodynamic Testing Conference, Bethesda, Md., July 8–10, 1974, 13 pp.

AIAA Paper 74-619 A74-36046#

YF-16 force-model results from several facilities are compared, with emphasis on the drag data. Rather large initial subsonic differences between the NASA-Ames 11-ft and Calspan 8-ft tunnels are reconciled by the 'relative buoyancy' discoveries of S. L. Treon, et al. (1971). Data from two model scales in these tunnels also demonstrate scale effects on profile and induced drag. The higher turbulence level of the Calspan tunnel is evident from the Reynolds number effects observed in both tunnels. It is further shown that simple force-model techniques can be used successfully to derive inlet spillage effects. It appears that nozzle-exit-diameter effects on airplane drag can also be derived by force-model testing on a single-engine fighter aircraft, but the size of the model support sting restricts the ability to simulate the small dry-power nozzle exit.

*General Dynamics Corp., Convair Aerospace Div., Fort Worth, Texas

70 *Huffman, Jarrett K.; and *Jackson, Charlie M., Jr.: **Investigation of the Static Lift Capability of a Low-Aspect-Ratio Wing Operating in a Powered Ground-Effect Mode.** NASA TM X-3031, July 1974, 32 pp.

N74-28483#

A preliminary experimental investigation has been made to evaluate the powered ground-effect capability of a low-aspect-ratio, wing-body configuration with forward-mounted propulsion. The tests were limited to static ground-effect conditions in order to obtain information on an air-cushion mode of operation. The results indicate, in general, that an air-cushion mode is within the capability of the type of configuration examined. The conditions examined indicated the possibility of hover mode and also forward acceleration capability in near ground effect. Center-of-pressure movement did not appear to be a problem. However, it was recognized that longitudinal trim would be a problem to consider in both the hover and acceleration modes.

*NASA, Langley Research Center, Hampton, Va.

71 *Patierno, J.: **YF-17 Design Concepts.** Presented at AIAA 6th Meeting on Aircraft Design, Flight Tests and Operations, Los Angeles, Calif., Aug. 12–14, 1974, 10 pp.

AIAA Paper 74-936 A74-41651#

The USAF Lightweight Fighter philosophy of high performance at low cost has been implemented in selecting the design concepts for the YF-17 aircraft. Unique aerodynamic, propulsion and structural design features have been developed for prototype demonstration. For example, incorporated in the YF-17 are a hybrid wing planform, automatic variable wing camber, differential area ruling, forebody strakes, a horizontal tail sized for supersonic maneuvering, an underwing inlet location, wing root slots for fuselage boundary layer diversion, a unique advanced turbojet engine, and extensive graphite composite structure. The concepts and the benefits derived are described to illustrate the rationale for selection.

*Northrop Corp., Hawthorne, Calif.

72 *Buckner, J. K.; *Benepe, D. B.; and *Hill, P. W.: **Aerodynamic Design Evolution of the YF-16.** Presented at AIAA 6th Meeting on Aircraft Design, Flight Tests and Operations, Los Angeles, Calif., Aug. 12–14, 1974, 17 pp.

AIAA Paper 74-935 A74-45100#

Evolution of the YF-16 aerodynamic features began in preliminary studies in 1968, intensified during analytical studies in 1970–71, and was finalized during wind tunnel tests in 1971–72 and detail design in 1972–73. Early design studies set the basic features of two widely different design approaches. The best features of the two separate initial models were combined into one model (parts from both models were actually fitted together) and the resulting configuration refined through several tunnel entries to produce the final aerodynamic design. The resultant configuration is an integrated design.

*General Dynamics Corp., Convair Aerospace Division, Fort Worth, Texas

73 *Coe, P. L., Jr.; and *Newsom, W. A., Jr.: **Wind-Tunnel Investigation to Determine the Low Speed Yawing Stability Derivatives of a Twin Jet Fighter Model at High Angles of Attack.** NASA TN D-7721, Aug. 1974, 41 pp.

N74-31506#

An investigation was conducted to determine the low-speed yawing stability derivatives of a twin-jet fighter airplane model at high angles of attack. Tests were performed in a low-speed tunnel utilizing variable-curvature walls to simulate pure yawing motion. The results of the study showed that at angles of attack below the stall the yawing derivatives were essentially independent of the yawing velocity and sideslip angle. However, at angles of attack above the stall some nonlinear variations were present and the derivatives were strongly dependent upon sideslip angle. The results also showed that the rolling moment due to yawing was primarily due to the wing-fuselage combination, and that at angles of attack below the stall both the vertical and horizontal tails produced significant contributions to the damping in yaw. Additionally, the tests showed that the use of the forced-oscillation data to represent the yawing stability derivatives is questionable, at high angles of attack, due to large effects arising from the acceleration in sideslip derivatives.

*NASA, Langley Research Center, Hampton, Va.

74 *Hallissy, James B.; and *Harris, Charles D.: **Wind-Tunnel Investigation of Aerodynamic Load Distribution on a Variable-Wing-Sweep Fighter Airplane with a NASA Supercritical Airfoil.** NASA TM X-3095, Oct. 1975, 34 pp.

N78-73129#

Wind-tunnel tests have been conducted at Mach numbers of 0.85, 0.88, and 0.90 to determine the aerodynamic load distribution for the 39° swept-wing configuration of a variable-wing-sweep fighter airplane with a NASA supercritical airfoil. Chordwise pressure distributions were measured at two wing stations. Also measured were the overall longitudinal aerodynamic force and moment characteristics and the buffet characteristics. The analysis indicates that localized regions of shock-induced flow separation may exist on the rearward portions of the supercritical wing at high subsonic speeds, and caution must be exercised in the prediction of buffet onset when using variations in trailing-edge pressure coefficients at isolated locations.

*NASA, Langley Research Center, Hampton, Va.

75 *Lockwood, Vernard E.; and ** Matarazzo, Aniello: **Subsonic Wind Tunnel Investigation of a Twin Engine Attack Airplane Model Having Nonmetric Powered Nacelles.** NASA TN D-7742, Nov. 1974, 135 pp.

N75-11932#

A 1/10-scale powered model of a twin-engine attack airplane was investigated in the Langley high-speed 7- by 10-foot tunnel. The study was made at several Mach numbers between 0.225 and 0.75 which correspond to Reynolds numbers, based on the mean aerodynamic chord, of 1.35×10^6 and 3.34×10^6. Unheated compressed air was used for jet simulation in the nonmetric engine nacelles which were located ahead of and above the horizontal stabilizer. The principal objective of the power testing was to assess the interference effects of the fuselage-mounted propulsion system on the aerodynamic characteristics of the airplane, both in and out of ground effect. In addition to the usual six-component balance measurements, elevator and rudder hinge moments were also measured.

*NASA, Langley Research Center, Hampton, Va.
**Fairchild Industries, Republic Division, Long Island, N.Y.

76 *Pitts, Felix L.; *Holmes, David C. E.; and *Zaepfel, Klaus P.: **Instrumentation and Control System for an F-15 Stall/Spin Model.** NASA TM X-72647, Dec. 1974, 74 pp.

N75-17353#

An instrumentation and control system is described that was used for radio-controlled F-15 airplane model stall/spin research at the NASA-Langley Research Center. This stall/spin research technique, using scale model aircraft, provides information on the post-stall and spin-entry characteristics of full-scale aircraft. The instrumentation described provides measurements of flight parameters such as angle of attack and sideslip, airspeed, control-surface position, and three-axis rotation rates; these data are recorded on an onboard magnetic tape recorder. The proportional radio control system, which utilizes analog potentiometric signals generated from ground-based pilot inputs, and the ground-based system used in the flight operation are also described.

*NASA, Langley Research Center, Hampton, Va.

77 Gilson, C. M.: **B-1 — USAF Priority Number One---Design and Feasibility Analysis.** Flight International, vol. 106, Dec. 26, 1974, pp. 911–919.

A75-17350

Studies concerning the Advanced Manned Strategic Aircraft were conducted in connection with investigations designed to define a low-altitude penetration bomber which was to succeed the USAF Strategic Air Command B-52s. The studies eventually led to the B-1. A drawing of the aircraft is presented. The engine for the B-1 is discussed along with questions regarding the control of the center-of-gravity location, aspects of system redundance, the avionics, and aspects of aircraft fracture mechanics.

78 *Reubush, David E.; and *Mercer, Charles E.: **Effects of Nozzle Interfairing Modifications on Longitudinal Aerodynamic Characteristics of a Twin-Jet, Variable-Wing-Sweep Fighter Model.** NASA TN D-7817, Feb. 1975, 126 pp.

N75-18180#

The model was tested in the Langley 16-foot transonic tunnel at Mach numbers of 0.6 to 1.3 and angles of attack from about -2° to 6° and in the Langley 4-foot supersonic pressure tunnel at a Mach number of 2.2 and an angle of attack of 0°. Compressed air was used to simulate nozzle exhaust flow at jet total-pressure ratios from 1 (jet off) to about 21. The results of this investigation show that the aircraft drag can be significantly reduced by replacing the basic interfairing with a modified interfairing.

*NASA, Langley Research Center, Hampton, Va.

79 Braybrook, Roy M.: **Variable Geometry Today I. Latest Swing-Wing Aircraft.** Air International, vol. 8, no. 3, March 1975, pp. 111–124.

A75-33447

Contemporary applications and requirements of variable geometry (VG) in high-speed aviation are discussed. Advantages and problems associated with the use of the VG wing are assessed, and the development of NASA's outboard hinge is described. The performance of the F-111 is evaluated, and the latest swing-wing aircraft are discussed in detail, including the American EF-111A, F-14A, and B1; the Soviet Su-20 and MiG-23; the French Mirage G; and the European Panavia MRCA. Reference is made to the MiG Fencer and Tupolev Backfire, two Soviet strategic fighter bombers about which very little information is available.

80 Braybrook, Roy M.: **The Annals of the Polymorph—A Short History of Variable Geometry II.** Air International, vol. 8, no. 4, April 1975, pp. 185–190.

This is part II of the series and continues the history of variable-geometry aircraft. It includes illustrations of the MiG-23 (FLOGGER), the Sa-17 (FITTER-C), and the Su 17/20.

81 Braybrook, Roy M.: **The Annals of the Polymorph—A Short History of Variable Geometry III--Variable Wing Aircraft.** Air International, vol. 8, no. 5, May 1975, pp. 249–257.

A75-33450

Early aerodynamic problems associated with the variable-sweep wing were related to effects of changes in wing geometry on the aerodynamic center. Design innovations related to NASA's outboard pivot provided the breakthrough which was destined to put the U.S. temporarily well ahead in variable geometry research. American, European, and Soviet developments concerning variable-sweep aircraft are discussed. Today, six military aircraft utilizing variable-sweep wings are in service. Two others are flying in prototype form.

82 *Reed, Wilmer H., III: **Comparison of Flight Measurements With Predictions from Aeroelastic Models in the NASA Langley Transonic Dynamics Tunnel.** Presented at the 46th AGARD Flight Mechanics Panel Symposium on Flight/Ground Facility Correlation, Valloire, Savoie, France, June 9–12, 1975, Paper No. 6 in AGARD-CP-187, May 1975. NASA TM X-72686, 9 pp.

N75-23610#

The NASA Langley Transonic Dynamics Tunnel, which has a variable density, Freon-12 (or air) test medium, was designed specifically for study of dynamics and aeroelastic problems of aerospace vehicles. During the fifteen years of operation of this facility there have been various opportunities to compare wind-tunnel and flight test results. Some of these opportunities arise from routine flight checks of the prototype, others from carefully designed comparative wind-tunnel and flight experiments. This paper brings together in one place a collection of such data obtained from various published and unpublished sources. The topics covered are: gust and buffet response, control surface effectiveness, flutter, and active control of aeroelastic effects. Some benefits and shortcomings of Freon-12 as a test medium are also discussed. Although areas of uncertainty are evident and there is a continuing need for improvements in model simulation and testing techniques, the results presented herein indicate that predictions from aeroelastic model tests are, in general, substantiated by full-scale flight tests.

*NASA, Langley Research Center, Hampton, Va.

83 *Burgin, George H.; *Fogel, Lawrence J.; and *Phelps, J. Price: **An Adaptive Maneuvering Logic Computer Program for the Simulation of One-on-One Air-to-Air Combat — Vol. I: General Description.** NASA CR-2582, Sept. 1975, 73 pp.

N75-30817#

A novel technique for computer simulation of air combat is described. Volume I describes the computer program and its development in general terms. Two versions of the program exist. Both incorporate a logic for selecting and executing air combat maneuvers with performance models of specific fighter aircraft. In the batch processing version the flight paths of two aircraft engaged in interactive aerial combat and controlled by the same logic are computed. The real-time version permits human pilots to fly air-to-air combat against the Adaptive Maneuvering Logic (AML) in the Langley Differential Maneuvering Simulator (DMS). Volume II consists of a detailed description of the computer programs.

*Decision Science, Inc., 4508 Mission Bay Drive, San Diego, Calif.

Contract NAS1-9115

84 *Fanning, A. E.; and *Glidewell, R. J.: **Reynolds Number Effect on Nozzle/Afterbody Throttle-Dependent Pressure Forces --- YF-17 Scale Model.** Paper presented at the AIAA and SAE 11th Propulsion Conference held at Anaheim, Calif., Sept. 29–Oct. 1, 1975, 11 pp.

AIAA Paper 75-1295 A76-10282#

A 0.10 scale, jet effects model of the YF-17 was tested in a wind tunnel at approximately 0.9 Mach number, using the Reynolds number as a fundamental scaling parameter. The effect of boundary layer transition grit is discussed. It is shown that the aerodynamic effects are due to two interrelated phenomena: (1) the throttle-dependent changes in the interaction of the propulsive jet with the basic nozzle/afterbody flow field; and (2) the throttle-dependent changes in the basic nozzle/afterbody flow field which interacts with the propulsive jet.

*Aero Propulsion Lab., Wright-Patterson AFB, Ohio

85 *Newsom, W. A., Jr.; and *Anglin, E. L.: **Free-Flight Model Investigation of a Vertical-Attitude VTOL Fighter.** NASA TN D-8054, Sept. 1975, 34 pp.

N75-30109#

Tests were made in the Langley full-scale tunnel and included a study of the stability and control characteristics of delta- and swept-wing configurations from hovering through the transition to normal forward flight. Static force tests were also conducted to aid in the analysis of the flight tests. With conventional artificial rate stabilization, very smooth transitions could be made consistently with relatively little difficulty. Because of the lower apparent damping and a tendency to diverge in yaw, however, the swept-wing configuration was considered to be much more difficult to fly than the delta-wing configuration. With rate dampers off, both configurations were very difficult to control and the control power needed for satisfactory flights was substantially higher than with the rate dampers operating.

*NASA, Langley Research Center, Hampton, Va.

86 *Grafton, S. B.; and *Anglin, E. L.: **Free-Flight Model Investigation of a Vertical-Attitude VTOL Fighter With Twin Vertical Tails.** NASA TN D-8089, Nov. 1975, 29 pp.

N76-11042#

Free-flight tests were conducted in the Langley full-scale tunnel to determine the stability and control characteristics of a vertical-attitude VTOL fighter having twin vertical tails and a pivoted fuselage forebody (nose-cockpit) arrangement. The flight tests included hovering flights and transition flights from hover to conventional forward flight. Static force tests were also made to aid in the analysis of the flight tests. The model exhibited satisfactory stability and control characteristics, and the transition from hovering flight to conventional forward flight was relatively smooth and straightforward.

*NASA, Langley Research Center, Hampton, Va.

87 Panyalev, Georgiy: **BACKFIRE—Soviet Counter to the B-1.** Interavia, vol. 30, Nov. 1975, pp. 1193–1194.

A76-13244

The characteristics and major design features of the Soviet supersonic variable-geometry bomber Backfire are presented. The bomber is capable of carrying a maximum payload of 22,050 lb, including two externally-carried AS-6 air-to-surface nuclear missiles with a warhead weight of 770 lb as the principal armament. The maximum combat radius with one in-flight refueling is 5400 mi. The optimum cruising speed at altitude is Mach 0.82, with supersonic dash capability to Mach 2.0. The avionics fit includes a newly-developed terrain-following radar of unknown performance and long-range inertial navigation equipment, possibly working in conjunction with military satellites. The fuselage cross-section is basically rectangular, tapering aft of the wings. The wing pivot placement is dictated by the undercarriage geometry and is not optimized aerodynamically.

(This article is based on a longer feature in the International Defense Review No. 5, 1975, pages 639 ff.

88 *Vogt, H.: **State of Development and Effectiveness of Flying Cranes in the GDR.** Technisch-oekonomische Information der zivilen Luftfahrt, vol. 11, no. 4, 1975, pp. 192–196. In German.

A76-10838#

The paper gives an outline of the growth of the application of helicopters for lifting, suspending, and placement of very heavy objects in East Germany from 1959 to the present. At first, the Mi-4 helicopter was used, which carried an average load of 700 kgf. In 1963, 90 flight hours by helicopter crane were recorded. A qualitative jump in the development of flying cranes was made with the appearance of the Soviet turbine helicopter Mi-8, which could lift up to 3 Mgf. In 1974, 540 flight hours were recorded for 126 applications. Helicopter cranes have been used in foundry repairs, mounting and dismantling of smokestacks, and in the electrification of railroad lines. Some future prospects for the use of helicopter cranes are mentioned.

*Gesellschaft fuer Internationalen Flugverkehr mbH Berlin, East Germany

89 *Bork, P.: **The New Soviet Airliner Jak-42.** Technisch-oekonomische Information der zivilen Luftfahrt, vol. 11, no. 5, 1975, pp. 252–257. (In German).

A76-17411#

The Jak-42 was designed to satisfy specific transportation requirements in the USSR of a new type. The new aircraft is to serve industrial centers which are located at a great distance from large railway lines or air traffic routes. Cases are considered in which a relatively large number of passengers for flights in the range from 1.000 to 1.500 km are involved. It is assumed that it is not possible to connect the centers economically to the main passenger routes by either railroad or motor traffic. The design requirements for the aircraft are discussed along with the approaches used for the implementation of these requirements in the Jak-42.

*Gesellschaft fuer Internationalen Flugverkehr mbH, Berlin, East Germany

90 Braybrook, R. M.: **Fighter Design Philosophy.** Air International, vol. 10, Jan. 1976, pp. 15–21.

A76-17343

Aspects of design philosophy leading to the development of the Cobra series and derivatives are discussed. Special attention is given to the development of the LEX (leading edge extension) concept. The relative advantages and disadvantages of straight and swept wings for attack aircraft with different capabilities and intended applications are considered together with the extent of thrust/weight improvement or degradation inherent in a twin-engined fighter design. Factors affecting the proper selection of armaments for a given aerodynamic configuration are discussed.

91 Malzeyev, Alexander: **Mil Mi-24–The First Soviet Combat Helicopter.** Interavia, vol. 31, Jan. 1976, pp. 44–45.

A76-18100

The Soviet combat helicopter Mil Mi-24 is basically a derivative of earlier Soviet helicopter designs. Stub wings incorporating 20 deg of incidence and 16 deg anhedral serve to carry the external hardpoints. The five-blade main rotor has flapping and drag hinges, while the three-blade tail rotor is linked to the hub by flapping hinges only. The powerplant appears to be a variant of the Glushenko GTD-3F turboshaft engine. An increase in output to 1500 hp has probably been accomplished by raising the turbine entry temperature. Gear operation is hydraulically activated. The tricycle undercarriage is completely retractable. The craft carries a 3-man crew and is capable of transporting an additional 16 combat troops. A 12 mm calibre machine gun is mounted in the nose. A variety of other armaments, including ground-to-air missiles and bombs of sizes ranging to 500 lb. may be carried. Speeds over 160 knots can be attained.

92 Panyalev, G.: **Sukhoi's Su-19 FENCER Combat Aircraft.** Interavia, vol. 31, March 1976, pp. 255–256.

A76-24065

Design features of the Su-19 multirole combat aircraft, NATO code-named Fencer, are discussed. The heavy fighter-bomber has twin Lyulka AL-21F-3 turbojet engines, swing wings similar to those of the MiG-23, and a single tail, fin, and rudder. The sweep of the leading edge is variable within 20 to 70 deg. The aspect ratio varies with sweep between 2.0 and 8.0 and the thickness-chord ratio between 6 and 12%. The maximum combat load is 7500 kg; maximum take-off weight is 35,500 kg. With full combat load the Fencer has a range of over 350 km at low altitude, increasing to 700 km on a hi-lo-hi mission.

93 *Dix, R. E.: **Influences of Sting Support on Aerodynamic Loads Acting on Captive Store Models.** Final Rept., April 1973–June 1975. ARO-PWT-TR-75-95; AEDC-TR-76-1; AFATL-TR-76-25; March 1976, 329 pp.

AD-A022257 N76-29184#

In a series of wind tunnel tests, measurements were made of the aerodynamic loads acting on eight different store configurations mounted in the external captive position on a one-twentieth-scale model of the F-4C aircraft. Store models included blunt and contoured afterbody shapes, stable and unstable designs, and large (one per pylon) and small (rack-mounted) configurations. The tests were conducted in an effort to evaluate sting effects on captive store loads. Sting effects were considered to consist of two contributions: the effect of altering the afterbody of a store to allow insertion of a sting, and the effect of the presence of the sting. Altering the afterbody of an unstable store influenced captive loads less than altering a stable configuration. It was also determined that the presence of a sting affected most the pitching and yawing moments.

*ARO, Inc., Arnold Air Force Station, Tenn.

94 *Petersen, K. L.: **Evaluation of an Envelope-Limiting Device Using Simulation and Flight Test of a Remotely Piloted Research Vehicle.** NASA TN D-8216, April 1976, 19 pp.

N76-21218#

The operating characteristics of a nonlinear envelope-limiting device were investigated at extreme flight conditions by using a real time digital aircraft spin simulation and flight tests of a scale model remotely piloted research vehicle. A digital mechanization of the F-15 control system, including the stall inhibiter, was used in the simulation and in the control system of the scale model. The operational characteristics of the stall inhibiter and the effects of the stall inhibiter on the spin susceptibility of the airplane were investigated.

*NASA, Dryden Flight Research Center, Edwards, Calif.

95 *Farmer, Moses G.; and *Hanson, Perry W.: **Comparison of Supercritical and Conventional Wing Flutter Characteristics.** Presented at the AIAA/ASME/SAE 17th Structures, Structural Dynamics, and Materials Conference, Valley Forge, Pa., May 5–7, 1976, 7 pp.

A76-30064#

To evaluate the concern that the flutter characteristics of supercritical wings might be significantly different from those of wings with conventional airfoils, a wind-tunnel study was undertaken to directly compare the measured flutter boundaries of two dynamically similar aeroelastic models which had the same planform, maximum thickness-to-chord ratio, and as nearly identical stiffness and mass distributions as possible, with one wing having a supercritical airfoil and the other a conventional airfoil. The considerations and problems associated with flutter testing supercritical wing models at or near design lift coefficients are discussed and the measured transonic boundaries of the two wings are compared with boundaries calculated with a subsonic lifting surface theory.

*NASA, Langley Research Center, Hampton, Va.

96 *Gilbert, William P.; *Nguyen, Luat T.; and *Van Gunst, Roger W.: **Simulator Study of the Effectiveness of an Automatic Control System Designed to Improve the High-Angle-of-Attack Characteristics of a Fighter Airplane.** NASA TN D-8176, May 1976, 155 pp.

N76-24266#

A piloted, fixed-base simulation was conducted to study the effectiveness of some automatic control system features designed to improve the stability and control characteristics of fighter airplanes at high angles of attack. These features include an angle-of-attack limiter, abnormal-acceleration limiter, an aileron-rudder interconnect, and a stability-axis yaw damper. The study was based on a current lightweight fighter prototype. The aerodynamic data used in the simulation were measured on a 0.15-scale model at low Reynolds number and low subsonic Mach number. The simulation was conducted on the Langley differential maneuvering simulator, and the evaluation involved representative combat maneuvering. Results of the investigation show the fully augmented airplane to be quite stable and maneuverable throughout the operational angle-of-attack range. The angle-of-attack/normal-acceleration limiting feature of the pitch control system is found to be a necessity to avoid angle-of-attack excursions at high angles of attack. The aileron-rudder interconnect system is shown to be very effective in making the airplane departure resistant while the stability-axis yaw damper provided improved high-angle-of-attack roll performance with a minimum of sideslip excursions.

*NASA, Langley Research Center, Hampton, Va.

97 Panyalev, Georgiy: **Sukhoi's Swing-Wing Su-17/20 FITTER C.** Interavia, vol. 31, June 1976, pp. 557, 558.

A76-33946

The design and performance characteristics of the Sukhoi Su-17/20 Fitter C combat aircraft are discussed. The aircraft is a swing-wing modification of the swept-wing Fitter A design introduced in 1959. Placement of the pivot point at half-span permits an aspect ratio change of only 3.0 to 4.9, indicating that swing-wing outer panels were incorporated primarily to improve landing and take-off performance. The addition of leading-edge slats has significantly reduced landing speed over that of the Fitter A. The Lyulka AL-7-F1 engine of the earlier aircraft has been replaced by a Lyulka AL-21-F3 turbojet powerplant rated at 25,000 lb thrust. The Fitter C can function in battlefield interdiction, close air support, and air combat, and carries a built-in armament of two 30 mm Nudelmann-Richter NR-30 cannons. External loads include 100, 250, 500, or 1000 kg bombs, pod-housed unguided rockets, and guided missiles.

Note: See the International Defense Review 2/1976 for the original, more complete article.

98 **Stall/Spin Problems of Military Aircraft.** AGARD-CP-199, presented at the AGARD Flight Mechanics Panel Specialist's Meeting, Rhode Saint Genese, Belgium, Nov. 18–21, 1975. June 1976, 242 pp.

N76-29245#

Stall/spin aspects of aircraft design are discussed in relation to the high angle of attack problem. Nineteen papers were presented; their numbers run from N76-29246 through N76-29266.

99 *Sewall, Charles A.; and *Whipple, Raymond D.: **F-14A Stall Spin Prevention System Flight Test.** AGARD CP-199, in AGARD Stall/Spin Problems of Military Aircraft, (N76-29245), June 1976, 7 pp.

N76-29263

The evaluation of various spin prevention design concepts for the F-14 Tomcat by analytical, simulational, and experimental methods is described. Preparation of the test vehicle is detailed showing unique emergency systems and qualification testing of these systems. Operational aspects of the flight test program including the problem of devising a system flexible enough to permit in-flight optimization of design parameters is treated. The gradual shift in emphasis from spin prevention, which was accomplished with relative ease, to departure amelioration for enhanced air combat effectiveness is documented. An overview of the final ARI with associated subsystems is given.

*Grumman Aerospace Corp., Calverton, N.Y.

100 *Lamers, John P.: **YF-16 High Angle of Attack Test Experience.** AGARD CP-199, presented at the AGARD Flight Mechanics Specialist's Meeting, Stall/Spin Problems of Military Aircraft, (N76-29245), June 1976, 14 pp.

N76-29265

The objective of high angle of attack flight tests was to clear the aircraft for the air combat maneuvering test phase. This was to be accomplished by validation of predicted aerodynamic data, and a comprehensive evaluation of handling qualities and flight control system performance during aggressive simulated tactical maneuvering. The program also included a realistic evaluation of the effectiveness of special automatic control system features designed to enhance high angle of attack maneuverability, handling qualities, and departure resistance. Of particular interest were the effects of the active control system (command and stability augmentation) and relaxed static stability concepts upon stall/spin characteristics and recovery capability. Engine operating characteristics at high angle of attack, high angle of sideslip, low airspeed conditions were also of interest. Results show excellent high angle of attack flight characteristics, good correlation with NASA spin model results, and normal flight control system operation over the range of conditions tested.

*General Dynamics Corp., Fort Worth, Texas

101 *Doggett, Robert V., Jr.; *Abel, Irving; and *Ruhlin, Charles L.: **Some Experiences Using Wind-Tunnel Models in Active Control Studies.** In "Advanced Control Technology and Its Potential for Future Transport Aircraft," Aug. 16, 1976, pp. 831–892.

N76-31170

A status report and review of wind tunnel model experimental techniques that have been developed to study and validate the use of active control technology for the minimization of aeroelastic response are presented. Modeling techniques, test procedures, and data analysis methods used in three model studies are described. The studies include flutter mode suppression on a delta-wing model, flutter mode suppression and ride quality control on a 1/30-size model of the B-52 CCV airplane, and an active lift distribution control system on a 1/22 size C-5A model.

*NASA, Langley Research Center, Hampton, Va.

102 *Burton, R. A.; and *Bischoff, D. E.: **More Effective Aircraft Stability and Control Flight Testing Through Use of System Identification Technology.** Presented at the AIAA Aircraft Systems and Technology Meeting, Dallas, Texas, Sept. 27–29, 1976, 17 pp.

AIAA Paper 76-894 A76-45381#

The development of system identification technology was undertaken to provide for more effective aircraft flight testing by reducing the time required to conduct specific tests and/or to provide for a more comprehensive data analysis. F-14A and TA-4J flight test results presented demonstrate that the flight time required to obtain stability and control data can be significantly reduced without loss in accuracy of conventional flight test derived parameters. Presentation of S-3A and EA-6B system identification results demonstrate that this technology can be successfully used to update the aerodynamic data bases of modern jet aircraft from flight test data. These system identification results are compared with wind tunnel data and flight test derived parameters to demonstrate the accuracy of this new technology. Applications of this technology to integrate several areas of aircraft flight testing are discussed.

*Naval Air Test Center, Patuxent River, Md.

103 Cherikov, Nikolai: **The Shenyang F-9 Combat Aircraft.** Interavia, vol. 31, Dec. 1976, pp. 1160-1162.

A77-15875

China began the development of its own combat aircraft, designated the F-9, after the final break with the Soviet Union at the beginning of the 1960s. The design of the F-9 is largely based on that of the Soviet MiG-19, which had been constructed in China under license. The F-9 was to be given an all-weather capability. A description is given of various modifications which had been made to improve aircraft performance and enhance its operational life. Technical data concerning the F-9 are listed in a table. The development of the F-9 from the MiG-19 is viewed as an interim solution. According to reports, a supersonic combat aircraft with delta wing is already at the design stage in China.

104 *Compton, W. B., III: **Jet Exhaust and Support Interference Effects on the Transonic Aerodynamic Characteristics of a Fighter Model With Two Widely Spaced Engines.** NASA TM X-3424, Dec. 1976, 135 pp.

N77-15978#

Jet exhaust, nozzle installation, and model support interference effects on the longitudinal aerodynamic characteristics of a twin-engine fighter model were determined. Realistic jet exhaust nozzle configuration and a reference configuration with a simulated vertical-tail support were tested. Free-stream Mach number was varied from 0.6 to 1.2, and model angle of attack from 0 deg to 9 deg. The jet exhaust affected drag more than it affected lift and pitching moment. The largest effects occurred at a Mach number of 0.9 and for the afterburning mode of exhaust nozzle operation. The combined differences between the aerodynamic characteristics of the realistic and reference configurations (which were due to afterbody and nozzle contours, jet operation, and simulated reference support interference) were considerably different from those for the jet interference alone. A translating-flap exhaust nozzle, a hinged-flap exhaust nozzle, and a flow-through-nacelle reference model were tested at both cruise and afterburner power settings; variables include afterbody drag coefficient, afterbody lift coefficient, afterbody pitching moment coefficient, scheduled jet pressure ratio, flow-through-nacelle pressure ratio, jet-off drag, jet total pressure ratio, Mach number, angle of attack, and incidence angle of horizontal tail; 20 figures and 5 tables include numeric data.

*NASA, Langley Research Center, Hampton, Va.

105 *Katz, Henry; *Foppe, G. Francis; and *Grossman, Daniel T.: **F-15 Flight Flutter Test Program.** Presented at Langley Research Center's "Flutter Testing Technology" Conference held at Dryden Flight Research Center, Edwards, Calif., 9–10 Oct. 1975. Conference Proceedings, NASA SP-415, 1976, (N77-21022#), pp. 413-432.

N77-21037#

The modes to be observed during the F-15 flight flutter test program were selected on the basis of the results of analytical studies, wind tunnel tests, and ground vibration tests. The modes (both symmetrical and antisymmetrical) tracked on this basis were: fin first bending, fin torsion, fin tip roll, stabilator bending, stabilator pitch, boom lateral bending, boom torsion, boom vertical bending, wing first bending, wing second bending, wing first torsion, outer wing torsion, and aileron rotation. Data obtained for these various modes were evaluated in terms of damping versus airspeed at 1525 m (5000 ft), damping versus altitude at the cross-section Mach numbers (to extrapolate to the damping value to be expected at sea level), and flutter boundaries on the basis of flutter margin of various modal pairs representing potential flutter mechanisms. Results of these evaluations are summarized in terms of minimum predicted flutter margin for the various mechanisms.

*Lockheed Aircraft Corp., Burbank, Calif.

106 *Brignac, Warren J.; *Ness, Halvor B.; *Johnson, Maynard K.; and *Smith, Larz M.: **F-16 Flight Flutter Test Procedures.** Presented at Langley Research Center's "Flutter Testing Technology" Conference held at Dryden Research Center, Edwards, Calif., 9–10 Oct. 1975. Conference Proceedings, NASA CP-415, 1976, (N77-21022#), pp. 433–456.

N77-21038#

The Random Decrement technique (Randomdec) was incorporated in procedures for flight testing of the YF-16 lightweight fighter prototype. Damping values obtained substantiate the adequacy of the flutter margin of safety. To confirm the structural modes which were being excited, a spectral analysis of each channel was performed using the AFFTC time/data 1923/50 time series analyzer. Inflight test procedure included the careful monitoring of strip charts, three axis pulses, rolls, and pullups.

*General Dynamics, Fort Worth, Texas

107 The Soviet 'FORGER' in Close-Up. Interavia, vol. 32, Jan. 1977, pp. 27–29.

A77-20036

A description of the VTOL fighter (NATO name Forger) seen operating from the deck of the Soviet aircraft carrier Kiev in Atlantic and Mediterranean waters is provided, with details on engine layout and performance, radar facilities, flight deck operation, VTOL modes, and deck safety equipment. 'Forger' radar is judged poor for maritime combat (compared to the Harrier V/STOL), and Kiev safety equipment is inadequate. Landing and takeoff, hover, transition to wingborne flight, and engine tilt capabilities of 'Forger' are described. Comparison of 'Forger' and Harrier is mostly to the advantage of the latter. A brief description is given of Kiev and other craft seen operating off its angled flight deck. Kiev and 'Forger' are viewed as designed for ASW, support to amphibious operations, neutralization of hostile aircraft carrier forces, and prototype for development of more adequate systems.

108 The Mi-24 Attack Helicopter. "Flug Revue Flugwelt," January 1977, pp. 43–44, (West Germany). In German.

The Soviet's Mi 24 (NATO code name Hind), first seen in East Germany in 1973, is a twin-turbine helicopter designed for much the same missions as the Sikorsky S-67 Blackhawk. Its engines are Glushenko GTD 3 shaft turbines with power increased to 1500 h.p. thanks to increased turbine inlet temperature, the five-bladed main rotor, diameter 17 m, has conventional flapping and lag hinges, and the three-bladed tail rotor merely a flapping hinge. Electric de-icing is provided for the two rotors, and a hot air system for the windshield. The hydraulically retracted landing gear is of simple, sturdy tricycle design, a tail skid is fitted to prevent damage from contact with the ground, and the stub wings, with an anhedral of 16°, have stations for missile pods or small bombs and for two AT 2 Swatter or Sagger anti-tank missiles. A laser ranger is also fitted, and there is a 12.7-mm machine gun in the nose, with 250 to 350 rounds of ammunition for defence against infantry fire. The maximum speed of 310 to 330 km/h is impressive, as are also the helicopter's versatility and payload capacity (for example, 14 to 16 troops). All in all, the Hind may be taken to be a serious threat to Western armoured units. Operating in conjunction with Mi 8 troop transport helicopters (and in the same regiment), its task would be to reduce the enemy's defences and so prepare the way for combat units to be landed in the operations area. Some 180 Hinds are stationed in East Germany.

109 Taylor, J. W. R.: **Trends in Soviet Aircraft Design.** Aerospace (UK), vol. 4, Feb. 1977, pp. 12–21.

A77-28471

Long-term trends in Soviet military aircraft design history are envisaged as: (1) favoring of large size; (2) continuing earlier successful solutions in manufacturing and design if they are still workable; (3) heavy armament on fighters; (4) minimizing frontal airframe cross section with more reliance on external stores. Earlier generations, World War II developments, earlier postwar generations, and more recent types of Soviet aircraft illustrate the trends. The TU-126 AWACS modification of the TU-114 intercontinental transport, new rotary wing craft (MI-6 and MI-12, the ASW KA-25 helicopter), and new designs (MiG-27 'Flogger,' 'Backfire,' MI-24 combat helicopter, and Yak-36 carrier-based VTOL) are discussed, among many others. The author does not concur with some western deprecation of Soviet military aircraft hardware following overexpectations placed on the MiG-25 'Foxbat.'

110 Sweetman, B.: **Aeroflot's STOL Trijet.** Flight International, vol. 111, March 19, 1977, pp. 712–714.

A77-27214

A description is presented of the Soviet airliner Yak-42, which is a highly specialized replacement for the An-24. The aircraft has been designed for operations from short fields under extreme climatic conditions. Aircraft interior designs for 100 and for 120 passengers are considered. The D-36 engine for the aircraft has been designed for a service life of 18,000 hours. A table is provided with data for a comparison of the Yak-42 with other aircraft, including the Boeing 727-100.

111 *Culhane, K. V.: **The Soviet Attack Helicopter.** March 1977, 15 pp.

AD-A050649 N78-22080#

This paper examines the evolution of the Soviet attack helicopter through its initial 'gunship' stages to the present sophisticated 'HIND D.' Also, it addresses the corresponding changes in Soviet helicopter tactics which have accompanied their increase in both firepower and maneuverability under the influence on Indochina and the Middle East experiences. Finally, a brief look is taken at possible future development of the attack helicopter force of the Soviet Union. Specifically, the author predicts that the Soviets will forsake the present scout, attack, and transport abilities of the Hind for a more powerfully equipped and more armored 'artillery platform' type helicopter.

*Army Institute for Advanced Russian and East European Studies, APO New York

112 *Gallagher, J. T.; and *Nelson, W. E., Jr.: **Flying Qualities Design of the Northrop YF-17 Fighter Prototypes.** Presented at the Society of Automotive Engineers' Business Aircraft Meeting, Wichita, Kan., Mar. 29–Apr. 1, 1977, 15 pp.

SAE Paper 770469 A77-37087

The YF-17 prototype aircraft is a twin-engined, low wing loaded, high thrust-to-weight ratio fighter aircraft, a derivative of which is intended for use by the U.S. Navy. The flying qualities design of this lightweight fighter was based on inflight and ground-based simulation data. The paper describes several design aspects, including longitudinal, lateral, directional, mechanical, and electronic control systems, and also failure management and flying qualities in the preliminary design. The role of ground-based simulation data in flying qualities design is considered.

*Northrop Corp., Aircraft Group, Hawthorne, Calif.

113 Panyalev, Georgiy: **The Mikoyan MiG-23 Combat Aircraft Family.** Interavia, vol. 32, March 1977, pp. 247–249.

A77-27030

The MiG-23 will ultimately replace the Mikoyan MiG-21 Fishbed as the principal combat aircraft in Soviet use. A prototype version of the aircraft was designed as a purely experimental aircraft for the development of variable-geometry technology. The Flogger-B model of the MiG-23 is primarily intended for intercept missions. Attention is also given to the MiG-23U Flogger-C conversion trainer, the MiG-27 Flogger-D tactical strike model, the MiG-23MS Flogger-E export interceptor, and the MiG-23MB Flogger-F export fighter-bomber.

(This article is an edited version of one first published in the January 1977 issue of the "International Defence Review.")

114 *Costakis, William G.: **Characteristics of Random Inlet Pressure Fluctuations During Flights of F-111A Airplane.** NASA TM X-3540, May 1977, 36 pp.

N77-25091#

Compressor face dynamic total pressures from four F-111 flights were analyzed. Statistics of the nonstationary data were investigated by analyzing the data in a quasi-stationary manner. Changes in the character of the dynamic signal are investigated as functions of flight conditions, time in flight, and location at the compressor face. The results, which are presented in the form of rms values, histograms, and power spectrum plots, show that the shape of the power spectra remains relatively flat while the histograms have an approximate normal distribution.

*NASA, Lewis Research Center, Cleveland, Ohio

115 Panyalev, Georgiy: **Under-Estimated in the West-The MiG-25 FOXBAT Weapon System.** Interavia, vol. 32, May 1977, pp. 498–502.

A77-33614

The MiG-25 ('Foxbat') is evaluated as a weapons system and recon vehicle for the medium altitude bracket, on the basis of reconnaissance data and the specimen examined on Hokkaido in late 1976. Data on the MiG-25 family, on MiG-25A characteristics, and on records set by MiG-25 flights, are tabulated. Good marks are awarded to the MiG-25 aerodynamic design, engine, 5-stage transonic compressor, and recon capabilities. While the MiG-25 was originally designed as response to the threat of the (since aborted) U.S. B-70 Mach-3 bomber, the concept is judged a worthy adversary of U.S. combat aircraft of the late Sixties; later versions (up to MiG-25M) 'could represent a danger to the F-14 and F-15.' Its use as bomber or guided missile carrier, and its high-speed interception capability, are taken note of.

116 *Nichols, James O.: **Analysis and Compilation of Missile Aerodynamic Data—Vol. I, Data Presentation and Analysis.** NASA CR-2835, May 1977, 124 pp.

77N-28084#

This summary document was prepared in order to facilitate dissemination of a large amount of missile aerodynamic data which has recently been declassified. Only summary data are presented in this report, but a list of reference documents provides sources of detailed data. Most of the configurations considered are suitable for highly maneuverable air-to-air or surface-to-air missiles; however, data for a few air-to-surface, cruise missile, and one projectile configuration are also presented. The Mach number range of the data is from about 0.2 to 4.63; however, data for most configurations cover only a portion of this range. The following aerodynamic characteristics at various Mach numbers and zero angle of attack are presented:

a) Base drag coefficient, $C_{D,b}$.

b) Drag coefficient, $C_{D,o}$.

c) Lift-curve slope, C_{L_α}.

d) Aerodynamic-center location, X_{ac}/ℓ.

e) Slideslip derivatives, C_{n_β}, C_{ℓ_β}, and C_{Y_β}.

f) Control effectiveness, C_{m_δ}, C_{n_δ}, C_{ℓ_δ}, and C_{Y_δ}.

The maximum lift-drag ratio is also presented for some configurations.

*Auburn University, Aerospace Engineering Dept., Auburn, Ala.

Grant NSG 1002

117 *Burkhalter, John E.: **Analysis and Compilation of Missile Aerodynamic Data—Vol. II, Performance Analysis.** NASA CR-2836, May 1977, 314 pp.

N77-28085#

This report provides a general analysis of the flight dynamics of several surface-to-air and two air-to-air missile configurations. The analysis involves three phases: vertical climb, straight and level flight, and constant altitude turn.

Wind tunnel aerodynamic data and full scale missile characteristics are used where available; unknown data are estimated. For the constant altitude turn phase, a three degree of freedom flight simulation is used. Important parameters considered in this analysis are the vehicle weight, Mach number, heading angle, thrust level, sideslip angle, g loading, and time to make the turn. The actual flight path during the turn is also determined. Results are presented in graphical form.

*Auburn University, Aerospace Engineering Dept., Auburn, Ala.

Grant NSG 1002

118 *Jacobs, Peter F.; *Flechner, Stuart G.; and **Montoya, Lawrence C.: **Effect of Winglets on a First-Generation Jet Transport Wing. 1: Longitudinal Aerodynamic Characteristics of a Semispan Model at Subsonic Speeds.** NASA TN D-8473, June 1977, 50 pp.

N78-20064#

The effects of winglets and a simple wing-tip extension on the aerodynamic forces and moments and the flow-field cross flow velocity vectors behind the wing tip of a first generation jet transport wing were investigated in the Langley 8-foot transonic pressure tunnel using a semi-span model. The test was conducted at Mach numbers of 0.30, 0.70, 0.75, 0.78, and 0.80. At a Mach number of 0.30, the configurations were tested with combinations of leading- and trailing-edge flaps.

*NASA, Langley Research Center, Hampton, Va.
**NASA, Dryden Flight Research Center, Edwards, Calif.

119 *Montoya, Lawrence C.; **Flechner, Stuart G.; and **Jacobs, Peter F.: **Effect of Winglets on a First-Generation Jet Transport Wing. 2: Pressure and Spanwise Load Distributions for a Semispan Model at High Subsonic Speeds.** NASA TN D-8474, July 1977, 211 pp.

N78-20065#

Pressure and spanwise load distributions on a first-generation jet transport semispan model at high subsonic speeds are presented for the basic wing and for configurations with an upper winglet only, upper and lower winglets, and a simple wing-tip extension. Selected data are discussed to show the general trends and effects of the various configurations.

*NASA, Dryden Flight Research Center, Edwards, Calif.
**NASA, Langley Research Center, Hampton, Va.

120 *Montoya, Lawrence C.; **Jacobs, Peter F.; and **Flechner, Stuart G.: **Effect of Winglets on a First-Generation Jet Transport Wing. 3: Pressure and Spanwise Load Distributions for a Semispan Model at Mach 0.30.** NASA TN D-8478, June 1977, 102 pp.

N78-20063#

Pressure and spanwise load distributions on a first-generation jet transport semispan model at a Mach number of 0.30 are given for the basic wing and for configurations with an upper winglet only, upper and lower winglets, and a simple wing-tip extension. To simulate second-segment-climb lift conditions, leading- and/or trailing-edge flaps were added to some configurations.

*NASA, Dryden Flight Research Center, Edwards, Calif.
**NASA, Langley Research Center, Hampton, Va.

121 *Richey, G. K.; **Berrier, B. L.; and ***Paloza, J. L.: **Two-Dimensional Nozzle/Airframe Integration Technology—An Overview.** Presented at the 13th AIAA, SAE Propulsion Conference at Orlando, Fla., July 11–13, 1977, 11 pp.

AIAA Paper 77-839 A77-41973#

The paper reviews the objectives and some of the accomplishments of a number of programs to develop nonaxisymmetric nozzle technology for future tactical aircraft applications. Specific existing fighter aircraft model tests and preliminary studies are discussed which are designed to generate installed nozzle data, including the effects of thrust vectoring and reversal.

*Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio
**NASA, Langley Research Center, Hampton, Va.
***Naval Air Propulsion Test Center, Trenton, N.J.

122 *Pendergraft, O. C., Jr.: **Comparison of Axisymmetric and Nonaxisymmetric Nozzles Installed on the F-15 Configuration.** Presented at the 13th AIAA and SAE Propulsion Conference at Orlando, Fla., July 11–13, 1977, 8 pp.

AIAA Paper 77-842 A77-38555#

An investigation has been conducted in the Langley 16-foot transonic tunnel to determine nozzle/afterbody performance of nonaxisymmetric nozzles installed in a 1/12-scale F-15 propulsion model. Tests were performed at Mach numbers from 0.60 to 1.20 at angles-of-attack from -2 to +9 deg and jet-total-pressure ratios from 1.0 (jet-off) to 5.0, depending on Mach number. The baseline F-15 afterbody was tested with axisymmetric nozzles, and two different two-dimensional wedge nozzle afterbody designs. Results of this investigation indicate that one of the two-dimensional afterbody designs had lower drag than the baseline at a Mach number of 1.20, and about the same drag for subsonic Mach numbers at scheduled nozzle pressure ratios. Thrust vectoring of the two-dimensional wedge nozzles produced significant induced lift on the afterbody and horizontal tails, while thrust reversing had little effect on horizontal tail effectiveness.

*NASA, Langley Research Center, Hampton, Va.

123 *Bennett, Robert M.; *Farmer, Moses G.; **Mohr, R. L.; and **Hall, W. E., Jr.: **Wind-Tunnel Technique for Determining Stability Derivatives from Cable-Mounted Models.** Presented at the AIAA 4th Atmospheric Flight Mechanics Conference, Hollywood, Fla., Aug. 8–10, 1977, Technical Papers in (A77-43151), revised Jan. 30, 1978. Published in Journal of Aircraft, vol. 15, no. 5, May 1978, pp. 304–310.

AIAA Paper 77-1128 A77-43161#

System identification techniques in common use for extracting stability derivatives from flight test data have been adapted for application to data obtained from aeroelastically scaled flutter models flown in a wind tunnel on a cable-mount system. The concept has been applied with reasonable success to data from rigid models of a space shuttle orbiter and a fighter tested in the NASA Langley transonic dynamics tunnel. Further application of this technique should permit extraction of derivatives that include scaled flexibility effects, thereby obtaining additional information from the testing of expensive flutter models.

*NASA, Langley Research Center, Hampton, Va.
**Systems Control, Inc., Palo Alto, Calif.

124 *Spearman, M. L.; *Fournier, R. H.; and *Lamb, M.: **Aerodynamic Characteristics of Supersonic Fighter Airplane Configurations Based on Soviet Design Concepts.** Presented at the AIAA 4th Atmospheric Flight Mechanics Conference, Hollywood, Fla., Aug. 8–10, 1977, Technical Papers; pp. 339–344, in A77-43151.

AIAA Paper 77-1162 A77-43188#

The aerodynamic, stability, and control characteristics of several supersonic fighter airplane concepts are examined. The configurations, which are based on Soviet design concepts, include fixed-wing aircraft having delta wings, swept wings, and trapezoidal wings, and a variable wing-sweep aircraft. Each concept employs aft tail controls. The concepts vary from lightweight, single-engine, air superiority, point interceptor, or ground attack types to larger twin-engine interceptor and reconnaissance designs. Analytical and experimental results indicate that careful application of the transonic or supersonic area rule can provide nearly optimum shaping for minimum drag for a specified Mach number requirement. In addition, through the proper location of components and the exploitation of interference flow fields, the concepts provide linear pitching moment characteristics, high control effectiveness, and reasonably small variations in aerodynamic center location with a resulting high potential for maneuvering capability.

*NASA, Langley Research Center, Hampton, Va.

125 *Wasson, H. R.; *Hall, G. R.; and **Paloza, J. L.: **Results of a Feasibility Study to Add Canards and ADEN Nozzle to the YF-17---(Augmented Deflecting Exhaust Nozzle).** Presented at the AIAA Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22–24, 1977, 10 pp.

AIAA Paper 77-1227 A77-45506#

The paper deals with an aerodynamic analysis and design feasibility study concerning the addition of canards and the 2-D ADEN (augmented deflecting exhaust nozzle) to the YF-17 aircraft. The results of the aerodynamic study showed that addition of the ADEN nozzle and canards did little to improve the turn rate and trimmed lift-drag polars. They did provide considerable direct lift control and aircraft pointing capability, as well as increased control and increased pitch rate at low dynamic pressure. The design feasibility study showed that addition of the ADEN nozzle and canards is readily achievable through structural modifications and modifications of the aircraft control system (using existing actuators). Taking into consideration the structural, weight, and control system requirements, the size of the canards could be reduced to 75 ft of included area, making it possible to accommodate the canard without increasing the aircraft gross weight significantly and to remain within the stability limits imposed by the modified control system.

*Northrop Corp., Aircraft Division, Hawthorne, Calif.
**Naval Air Propulsion Test Center, Trenton, N.J.

126 *Hallissy, James B.; and *Ayers, Theodore G.: **Transonic Wind-Tunnel Investigation of the Maneuver Potential of the NASA Supercritical Wing Concept—Phase I.** NASA TM X-3534, Sept. 1977, 293 pp.

N77-33115#

An investigation was conducted in the NASA Langley 8-foot transonic pressure tunnel at Mach numbers from 0.60 to 0.975 with a variable-wing-sweep airplane model in order to evaluate a series of wings designed to demonstrate the maneuver potential of the NASA supercritical airfoil concept. Both conventional and supercritical wing designs for several planform configurations were investigated with wing sweep angles from 16.0° to 72.5°, depending on Mach number and wing configuration. The supercritical wing configurations showed significant improvements over the conventional configurations in drag-divergence Mach number and in drag level at transonic maneuver conditions.

*NASA, Langley Research Center, Hampton, Va.

127 *Foughner, Jerome T., Jr.; and **Bensinger, Charles T.: **F-16 Flutter Model Studies with External Wing Stores.** Presented at the 4th JTCG/MD Aircraft/Stores Compatibility Symposium, Ft. Walton Beach, Fla., Oct. 12–14, 1977. NASA TM-74078, Oct. 1977, 18 pp.

A78-18801# N78-11004#

The flutter prevention and clearance task for the F-16 airplane is being accomplished in a combined analysis, wind tunnel dynamic model test, and flight flutter test program. This paper presents highlight results from transonic flutter model studies. The flutter model was constructed to support the flutter prevention and clearance program from preliminary design through flight flutter tests. The model tests were conducted in the National Aeronautics and Space Administration's Langley Transonic Dynamics Tunnel. The large full-span free-flying model is shown to be an effective tool in defining airplane flutter characteristics by demonstrating freedom from flutter for most configurations and by defining optimum solutions for a few troublesome configurations.

*NASA, Langley Research Center, Hampton, Va.
**General Dynamics Corp., Fort Worth, Texas

128 *Ettinger, R. C.; and *Johnston, M. B.: **F-16 Flight Test Progress Report.** Presented at the 21st Symposium of the Society of Experimental Test Pilots, Beverly Hills, Calif., Oct. 12–15, 1977, Technical Review, vol. 13, no. 4, 1977, pp. 1–13.

A78-28452

The F-16 aircraft is evaluated in terms of aerial performance and weapons delivery capability. Test flights in both air-superiority and ground-attack modes were conducted to measure g-stress resistance, payload capacity, climb and cruise parameters, and maneuverability using visual and instrument systems. Attention is given to weapons configuration, and to the ability to track and destroy a target either on the ground or in the air.

*USAF, Flight Test Center, Edwards AFB, Calif.

129 *Singleton, T. J.; and **Kendall, W. F., Jr.: **F-15/16 Canopy Off Testing.** Presented at the 21st Symposium of the Society of Experimental Test Pilots, Beverly Hills, Calif., Oct. 12–15, 1977, Technical Review, vol. 13, no. 4, 1977, pp. 14–32.

A78-28453

The history of canopy loss in USAF aircraft during 1965–75 is reviewed in terms of pilot injury and subsequent difficulties in controlling the plane. It is found that since most canopy losses occur at low speeds (due to aircraft pressurization schedules), injury and control impairment are minimal if there is a windscreen, but severe if there is not. The unitary construction of the F-16 cockpit could, therefore, pose a problem in this regard. Tests are described in which dummies and humans were subjected to both simulated (wind tunnel) and actual (runway) canopy-off conditions in F-16 and one- and two-seater F-15 aircraft. Various evasive maneuvers are outlined to help reduce air drag around the pilot, and modifications in helmet design are discussed to help the pilot maintain communication with the ground. The possibility of a pop-up windscreen for F-16 emergency use is also mentioned.

*USAF, Flight Test Center, Edwards AFB, Calif.
**USAF, Aerospace Medical Research Lab, Wright-Patterson AFB, Ohio

130 *Brinks, W. H.: **F-18A--Configurational development from YF-17 Prototype.** Presented at the 21st Symposium of the Society of Experimental Test Pilots, Beverly Hills, Calif., Oct. 12–15, 1977, Technical Review, vol. 13, no. 4, 1977, pp. 32–42.

A78-28454

This paper discusses the configurational development of the F-18 from the YF-17 prototype. Various changes in the YF-17 are described in terms of the foreseen mission requirements of the F-18, i.e., a carrier-based all-weather escort and interdiction aircraft. Attention is given to the leading edge extension (LEX), whose main function is to produce a high energy vortex to provide maximum lift, especially at high angles of attack, and to handling characteristics, in general. Also dealt with are the aircraft's armaments, including the AIM-7F missile and automatic fire-control system.

*McDonnell Douglas Corp., St. Louis, Mo.

131 *Huffman, Jarrett K.; *Fox, Charles H., Jr.; and *Grafton, Sue B.: **Subsonic Longitudinal and Lateral Directional Static Stability Characteristics of a Variable Sweep Fighter Configuration Employing Various Control Surface Deflections at Angles of Attack of 0° to 50° and Large Sideslip Angles.** NASA TM-74050, Oct. 1977, 243 pp.

N78-13010#

A variable sweep fighter configuration with the wing in the 22° sweep position having leading-edge slats and trailing-edge flaps on the outboard panels was tested at a Mach number of 0.15. The angle of attack range was 0° to 50° and the sideslip angle range was -20° to 20°. Pitch, roll, and yaw control effectiveness were studied as well as the effects of spoilers. The data are presented without analysis in order to expedite publication.

*NASA, Langley Research Center, Hampton, Va.

132 *Eigenmann, M. F.; and **Bailey, R. O.: **Development of the Propulsion Simulator—A Test Tool Applicable to V/STOL Configurations.** Presented at the SAE Aerospace Meeting, Los Angeles, Calif., Nov. 14–17, 1977, 13 pp.

SAE Paper 77-0984 A78-23823

A turbine engine multi-mission propulsion simulator, capable of representing inlet/airframe/nozzle flowfield interactions for supersonic V/STOL aircraft wind tunnel models, is described. The propulsion simulator replaces conventional aero flow-through and jet effects models with a single model; flow field interactions modeled by the simulator may include close-coupled inlets and nozzles, non-axisymmetric vectoring exhaust nozzles, and forward canards mounted near the inlets and wings. Wind tunnel tests of the simulation system at Mach numbers up to 1.2 are reported for a model typical of an F-15 aircraft installation. The possibility of applying the simulator to advanced V/STOL design programs is also discussed.

*McDonnell Aircraft Co., St. Louis, Mo.

**NASA, Ames Research Center, Moffett Field, Calif.

133 *Monta, W. J.: **Supersonic Aerodynamic Characteristics of a Sparrow 3 Type Missile Model with Wing Controls and Comparison with Existing Tail-Control Results.** NASA TP-1078, Nov. 1977, 84 pp.

N78-12041#

An experimental investigation was conducted on a model of a wing control version of the Sparrow III type missile to determine the static aerodynamic characteristics over an angle of attack range from 0 deg to 40 deg for Mach numbers from 1.50 to 4.60.

*NASA, Langley Research Center, Hampton, Va.

134 *Hoffman, Sherwood: **Bibliography of Supersonic Cruise Aircraft Research (SCAR) Program From 1972 to Mid-1977.** NASA RP-1003, Nov. 1977, 102 pp.

N78-12895#

This bibliography documents publications of the Supersonic Cruise Aircraft Research (SCAR) Program that were generated during the first 5 years of effort. The reports are arranged according to Systems Studies and five SCAR disciplines: Propulsion, Stratospheric Emissions Impact, Structures and Materials, Aerodynamic Performance, and Stability and Control. The specific objectives of each discipline are summarized. Annotation is included for all NASA inhouse and low-number contractor reports. There are 444 papers and articles included.

*NASA, Langley Research Center, Hampton, Va.

135 Sweetman, B.: **BACKFIRE – The Bogeyman Bomber--.** Flight International, vol. 112, Dec. 17, 1977, pp. 1810–1815.

A78-18699

Backfire is described as a mediocre USSR strategic bomber which has a general layout with characteristics that might be expected of a much smaller aircraft. The general arrangement, which includes side intakes and long ducts, indicates the ancestry of the aircraft from the experimental Tu-98 Backfin of the late 1950s through its refined Tu-102 development, which entered service as the Tu-28P Fiddler interceptor. Backfire is a low-risk design, inasmuch as any large swing-wing aircraft is low-risk. It has a basic internal fuel capacity from 105,000 to 110,000 lb. For the time being, Backfire is important to the Soviet forces in the central European theater because it is the only aircraft which can cover the British Isles without refueling. The absolute maximum speed of Backfire is probably close to Mach 2.

(Includes a good 3-view drawing.)

136 *Spearman, M. Leroy; and *Monta, William J.: **Effects of External Stores on the Aerodynamic Characteristics of a 60° Delta-Wing Fighter Model at Mach 1.60 to 2.87.** NASA TM-74090, Dec. 1977, 31 pp.

N78-12033#

An investigation was conducted to determine the effects of wing-mounted external stores on the longitudinal and lateral aerodynamic characteristics of a 60° delta-wing fighter model with aft tail controls. Data are presented for the clean configuration and for various combinations of pylons and stores. Data were obtained in the Langley Unitary Plan wind tunnel for angles of attack to approximately 22° and tail control deflections of 0° and -10°.

*NASA, Langley Research Center, Hampton, Va.

137 *Chambers, J. R.; and *Grafton, S. B.: **Aerodynamic Characteristics of Airplanes at High Angles of Attack.** NASA TM-74097, Dec. 1977, 95 pp.

N78-13011#

An introduction to, and a broad overview of, the aerodynamic characteristics of airplanes at high angles of attack are provided. Items include: (1) some important fundamental phenomena which determine the aerodynamic characteristics of airplanes at high angles of attack; (2) static and dynamic aerodynamic characteristics near the stall; (3) aerodynamics of the spin; (4) test techniques used in stall/spin studies; (5) applications of aerodynamic data to problems in flight dynamics in the stall/spin area; and (6) the outlook for future research in the area. Although stalling and spinning are flight dynamic problems of importance to all aircraft, including general aviation aircraft, commercial transports, and military airplanes, emphasis is placed on military configurations and the principle aerodynamic factors which influence the stability and control of such vehicles at high angles of attack.

*NASA, Langley Research Center, Hampton, Va.

138 *Mohr, R. L.; and *Hall, W. E., Jr.: **Identification of Stability Derivatives from Wind Tunnel Tests of Cable-Mounted Aeroelastic Models.** NASA CR-145123, 1977, 124 pp.

N77-29166#

The test models were mounted within the wind tunnel on a cable support system which allowed five degrees of freedom in the model's motion. A parameter identification algorithm was computer coded to calculate the maximum likelihood estimates of the stability and control derivatives based on an assumed structure of the equations of motion. Models of the F-14 aircraft and the space shuttle orbiter were tested in the transonic dynamics tunnel to demonstrate the feasibility of identifying aerodynamic coefficients from wind tunnel test data of cable-mounted models.

*Systems Control, Inc., Palo Alto, Calif.

Contract NAS1-13928

139 *Iakovlev, S.: **Jakowlew Jak-42 – Uncomplicated, Reliable, Economical.** Grazhdanskaia Aviatsiia, no. 1, 1977. Technisch-oekonomische Information der zivilen Luftfahrt, vol. 13, no. 3, 1977, pp. 146–150. (In German).

A77-49653#

The Jak-42, which was designed for employment on short-haul local routes in the Soviet Union, is to replace the Tu-134, IL-18, and An-24. The new airliner provides accommodations for 100 to 120 passengers. Freight and mail can be carried in addition to the passengers and their baggage. The Jak-42 can carry a normal commercial payload of 10.5 tons over a distance of 1850 km at a speed of 820 km/hr. Attention is given to the takeoff and landing characteristics of the aircraft, aspects of wing design leading to a lowering of production costs, advances in the design of lift-producing devices, aspects of aircraft control, problems of cockpit design, and various approaches used to obtain a high level of reliability and a long operational life for the aircraft.

*O. Konstruktorskoe Bluro Iakovlev, U.S.S.R.

140 *Bork, P.: **20 years IL-18----Aircraft Design Features, Capabilities and Applications.** Technisch-oekonomische Information der zivilen Luftfahrt, vol. 13, no. 4, 1977, pp. 188–193, 230. (In German).

A78-13497#

The 4th of July is the 20th anniversary of the day on which the Soviet turboprop airliner Iljuschin IL-18 made its first flight. Since 1960 it is widely used in civil aviation in the German Democratic Republic. The airline Interflug uses the aircraft for the transportation of passengers and in freight charter services. Attention is given to historical developments related to the origin of the IL-18, the radio and navigational equipment of the IL-18, and possibilities for an improvement of the engine design leading to a reduction of aircraft noise.

*Gesellschaft fuer Internationalen Flugverkehr mbH, Berlin, East Germany

141 Braybrook, Roy M.: **Fighters for the 1990s: Building on Today's Technology.** Interavia, vol. 33, Jan. 1978, pp. 23–27.

A78-20188

Fighter development is projected into the 1990's, with emphasis on modifications of existing aircraft rather than the development of totally new aircraft types (an exception is Rockwell International's HiMAT, Highly Maneuverable Advanced Technology, aircraft for NASA). Special attention is given to cockpit design e.g., seat geometry, head-up displays (HUD), throttle mounted controls for hands-on, eyes-out flying, and variable mode (attack/dogfight) avionics. The General Dynamics F-16 is described as incorporating the very latest in cockpit design. Also mentioned are refinements in airframe development, using composite materials; and the handling characteristics imparted by airframe design: angle of attack capability, spin resistance, g-resistance, and overall flight stability. Aircraft and cockpit design of advanced aircraft from Sweden, Israel, France, the U.S., and the U.S.S.R. are compared.

142 *Spearman, M. L.: **Historical Development of Worldwide Guided Missiles.** Presented at the AIAA 16th Aerospace Sciences Meeting held at Huntsville, Ala., Jan. 16–18, 1978, 14 pp.

AIAA Paper 78-210 A78-20747#

This paper attempts to put in perspective the development of missiles from early history to present time. The influence of World War II in accelerating the development of guided missiles, particularly through German scientists, is discussed. The dispersion of German scientists to other countries and the coupling of their work with native talent to develop guided missiles is traced. Particular emphasis is placed on the evolution of the missile in the U.S. and the U.S.S.R. Since the Soviets possess what is probably the world's most complete array of dedicated missile system types, their known inventory is reviewed in some detail.

*NASA, Langley Research Center, Hampton, Va.

143 *Jacobs, Peter F.: **Effect of Winglets on a First-Generation Jet Transport Wing. 5: Stability Characteristics of a Full-Span Wing with a Generalized Fuselage at High Subsonic Speeds.** NASA TP-1163, March 1978, 71 pp.

N78-20081#

The effects of winglets on the static aerodynamic stability characteristics of a KC-135A jet transport model at high subsonic speeds are presented. The investigation was conducted in the Langley 8 foot transonic pressure tunnel using 0.035-scale wing panels mounted on a generalized research fuselage. Data were taken over a Mach number range from 0.50 to 0.95 at angles of attack ranging from -12 deg to 20 deg and sideslip angles of 0 deg, 5 deg, and -5 deg. The model was tested at two Reynolds number ranges to achieve a wide angle of attack range and to determine the effect of Reynolds number on stability. Results indicate that adding the winglets to the basic wing configuration produces small increases in both lateral and longitudinal aerodynamic stability and that the model stability increases slightly with Reynolds number. The winglets do increase the wing bending moments slightly, but the buffet onset characteristics of the model are not affected by the winglets.

*NASA, Langley Research Center, Hampton, Va.

144 *Petroff, D. N.; **Scher, S. H.; and ***Sutton, C. E.: **Low-Speed Aerodynamic Characteristics of a 0.08-Scale YF-17 Airplane Model at High Angles of Attack and Sideslip.** NASA TM-78438, April 1978, 118 pp.

N78-22025#

Data were obtained with and without the nose boom and with several strake configurations; also, data were obtained for various control surface deflections. Analysis of the results revealed that selected strake configurations adequately provided low Reynolds number simulation of the high Reynolds number characteristics. The addition of the boom in general tended to reduce the Reynolds number effects.

*NASA, Ames Research Center, Moffett Field, Calif.
**NASA, Langley Research Center, Hampton, Va.
*** ARO, Inc., Moffett Field, Calif.

145 *Abercrombie, J. M.: **Flight Test Verification of F-15 Performance Predictions.** In AGARD "Performance Prediction Methods," (N78-26074), May 1978, 13 pp.

N78-26090#

The prediction of the performance characteristics of the F-15 Eagle was based primarily on data obtained in an extensive wind tunnel test program. This test program was designed to determine the basic lift and drag characteristics for all flight conditions. In addition, the effects of engine operating conditions as reflected in inlet mass flow and engine nozzle geometry and jet plume characteristics were carefully measured. Inlet performance model tests served to provide accurate definition of recovery characteristics for calculation of net propulsive forces. The test techniques and the methods used to adjust the wind tunnel results to predicted flight performance are discussed. A description of the flight test program for performance with flight qualification is also included. Selected comparison of predicted performance with flight test results are presented. Assessment of the performance prediction methods used, based on the degree of verification available from flight test data, is also included. The results prove that with sufficiently sophisticated wind tunnel models and thorough test techniques, satisfactory performance predictions can be made.

*McDonnell Aircraft Co., St. Louis, Mo.

146 *Grellmann, H. W.: **YF-17 Full Scale Minimum Drag Prediction.** In AGARD "Performance Prediction Methods," (N78-26074), May 1978, 12 pp.

N78-26091#

The problem of predicting the full scale minimum drag of supersonic fighter aircraft is addressed. The YF-17 aircraft is used to illustrate the various factors which must be taken into account. Two comparisons of YF-17 minimum drag are presented. The first comparison is between analytical estimates and wind tunnel results. The second comparison is between the full scale predicted minimum drag based on wind tunnel data and the flight test drag level based on in-flight measured thrust. The data presented show in detail how the YF-17 full scale minimum drag was predicted. Areas of uncertainty are discussed which may contribute to the differences between the predicted and measured flight test minimum drag.

*Northrop Corp., Hawthorne, Calif.

147 *Webb, T. S.; *Kent, D. R.; and *Webb, J. B.: **Correlation of F-16 Aerodynamics and Performance Predictions With Early Flight Test Results.** (In AGARD "Performance Prediction Methods." See N78-26074-17-01) May 1978, 17 pp.

N78-26092#

F-16 design objectives and pertinent configuration features are reviewed, and the major external configuration differences between the YF-16 prototype and the F-16 full-scale development airplanes are discussed. The approach to predicting F-16 aerodynamics was to use YF-16 flight-test-derived data corrected for YF-16-to-F-16 configuration differences as determined from wind tunnel tests. A comparison of YF-16 and F-16 wind tunnel lift, drag, and pitching-moment data reflects the close similarity between the F-16 and YF-16 configurations. Early F-16 flight test results show similar differences between wind tunnel and flight test lift and drag as experienced on the YF-16 and, therefore, validate this empirical approach. The untrimmed drag due to lift generally appears lower in flight than in the wind tunnel, and therefore was not predicted. This results in a small increase in trim drag.

*General Dynamics Corp., Fort Worth, Texas

148 **Fighter Aircraft Design.** Advisory Group for Aerospace Research and Development, NATO, Conference Proceedings, AGARD-CP-241, June 1978, 298 pp. (Partly in English, partly in French.) Presented at the Multi-Panel Symposium, Florence, Italy, 3–6 Oct. 1977.

AD-A057703 N78-30099#

These proceedings consist of the unclassified papers that were presented at the AGARD Multi-Panel Symposium on Fighter Aircraft Design, Florence, Italy, 3–6, Oct. 1977. The state of technology as related to future fighter aircraft design is assessed in terms of military requirements for the 80's. System design approach, aerodynamics and aircraft configurations, propulsion, structures design, avionics/guidance, and human factors are among the topics covered.

149 *Murden, W. P.; *Altis, H. D.; and *Ramey, M. L.: **Fighter Superiority by Design.** In AGARD-CP-241 "Fighter Aircraft Design," (N78-30099), June 1978, 16 pp.

N78-30105#

Aspects of the F-18 program are discussed in terms of increasing combat effectiveness and decreasing combat costs. Combat performance, firepower and weapon system capability, multimission versatility, increased reliability and maintainability, and combat survivability are among the factors considered.

*McDonnell Aircraft Co., St. Louis, Mo.

150 *Bohm, M. P.: **Aerodynamics of the New Generation of Combat Aircraft With Delta Wings.** NASA TM-75793. (Translation into English of "Aerodynamique de la Nouvelle Generation d'Avions de Combat a Aile Delta," pp. 11-1 through 11-13 of AGARD-CP-241, June 1978.) Presented at the Multi-Panel Symposium on Fighter Aircraft Design, Florence, Italy, 3–6 Oct. 1977. (The original, in French, was announced as N78-30106#.)

Available in English. N80-22306#

Utilization of various aerodynamic configurations for modern delta wing combat aircraft is discussed in relation to approach speeds and reducing impact damage at Supersonic speeds. Mission requirements such as maneuverability were examined in detail, and principle reasons for the discontinuation of fixed winged aircraft for combat were illustrated. Various current French fighter airplanes are utilized for comparisons.

*Avions Marcel Dassault-Brequet Aviation, St. Cloud, France
Contract NASw-3198

151 *Bruner, Georges: **Le Bombardier Supersonique Soviétique "BACKFIRE." (The Soviet Supersonic "BACKFIRE" Bomber).** L'Aéronautique et L'Astronautique, no. 70, 1978–3, pp. 69–76.

(In French). A78-43765

General design features of the Tupolev Backfire B variable-geometry supersonic bomber are described. Attention is given to the wings, fuselage, tail structures, landing gear, propulsion unit, armament, and electronic equipment. Data are given on the ascent speed as a function of altitude, flight distance as function of altitude, and speed as function of altitude for different conditions of the variable wings and with and without afterburner. The aircraft's possibilities with regard to penetrating Western Europe, the North Atlantic, and the United States are discussed. (A 3-view drawing of the "BACKFIRE B" is included.)

*Centre de Documentation de l'Armement, Paris, France

152 Sweetman, B.: **Su-19 FENCER.** Flight International, vol. 114, July 29, 1978, pp. 350–352.

A78-46494

Available technical data on the Soviet swing-wing air-to-ground fighter, the Sukhoi Su-19 Fencer, are given. Based on the one poor-quality photograph made available, a reconstruction of the planform and fairly reliable guesses at the front and side views are given. Features of the aircraft include a fairly well inboard location of the wing pivots, large slab ailerons for roll control, side-by-side seating, and weaponry including the radio-guided short range AS-7 Kerry, anti-radar weapons, and a 40 km-range EO weapon known as Advanced TASM. The power plants are conjectured to be two reheat turbofans with a dry thrust of 11,000 lb and reheat thrust of 18,000 lb. Maximum speed at 36,000 ft is Mach 2+, long-range cruise at 36,000 ft is Mach 0.75. Most of the European central region can be attacked by the Fencer on a nonstop mission returning directly to Soviet bases.

153 *Nugent, J.; *Taillon, N. V.; and **Pendergraft, O. C., Jr.: **Status of a Nozzle-Airframe Study of a Highly Maneuverable Fighter.** Presented at the 14th AIAA and SAE Joint Propulsion Conference, Las Vegas, Nev., July 25–27, 1978, 18 pp.

AIAA Paper 78-990 A78-48470#

NASA is sponsoring a research program that uses coordinated wind tunnel and flight tests to investigate nozzle-airframe flow interactions. The program objective is to compare transonic flight and wind tunnel measurements over a wide Reynolds number range. The paper discusses the progress of the program and the coordination of the wind tunnel and flight tests with regard to program elements, model-airplane differences, instrument locations, and test conditions. The real-time feedback techniques used to obtain steady flight conditions are presented. Available wind tunnel results are presented for the jet effects model showing the influence of the rear-end geometry and test variables on nozzle drag. Available flight results show the effect of the variable inlet ramp angle and angle of attack on fuselage pressures and upper surface boundary layers.

*NASA, Dryden Flight Research Center, Edwards, Calif.
**NASA, Langley Research Center, Hampton, Va.

154 *Lucas, E. J.; **Fanning, A. E.; and ***Steers, L. L.: **Comparison of Nozzle and Afterbody Surface Pressures from Wind Tunnel and Flight Test of the YF-17 Aircraft.** Presented at the 14th AIAA and SAE Joint Propulsion Conference, Las Vegas, Nev., July 25–27, 1978, 12 pp.

AIAA Paper 78-992 A78-43540#

Results are reported from the initial phase of an effort to provide an adequate technical capability to accurately predict the full scale, flight vehicle, nozzle-afterbody performance of future aircraft based on partial scale, wind tunnel testing. The primary emphasis of this initial effort is to assess the current capability and identify the cause of limitations on this capability. A direct comparison of surface pressure data is made between the results from an 0.1-scale model wind tunnel investigation and a full-scale flight test program to evaluate the current subscale testing techniques. These data were acquired at Mach numbers 0.6, 0.8, 0.9, 1.2, and 1.5 on four nozzle configurations at various vehicle pitch attitudes. Support system interference increments were also documented during the wind tunnel investigation. In general, the results presented indicate a good agreement in trend and level of the surface pressures when corrective increments are applied for known effects and surface differences between the two articles under investigation.

*ARO, Inc., Arnold Air Force Station, Tenn.
**USAF, Aero Propulsion Lab., Wright-Patterson AFB, Ohio
***NASA, Dryden Flight Research Center, Edwards, Calif.

155 Farrow, George: **Combat Aircraft Design Analysis No. 2 – McDonnell Douglas/Northrop F-18.** Interavia, vol. 33, July 1978, pp. 605–608.

The most distinctive features of the F-18 Hornet are the large wing leading edge extensions (LEXs), or strakes, resembling the hood of a cobra (which was the name given to the original Northrop P-530 project and now to the land-based version, the F-18L). These strakes, together with the less obvious combat high-lift devices, augment the performance of the wing. Discussed are the F-18 wing design, longitudinal stability and trim, lateral stability and control, intake design, supersonic design features, structural design and weights, powerplants, weapon carriage and performance. The F-18/F-18L programs are outlined.

156 *Headley, J. W.: **Analysis of Wind Tunnel Data Pertaining to High Angle-of-Attack Aerodynamics. Vol. 1 – Technical Discussion and Analysis of Results.** NOR-78-69, Vol. 1; AFFDL-TR-78-94, Vol. 1, July 1978, 180 pp.

AD-A069646 N79-30148#

This report provides a technical discussion and analysis of wind tunnel data obtained from tests conducted on a family of Northrop fighter aircraft. These tests were performed mainly in the Northrop Low Speed Wind Tunnel, and cover the time period between 1966 and 1976. This report concentrates on data in the stall, post-stall region, and for convenience is provided in two sections. This volume presents the results of the analysis of wind tunnel data which concentrates on the high angle of attack regime, and on three major aircraft components. These components are the nose and forebody, the wing leading edge extension, and the vertical tail. The effects of geometric changes in these components on the aircraft's high angle of attack aerodynamics are analyzed. Wherever possible design guidelines which identify the sensitivity of aerodynamic characteristics to geometric parameter variations are presented. Geometric changes or effects which were configuration dependent are also discussed. The second volume, Volume 2: 'Data base,' contains summaries of the wind tunnel tests which were selected to provide data for the analysis.

*Northrop Corp., Aircraft Group, Hawthorne, Calif.

Contract F33615-77-C-3062

157 *Headley, J. W.: **Analysis of Wind Tunnel Data Pertaining to High Angle of Attack Aerodynamics. Vol. 2: Data Base.** Progress Rept. June 1977–April 1978. NOR-78-69–Vol. 2; AFFDL-TR-78-94–Vol. 2, July 1978, 391 pp.

AD-A069647 N79-30149#

This volume presents, in summary form, the geometric and aerodynamic data used as a basis for the design guidelines presented in Volume 1. The summaries have been divided into eight sections, the first seven being the low speed tests, which include almost all the configuration development studies and most of the high AOA testing. Data summaries for the transonic and supersonic testing form the eighth and last section. Because of the considerable quantity of data available from all the testing (some test reports containing as much as thirteen volumes), it is not practical to include the summaries of all the basic aerodynamic data available. In general, only the main aerodynamic effects are presented or summarized, and for more detailed information on a particular configuration, reference should be made to the actual wind tunnel report. All the data summaries are presented in a similar way, and include the following information: a data sheet including the test report title, a summary of the report, and the test conditions; a general three view of a representative test model configuration; detailed sketches of the pertinent configurations changes; and the relevant aerodynamic data.

*Northrop Corp., Aircraft Group, Hawthorne, Calif.
Contract F33615-77-C-3062

158 *Smith, C. W.; and *Bateley, I. C.: **Aerodynamic Characteristics of Forebody and Nose Strakes Based on F-16 Wind Tunnel Test Experience. Vol. 2: Data Base.** NASA CR-158922, Sept. 1978, 757 pp.

N79-12066#

The YF-16 and F-16 developmental wind tunnel test program was reviewed and all force data pertinent to the design of forebody and nose strakes extracted. A complete set of these data is presented without analysis. (For Vol. 1 see #188 in this compilation.)

*General Dynamics, Fort Worth Division, P.O. Box 748, Fort Worth, Texas

Contract NAS1-15006

159 *Edwards, O. R.: **Northrop F-5F Shark Nose Development.** NASA CR-158936, Oct. 1978, 232 pp., 15 refs.

N79-10047#

During spin susceptibility testing of the Northrop F-5F airplane, two erect spin entries were obtained from purely longitudinal control inputs at low speed. Post flight analysis of the data showed that the initial yaw departure occurred at zero sideslip and review of wind tunnel data showed significant yawing moments present at angles of attack well above stall. Further analysis of this wind tunnel data indicated that the yawing moments were being generated by the long slender nose of the airplane. Redesign of the nose was accomplished, resulting in a nose configuration which completely alleviated the asymmetric yawing moments. This report documents the development of this new F-5F nose configuration from the initial identification of the importance of the nose region for high angle-of-attack flying qualities through the experimental studies in the Northrop low-speed wind tunnel and water tunnel to the flight testing of the finally developed nose configuration, the so-called "Shark nose." The report draws on a unique data base of experimental wind tunnel and flight test data obtained by Northrop during the development of the F-5F aircraft.

*Northrop Corp., Aircraft Group, Hawthorne, Calif.
Contract NAS1-15159

160 **Dynamic Stability Parameters.** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France) Symposium held in Athens, May 22–24, 1978. AGARD-CP-235, Nov. 1978, 623 pp. (In English and French.)

N79-15061#

The mission of AGARD is to bring together the leading personalities of the NATO nations in the fields of science and technology relating to aerospace. This symposium was organized in recognition of the strong present-day interest in dynamic stability of aerospace vehicles. The purpose of the symposium was to discuss the specific needs for dynamic stability information, the form in which it should be presented and the various means of obtaining it. The symposium was divided into the following sessions: (1) wind tunnel techniques 1; (2) wind tunnel techniques 2; (3) flight testing techniques; (4) analytical techniques; (5) motion analysis and nonlinear formulations; (6) sensitivity and simulator studies; and (7) workshop session. For individual titles, see N79-15062 through N79-15097.

161 *Whitmoyer, Robert A.: **Aerodynamic Interactions on the Fighter CCV Test Aircraft.** In AGARD-CP-235, (N79-15061), "Dynamic Stability Parameters," Paper No. 16, 13 pp., Nov. 1978.

N79-15076#

The Fighter CCV YF-16 testbed aircraft completed an 87 flight, 125 hour test program in June 1977. The aircraft achieved higher levels of direct force control than had previously been flight tested. The direct force capabilities were used to implement six unconventional control modes on the aircraft, consisting of flat-turns, decoupled normal acceleration control, independent longitudinal and lateral translations, and uncoupled elevation and azimuth aiming. The flight test program and supporting wind tunnel testing produced a wealth of data concerning the complex aerodynamic interactions between the force and moment producers on a Control Configured Vehicle design. The interactions were prime factors in determining the viability of the unconventional control concepts investigated.

*Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio

162 *Chambers, Joseph R.; *Gilbert, William P.; and *Nguyen, Luat T.: **Results of Piloted Simulator Studies of Fighter Aircraft at High Angles of Attack.** In AGARD-CP-235, Paper No. 33, Nov. 1978, 13 pp.

N79-15093#

The experience gained at the NASA Langley Research Center during the application of simulator techniques to high angle of attack flight conditions for several current fighters is discussed. The discussion includes (1) the simulator hardware, (2) requirements for static and dynamic aerodynamic data inputs, (3) evaluation procedures, (4) correlation with flight, and (5) the effects of dynamic stability parameters. Results obtained with the simulator technique have correlated well with flight test experience, resulting in early identification of potential problems, identification of critical flight conditions, and solutions to various deficiencies in stability and control characteristics. Results indicate that certain dynamic stability parameters can have a large influence on the flying qualities and tactical effectiveness of fighters at high angles of attack.

*NASA, Langley Research Center, Hampton, Va.

163 *Butler, R. W.; and *Langham, T. F.: **Aircraft Motion Sensitivity to Variations in Dynamic Stability Parameters.** In AGARD-CP-235, (N79-15061), "Dynamic Stability Parameters," Paper No. 35, Nov. 1978, 11 pp.

N79-15095#

A 6-DOF nonlinear and 5-DOF linearized dynamic sensitivity study was conducted on a fighter/bomber and attack type aircraft. The dynamic derivatives investigated in the study were C sub l sub q, C sub n sub q, C sub m sub r, C sub l sub Beta, and C sub n sub Beta. The cross-coupling derivatives C sub l sub q and C sub n sub q are shown to have significant effects on the aircraft motion in 1 g flight and 2 g turning flight while the derivatives C sub m sub r show little effect in the same regime. The acceleration derivatives C sub n sub Beta each have a significant influence on the aircraft motion in 1 g flight. The interactive nature of the dynamic derivatives in the aircraft equations of motion is documented.

*ARO, Inc., Arnold Air Force Station, Tenn.

164 **USAF Standard Aircraft/Missile Characteristics – Air Force Guide Number Two, Vol. II (Brown Book).** Loose-leaf, periodically revised. Aeronautical

Systems Division (AFSC), Wright-Patterson AFB, Ohio, Nov. 1978. LaRC requestors ask for CN-151,145.

The "USAF Standard Aircraft/Missile Characteristics," Air Force Guide Number Two, Vol. II (Brown Book) reflects the military capabilities of cargo, helicopter, trainer, utility, and miscellaneous aircraft. The data are prepared in accordance with the latest revision of Specification MIL-C-5011. Each aircraft is covered in a six-page brochure consisting of a photograph, three-view drawing, fuel tankage diagram, interior arrangement, propulsion data, dimensions, weights, electronics, development data, tactical or cargo capability, tabulation of basic and typical missions, performance graphs and a narrative description of the tabulated missions. The guide is divided into five sections, each section contains aircraft systems arranged in numerical order within type of aircraft.

165 Hamill, Tom: **F-18 HORNET.** Flight International, vol. 114, Dec. 2, 1978, pp. 2021–2036.

A79-17650

The F-18 Hornet aircraft, a development of the YF-17, is described. The F-18, smaller than the F-4 it is designed to replace, achieves light weight by simple design, including fixed geometry intakes and unswept mainplane. Several surfaces or structures are made of graphite-epoxy. Powerplants, cockpit, avionics, and weapons systems are discussed. Performance and the U.S. Navy production and evaluation program are examined. It is suggested that each F-18 is likely to cost about $10 million in 1978 dollars. Design modifications for the proposed land-based F-18L are surveyed. Three-view and cutaway drawings are included with this article.

166 Sweetman, Bill: **Mikoyan FLOGGER.** Flight International, vol. 114, no. 3639, Dec. 16, 1978, pp. 2181–2184.

Visits by new MiG-23s to Finland and France have raised the curtain on Russia's most important warplane, and allowed the preparation of this new analysis. Specifications and a three-view diagram are included.

167 Braybrook, Roy M.: **Soviet Swing-Wings.** Air International, vol. 15, no. 12, Dec. 1978, pp. 266–272.

A79-17125

The MiG-23 and MiG-27 family of fighters is analyzed in some detail. Attention is given to considerations that led to its development, design options, and the basic configuration. Photographs of MiG-23S fighters in flight are presented.

168 *Lorincz, D. J.: **A Water Tunnel Flow Visualization Study of the F-15.** Final Rept. NOR-78-176; NASA CR-144878, Dec. 1978, 96 pp.

N79-18286#

Water tunnel studies were performed to qualitatively define the flow field of the F-15 aircraft. Two lengthened forebodies, one with a modified cross-sectional shape, were tested in addition to the basic forebody. Particular emphasis was placed on defining vortex flows generated at high angles of attack. The flow visualization tests were conducted in the Northrop diagnostic water tunnel using a 1/48-scale model of the F-15. Flow visualization pictures were obtained over an angle-of-attack range to 55 deg and sideslip angles up to 10 deg. The basic aircraft configuration was investigated in detail to determine the vortex flow field development, vortex path, and vortex breakdown characteristics as a function of angle of attack and sideslip. Additional tests showed that the wing upper surface vortex flow fields were sensitive to variations in inlet mass flow ratio and inlet cowl deflection angle. Asymmetries in the vortex systems generated by each of the three forebodies were observed in the water tunnel at zero sideslip and high angles of attack.

*Northrop Corp. Labs., Hawthorne, Calif.
Contract NAS4-2526

169 Stepniewski, W. Z.: **A Glance at Soviet Helicopter Design Philosophy.** Presented at the Conference on Helicopter Structures Technology held at Moffett Field, Calif., Nov. 16–18, 1977, 12 pp.

A79-10910#

The author gives a report on what current trends in Soviet helicopter design are, as judged from the contents of the book 'Helicopters' by Tischenko et al. The optimization criteria that Soviet designers appear to be concerned with are (1) weight and transport effectiveness, (2) an economic integration of functional, producible, and operational effectiveness, and (3) general economic effect of total cost of all machines of a given type on the economy. Most attention in the review is directed at the studies of maximization of useful load.

*U.S. Army Air Mobility Research & Development Lab.

170 *Nissim, E.: **Flutter Suppression and Gust Alleviation Using Active Controls – Review of Developments and Applications Based on the Aerodynamic Energy Concept.** Presented at the 11th Congress of the International Council of the Aeronautical Sciences Proceedings, Vol. I, Lisbon, Portugal, Sept. 10–16, 1978, pp. 600–615.

A79-20128#

The state of the art of the aerodynamic energy concept, involving the use of active controls for flutter suppression, is reviewed. Applications of the concept include the suppression of external-store flutter of three different configurations of the YF-17 flutter model using a single trailing edge control surface activated by a single fixed-gain control law. Consideration is also given to some initial results concerning the flutter suppression of the 1/20 scale low speed wind-tunnel model of the Boeing 2707-300 supersonic transport using an activated trailing edge control surface.

*Technion—Israel Institute of Technology, Haifa, Israel
NASA-supported research

171 *Capone, F. J.; **Gowadia, N. S.; and ***Wooten, W. H.: **Performance Characteristics of Nonaxisymmetric Nozzles Installed on the F-18 Aircraft.** Presented at the 17th AIAA Aerospace Sciences Meeting, New Orleans, La., Jan. 15–17, 1979, 31 pp.

AIAA Paper 79-0101 A79-23532#

The Langley Research Center has conducted an experimental program on a model of the F-18 airplane to determine the performance of nonaxisymmetric nozzles relative to the aircraft's baseline axisymmetric nozzle. The performance of a single expansion ramp (ADEN) and two-dimensional convergent-divergent (2-D C-D) nozzle were compared to the baseline axisymmetric nozzles. The effects of vectoring and reversing were also studied. Performance of a modified YF-17 airplane with the ADEN nozzle was also estimated. The results of this investigation indicate that nonaxisymmetric nozzles can be installed on a twin engine fighter airplane with equal or better performance than axisymmetric nozzles. The nonaxisymmetric nozzles also offer potential for innovative and improved aircraft maneuver through thrust vectoring and reversing. The YF-17/ADEN flown as a technology demonstrator would have reduced performance compared to an unmodified YF-17. However, on an equal aircraft weight basis, performance would essentially be equivalent. This study also showed that the YF-17 can serve as a testbed to validate nonaxisymmetric nozzle technology.

*NASA, Langley Research Center, Hampton, Va.
**Northrop Corp., Hawthorne, Calif.
***General Electric Co., Cincinnati, Ohio

172 **High Angle of Attack Aerodynamics.** Conference held at Sandefjord, Norway, 4–6, Oct. 1978. AGARD-CP-247, Jan. 1979, 542 pp.

N79-21996#

Reports were presented on: (1) studies of configurations of practical application (10 papers); (2) mathematical modeling and supporting investigations (12 papers); (3) design methods (7 papers), and (4) air intakes (2 papers). Eight additional short presentations on these subjects are also documented. For individual titles, see N79-21997 through N79-22034.

173 *Smith, C. W.; and *Anderson, C. A.: **Design Guidelines for the Application of Forebody and Nose Strakes to a Fighter Aircraft Based on F-16 Wind Tunnel Testing Experiment.** In AGARD-CP-247, "High Angle of Attack Aerodynamics," N79-21996, 11 pp.

N79-22000#

During the YF-16 and F-16 developmental wind tunnel test program, numerous variations in nose and forebody strakes were investigated. These data were reviewed, and the strake aerodynamic characteristics coalesced into design guidelines for the application of strakes to fighter aircraft. The design guides take the form of general equations governing the modification of forebody strakes to obtain a linear pitching moment curve and the calculation of the resulting lift and drag increments. Additionally, qualitative comments are made concerning the effects of strake geometry on lateral/directional stability. It is concluded that the generation of incremental strake lift is primarily dependent upon the area affected by the strake-induced vortex and that strake planform is of secondary importance. Forebody strakes have small beneficial effects on lateral/directional stability if properly designed; however, significant gains are easily attained with nose strakes.

*General Dynamics, Fort Worth, Texas

Contract NAS1-15006

174 *Cornish, J. J., III; and *Jenkins, M. W. M.: **The Application of Spanwise Blowing for High Angle of Attack Spin Recovery.** In AGARD-CP-247, "High Angle of Attack Aerodynamics," N79-21996, Jan. 1979, 12 pp.

N79-22004#

A unique autorotation tunnel test was performed on a 1/30th scaled model of an F-4 fighter configuration. During this test, air was blown spanwise over the wing from various nozzle locations and the influence of this blowing on the spinning mode was recorded. Over 50 test conditions were evaluated for both flat (alpha = 45 degrees) and steep (alpha = 80 degrees) spin modes. The wing blowing was very effective in arresting the spin for the steep spin mode and not very effective in stopping the flat spin. Nose blowing was also evaluated with only marginal success. An optimum wing nozzle location and blowing level was identified. These data, when scaled to full-scale values, showed that the required nozzle diameter was 1.92 inches, located close to the wing root 1/4 chord point and 18 lb/sec. of air was required to affect recovery. More efficient and effective recovery is possible in the tunnel with an additional degree of freedom and with empennage blowing. Further, larger scale testing is urged.

*Lockheed-Georgia, Co., Flight Sciences Division, Marietta, Ga.

175 **Yakovlev 36 MP--In Soviet Service—1.** Air International, vol. 16, Jan. 1979, pp. 18–20.

The Yak-36MP (FORGER), first seen on the aircraft carrier Kiev in July 1976, is a VTOL combat aircraft, the primary role of which remains obscure. Three-view and cutaway drawings are included in this article along with photographs and available descriptive material.

176 Boyle, Dan: **F-16, The Multi-National, Multi-Role Aircraft.** Interavia, vol. 34, no. 1, Jan. 1979, pp. 39–43.

The choosing of the F-16 for the NATO countries in Europe is discussed. The author visited Belgium and the Netherlands and here describes the progress of the program as he learned it from some of the companies and Air Forces involved. The first flight, by an F-16 to be built in Europe, took place on Dec. 11, 1978, from the Gosselies airfield in Belgium. The aircraft and engine are briefly described and the unique features of the cooperative program are listed.

177 *Montoya, R. J.; *Jai, A. R.; and *Parker, C. D.: **Systems Development of a Stall/Spin Research Facility Using Remotelv Controlled/Augmented Aircraft Models. Volume 1: Systems Overview.** NASA CR-145351; RTI/1362/00-01F; Jan. 1979, 87 pp.

N79-15101#

A ground based, general purpose, real time, digital control system simulator (CSS) is specified, developed, and integrated with the existing instrumentation van of the testing facility. This CSS is built around a PDP-11/55, and its operational software was developed to meet the dual goal of providing the immediate capability to represent the F-18 drop model control laws and the flexibility for expansion to represent more complex control laws typical of control configured vehicles. Overviews of the two CSS's developed are reviewed as well as the overall system after their integration with the existing facility. Also the latest version of the F-18 drop model control laws (REV D) is described and the changes needed for its incorporation in the digital and analog CSS's are discussed.

*Research Triangle Inst., Research Triangle Park Systems and Measurements Division, N.C.

Contract NAS1-14638; RTI Proj. 43U-1362

178 **MIL HIND-D – In Soviet Service – 2.** Air International, vol. 16, no. 2, Feb. 1979, pp. 70–72.

The HIND-D (a version of the Mi-24) is a highly potent multiple-weapon helicopter with electro-optical weapon-aiming aids optimized for the anti-armor task. It compares favorably in performance and equipment respects with the Hughes AH-64. A 3-view drawing is included.

179 **Sukhoi FLAGON---In Soviet Service-3.** Air International, vol. 16, no. 4, April 1979, pp. 174–176.

The Su-15 (FLAGON), a single-seat tailed-delta all-weather interceptor is one of the most extraordinary examples of incremental combat aircraft design development of the post-WW II era. The history of the FLAGON series is detailed and 3-view drawings and some photographs are included. Production of the Su-15 series is believed to have been phased out in 1977, but since then the FLAGON-E version has been brought up to F-standard, and the Su FLAGON-F will retain its important place well into the eighties.

180 *Nichols, James H., Jr.: **Development of High Lift Devices for Application to Advanced Navy Aircraft.** Final Rept. Presented at the Workshop on V/STOL Aerodynamics, Monterey, Calif., 16–18 May 1979. DTNSRDC-80-058; DTNSRDC/AERO-1266, Apr. 1980, 47 pp.

AD-A084226 N80-32382#

A number of methods for generating high lift to provide a short takeoff and landing (STOL) capability for advanced Navy aircraft are evaluated with emphasis on low aspect ratio wings. Upper surface blowing, circulation control wing, and wing tip sails are given the most attention. Experimental data were obtained in the wind tunnels on these concepts as specifically applied to wings of aspect ratios 3 to 5. Flight demonstrations of a circulation control wing application to the A-6 aircraft showed the ability to more than double the lifting capability which resulted in landing speed reductions of more than 30 percent, landing ground roll reductions of more than 50 percent, and takeoff distance reductions of at least 25 percent. The experimental high lift system data was applied to a conceptual STOL baseline aircraft in order to estimate the impact on mission performance and identify their various merits as applicable to the particular restructions of small ship operations.

*Naval Ship Research and Development Center, Bethesda, Md.

181 *Herman, J. F.: **Wind Tunnel Test to Investigate Aerodynamic Hysteresis Phenomena of the F-4 and F-111 Aircraft Models.** AEDC-TSR-79-P27, May 15, 1979, 37 pp.

AD-A077196 N80-19040#

Wind tunnel tests were conducted to investigate aerodynamic hysteresis phenomena found in other investigations of the F-4 and F-111 aircraft models. A 1/20-scale model of the F-4C aircraft was used to obtain static force, moment and wing pressure data in pitch and sideslip over a Mach number range from 0.7 to 0.95. A 1/24-scale model of the F-111 aircraft was used to obtain static force and moment data for a Mach number range of 0.7 to 1.3. Data on the F-111 were obtained for wing sweep angles of 26 and 54 deg. In addition, tuft and oil flow visualization data were obtained for selected configurations.

*ARO, Inc., Arnold Air Force Station, Tenn.

182 **Sukhoi SU-17---In Soviet Service-4.** Air International, vol. 16, no. 5, May 1979, pp. 222–225.

One of the most prolific of the newer warplanes now facing NATO in Central Europe is this Sukhoi Su-17 (FITTER) variable-geometry close air support, counter-air and battlefield interdiction aircraft. First deployed in 1971–'72, the Su-17 is now replacing the Su-7 ground attack fighter. It is also being used on the Baltic and Black Seas for anti-shipping strikes and amphibious support roles. It is currently one of the most important tactical aircraft in the War Pac armory. The history of the Su-17 is given. Photographs and 3-view drawings are included and the series is described through the latest identified service version, the FITTER-D.

183 *Butler, G. F.; and *Spavins, G. R.: **Wind Tunnel/Flight Comparison of the Levels of Buffeting Response Intensity for the TACT F-111.** RAE-TM-Aero-1806; BR69201; May, 1979, DCAF E010260. Presented at USAF/NASA Symposium on Transonic Aircraft Technology, Lancaster, Calif., Aug. 1978, 20 pp.

N80-24331#

A wind-tunnel/flight correlation has been made of the levels of buffeting response intensity of the TACT F-111 aircraft. Wind-tunnel measurements of the buffeting response of a 1/8 scale half-model of conventional construction have been used to predict the response of the TACT aircraft under full-scale flight conditions. Comparison with flight measurements shows good agreement.

*Royal Aircraft Establishment, Farnborough, England

184 *Sisk, T. R.; and *Matheny, N. W.: **Precision Controllability of the F-15 Airplane.** NASA TM-72861, May 1979, 46 pp.

N79-23979#

A flying qualities evaluation conducted on a preproduction F-15 airplane permitted an assessment to be made of its precision controllability in the high subsonic and low transonic flight regime over the allowable angle of attack range. Precision controllability, or gunsight tracking, studies were conducted in windup turn maneuvers with the gunsight in the caged pipper mode and depressed 70 mils. This evaluation showed the F-15 airplane to experience severe buffet and mild-to-moderate wing rock at the higher angles of attack. It showed the F-15 airplane radial tracking precision to vary from approximately 6 to 20 mils over the load factor range tested. Tracking in the presence of wing rock essentially doubled the radial tracking error generated at the lower angles of attack. The stability augmentation system affected the tracking precision of the F-15 airplane more than it did that of previous aircraft studied.

*NASA, Dryden Flight Research Center, Edwards, Calif.

185 *Petit, J. E.; and **Capone, F. J.: **Performance Characteristics of a Wedge Nozzle Installed on an F-18 Propulsion Wind Tunnel Model.** Presented at the 15th AIAA, SAE, and ASME Joint Propulsion Conference, Las Vegas, Nev., June 18–20, 1979, 19 pp.

AIAA Paper 79-1164 A79-41174#

The results of two-dimensional wedge non-axisymmetric nozzle (2D-AIN) tests to determine its performance relative to the baseline axisymmetric nozzle using an F-18 jet effects wind tunnel model are presented. Configurations and test conditions simulated forward thrust-minus drag, thrust vectoring/induced lift, and thrust reversing flight conditions from Mach .6 to 1.20 and attack angles up to 10 degrees. Results of the model test program indicate that non-axisymmetric nozzles can be installed on a twin engine fighter aircraft model with equivalent thrust minus drag performance as the baseline axisymmetric nozzles. Thrust vectoring capability of the non-axisymmetric nozzles provided significant jet-induced lift on the nozzle/aftbody and horizontal tail surfaces. Thrust reversing panels deployed from the 2D-AIN centerbody wedge were very effective for static and inflight operation.

*Boeing Aerospace Co., Seattle, Wash.
**NASA, Langley Research Center, Hampton, Va.

186 **"BACKFIRE"–In Soviet Service-5.** Air International, vol. 16, June 1979, pp. 289–291, 308.

A79-36775

The article discusses the Soviet Backfire bomber and the roles for which the aircraft may be used. While basically a tactical weapon, Arctic staging, in-flight refueling, and high altitude subsonic cruising would enable attacks on east coast U.S. targets. The Backfire's low-risk design, which makes little use of new technology, and similarity to the TU-28P Fiddler is examined. The 'Downbeat' bombing and terrain following navigation radar is analyzed. Maximum take-off weight is about 260,000 lbs. and length and width are 138 ft and 29.5 ft, respectively. The engines are believed to be based on the TU-144 turbofan, and performance estimates such as maximum dash speed of close to Mach 2 at about 39,370 ft are presented. Weapon load of the aircraft is about 21,000 lbs, and use as a cruise missile launch platform is expected. It is concluded that at the present the Backfire, while a serious threat to Central Europe, possesses little strategic value in the intercontinental sense. Three-view drawings and photographs are included. (The 3-view drawings have been superseded by drawings in "Air International" for June 1980.)

187 *Gowadia, N. S.; *Bard, W. D.; and **Wooten, W. H.: **YF-17/ADEN System Study.** Final Rept. NASA CR-144882, July 1979, 160 pp.

N79-27126#

The YF-17 aircraft was evaluated as a candidate nonaxisymmetric nozzle flight demonstrator. Configuration design modifications, control system design, flight performance assessment, and program plan and cost were summarized. Two aircraft configurations were studied. The first was modified as required to install only the augmented deflector exhaust nozzle (ADEN). The second one added a canard installation to take advantage of the full (up to 20 deg) nozzle vectoring capability. Results indicate that: (1) the program is feasible and can be accomplished at reasonable cost and low risk; (2) installation of ADEN increases the aircraft weight by 600 kg (1325 lb); (3) the control system can be modified to accomplish direct lift, pointing capability, variable static margin and deceleration modes of operation; (4) unvectored thrust-minus-drag is similar to the baseline YF-17; and (5) vectoring does not improve maneuvering performance. However, some potential benefits in direct lift, aircraft pointing, handling at low dynamic pressure and takeoff/landing ground roll are available. A 27 month program with 12 months of flight test is envisioned, with the cost estimated to be $15.9 million for the canard equipped aircraft and $13.2 million for the version without canard. The feasibility of adding a thrust reverser to the YF-17/ADEN was investigated.

*Northrop Corp., Hawthorne, Calif.
**General Electric Co.

Contract NAS4-2499

188 *Smith, C. W.; *Ralston, J. N.; and *Mann, H. W.: **Aerodynamic Characteristics of Forebody and Nose Strakes Based on F-16 Wind Tunnel Test Experience; Vol. I, Summary and Analysis.** NASA CR-3053, July 1979, 142 pp., 9 refs.

N79-28143#

The YF-16 and F-16 developmental wind tunnel test program was reviewed. Geometrical descriptions, general comments, representative data, and the initial efforts toward the development of design guides for the application of strakes to future aircraft are presented. (For Vol. 2 see #158 in this compilation.)

*General Dynamics, Fort Worth Division, P.O. Box 748, Fort Worth, Texas

Contract NAS1-15006

189 **Ilyushin "CANDID"—In Soviet Service-6.** Air International, vol. 17, July 1979, pp. 42–44.

A79-42423

The Ilyushin Il-76 Candid is the key element in the current Soviet military air mobility enhancement program and a more effective logistic support aircraft than the An 12 Cub, affording twice the payload and twice the range. Essentially of similar concept to the Lockheed C-141B StarLifter, with which it compares closely in size and weight, the Il-76 is 20% more powerful and capable of utilizing relatively primitive airstrips. With nominal task of transporting 40 tons of freight over 3100 miles in less than six hours, the Il-76 combines full-span slats, double-slotted trailing-edge flaps and high-flotation 20-wheel undercarriage with ample power to permit operation from short, unprepared strips. The four Soloviev D-30KP two-shaft turbofans are each rated at 26.455 lb for take-off and are fitted with clamshell-type thrust reversers. The aircraft is expected to enter service with both the long-range Aviation and the Naval Air Force as a flight refuelling tanker compatible with the Backfire, and it is serving as the basis of the new AWACS aircraft. Includes 3-view drawing and photographs.

190 *Lorincz, D. J.; and **Friend, E. L.: **Water Tunnel Visualization of the Vortex Flows of the F-15.** In AIAA Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., Aug. 6–8, 1979. Technical Papers, (A79-45302), pp. 194–208.

AIAA Paper 79-1649 A79-45325#

Flow visualization studies were conducted in a diagnostic water tunnel to provide details of the wing, glove, and forebody vortex flow fields of the F-15 aircraft over a range of angles of attack and sideslip. Both the formation and breakdown of the vortex flow as a function of angle of attack and sideslip are detailed for the basic aircraft configuration. Additional tests showed that the wing upper surface vortex flows were sensitive to variations in an inlet mass flow ratio and an inlet cowl deflection angle. Two lengthened forebodies, one with a modified cross-sectional shape, were tested in addition to the basic forebody. Asymmetric forebody vortices were observed at zero sideslip and high angles of attack on each forebody. A large nose boom was added to each of the three forebodies, and it was observed that the turbulent wake shed from the boom disrupted the forebody vortices.

*Northrop Corp., Hawthorne, Calif.
**NASA, Dryden Flight Research Center, Edwards, Calif.

Contract NAS4-2526

191 *Spearman, M. Leroy: **Aerodynamic Characteristics of Missile Configurations Based on Soviet Design Concepts.** In AIAA Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., Aug. 6–8, 1979. Technical Papers, (A79-45302), pp. 243–250.

AIAA Paper 79-1657 A79-45329#

The aerodynamic characteristics of several missile concepts are examined. The configurations, which are based on some typical Soviet design concepts, include fixed-wing missiles with either forward- or aft-tail controls, and wing-control missiles with fixed aft stabilizing surfaces. The conceptual missions include air-to-air, surface-to-air, air-to-surface, and surface-to-surface. Analytical and experimental results indicate that through the proper shaping and location of components, and through the exploitation of local flow fields, the concepts provide generally good stability characteristics, high control effectiveness, and low control hinge moments. In addition, in the case of some cruise-type missions, there are indications of the application of area ruling as a means of improving the aerodynamic efficiency. In general, a point-design philosophy is indicated whereby a particular configuration is developed for performing a particular mission.

*NASA, Langley Research Center, Hampton, Va.

192 *Spearman, M. Leroy: **Historical Development of Worldwide Supersonic Aircraft.** Presented at the AIAA Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20–22, 1979, 15 pp.

AIAA Paper 79-1815 A79-47895#

Aerodynamic problems in the development of supersonic aircraft, their solutions, and innovative design features are presented. Studies of compressibility, introduction of jets, supersonic phenomena, transonic drag and lift, longitudinal and directional stability, dynamic pressure fields, and advent of the supersonic fighter are discussed. The flight research aircraft such as the Bell X-1 and the Douglas-558, the century series models, reconnaissance aircraft, the multimission tactical fighter, and the current generation fighters such as F-16 and F-18 are described. The SCAT program is considered, along with supersonic developments in Great Britain, France, and USSR. It is concluded that the sonic boom still appears to be an inherent problem of supersonic flight that particularly affects overland commercial flight, and efforts continue for increased efficiency for economic and performance gains and increased safety for military and civilian aircraft.

*NASA, Langley Research Center, Hampton, Va.

193 *Anderson, C. F.: **Aerodynamic Characteristics and Store Loads of the 1/24-Scale F-111 Aircraft Model With Several External Store Loadings.** Final Rept., 18–23 June 1979. AEDC-TSR-79-P48, Aug. 1979, 48 pp.

AD-A078677 N80-20235#

The 1/24-scale F-111 aircraft model was tested to obtain simultaneous measurements of the aircraft and store aerodynamic loads and to evaluate the effects of the TAWDS pod on aircraft stability and control. Static stability and store loads data were obtained at 5 wing sweep angles for Mach numbers from 0.4 to 1.2. Data were also obtained for stabilizer deflections of + or 10 deg and with the speed brake deflected 50 deg for some configurations. The angle of attack range was from -2 to 24 deg and the angle of sideslip range was from -10 to 10 deg.

*ARO, Inc., Arnold Air Force Station, Tenn.

194 *Mehra, Raman K.; and *Carroll, James V.: **Global Stability and Control Analysis of Aircraft at High Angles of Attack.** Annual Tech. Rept., June 1, 1978—May 31, 1979. ONR-CR-215-245-3; ATR-3; Aug. 1979, 348 pp.

AD-A084938 N80-28374#

High angle-of-attack phenomena have been of interest to aerodynamicists, aircraft designers, pilots and control system analysts ever since the advent of modern high performance aircraft. Due to the concentration of inertia along the fuselage, the modern jet fighters are highly susceptible to poststall departures and spin. In spite of extensive design effort, modern aircraft still inadvertently enter spins which sometimes result in loss of life and/or property. Extensive wind-tunnel testing and radio-controlled flight testing has been done over the last 20 years to gain a better understanding of the dynamic instabilities at high angles-of-attack. A basic problem has existed in interpreting these data and in making predictions of aircraft dynamic behavior so as to achieve close agreement with flight test data. Most of the work on this project involved a study of the second aircraft model, the F-4. A detailed description of modeling this aircraft, correlation time history runs, and a high angle-of-attack analysis utilizing equilibrium and bifurcation surfaces, is included in this report. The equilibrium spin regimes were found to be rather insensitive to aerosurface control deflections, a result consistent with observed performance. Studies were conducted as well in the stall/post-stall/spin entry regime, a control synthesis approach was initiated, and thrust effects were analyzed.

*Scientific Systems, Inc., Cambridge, Mass.
Contract NO0014-76-C-0780

195 *Mehra, R. K.; *Washburn, R. B.; *Sajan, S.; and *Carroll, J. V.: **A Study of the Application of Singular Perturbation Theory---Development of a Real Time Algorithm for Optimal Three Dimensional Aircraft Maneuvers: Final Rept.** NASA CR-3167, Aug. 1979, 339 pp.

N79-30194#

A hierarchical real time algorithm for optimal three dimensional control of aircraft is described. Systematic methods are developed for real time computation of nonlinear feedback controls by means of singular perturbation theory. The results are applied to a six state, three control variable, point mass model of an F-4 aircraft. Nonlinear feedback laws are presented for computing the optimal control of throttle, bank angle, and angle of attack. Real Time capability is assessed on a TI 9900 microcomputer. The breakdown of the singular perturbation approximation near the terminal point is examined. Continuation methods are examined to obtain exact optimal trajectories starting from the singular perturbation solutions.

*Scientific Systems, Inc., Cambridge, Mass.

Contract NAS1-15113

196 **Manoeuvre Limitations of Combat Aircraft.** AGARD-AR-155A; ISBN-92-835-1336-3, Aug. 1979, 33 pp.

N80-10203#

The choice of aircraft detail arrangement and configuration is closely related to desired flight speed, altitude, and maneuverability. The maneuver limitations that are directly related to configuration, flight speed, and attitude are reasonably independent of airplane size and engine thrust. These limiting flight characteristics include pitchup, wing rock, wing drop, nose slice, and buffeting. These configuration and detail-sensitive limitations and the aircraft characteristics that cause them are discussed for 15 NATO aircraft.

*Prepared by Advisory Group for Aerospace Research and Development (AGARD), Neuilly-Sur-Seine, France

197 *Agnew, J. W.; and *Mello, J. F.: **Correlation of F-15 Flight and Wind-Tunnel Test Control Effectiveness.** In

AGARD "Aerodynamic Characteristics of Controls," (N80-15149), 11 pp. Paper presented at Pozzuoli, Italy, May 14–17, 1979.

N80-15152#

The F-15 aerodynamic configuration and control system development relied on data obtained in an extensive wind tunnel test program. Subsequently, a large body of flight test data was obtained. Control surface effectiveness characteristics were derived from flight test data and were compared with the data obtained in the wind tunnel test program. Data correlations are available for the ailerons, rudders, and stabilators. The latter surfaces are deflected symmetrically for longitudinal control and are deflected differentially for roll control. Primary axis effectiveness is addressed for each of these control surfaces. Significant secondary axis contributions (e.g., yawing moments due to aileron deflection) are also addressed. In addition to the conventional control surfaces, the longitudinal control effectiveness of the F-15 movable inlet ramp is discussed. As a result of the excellent resistance to departure from controlled flight, the spin resistance and spin recovery characteristics of the F-15, it was possible to flight test and to obtain control effectiveness data to 90 deg angle of attack at low speeds and to approximately 40 deg at transonic speeds. Thus, the correlation of control effectiveness is addressed for a large range of conditions.

*McDonnell Aircraft Co., St. Louis, Mo.

198 *Newbauer, J.: **U.S. Cruise Missile Development.** Astronautics and Aeronautics, vol. 17, Sept. 1979, pp. 24–35.

A79-49485#

A survey of U.S. cruise missile development and a comparison with Soviet cruise missiles is presented. Attention is given to the Air Force ALCM and the Navy 'Tomahawk' SLCM and the GLCM. Advances in guidance accuracy such as terrain contour matching (TERCOM) are discussed. Performance and other characteristics are given for several missiles, and test procedures and results are reviewed. Other topics covered include parts commonality such as software and warhead interface, design to cost and acquisition strategy, production readiness reviews, and the warranty/guaranty program. In conclusion it is noted that while the U.S. leads the USSR in cruise missile technology, the Soviets have built up a large arsenal which can be updated technically, and made more formidable. This article is based on a report by Walter M. Locke** given in Congressional Testimony.

*Editor in Chief for "Astronautics and Aeronautics

**Director of the Joint Cruise Missiles Office, U.S.N.

199 *Moynes, J. F.; and *Nelson, W. E., Jr.: **Flaperon Control; The Versatile Surface for Fighter Aircraft.** (In AGARD Aerodynamic Characteristics of Controls, N80-15149.) Sept. 1979, 18 pp.

N80-15158#

The versatility of a flaperon is presented for roll performance and for several longitudinal active control modes. Particular emphasis is given to the advantages of a segmented flaperon over a full span for a YF-17 type aircraft. The areas of ride smoothing, direct lift, pitch pointing, vertical flight path control, and flight control system reconfiguration are addressed for the active longitudinal control modes. The effect of flaperon pitching moment on the implementation of these modes is discussed.

*Northrop Corp., Los Angeles, Calif.

200 *Smith, J. W.: **Analysis of a Lateral Pilot-Induced Oscillation Experienced on the First Flight of the YF-16 Aircraft.** NASA TM-72867, Sept. 1979, 53 pp.

N79-31220#

In order to compare and assess potential improvements, two control systems were modeled: the original first flight or prototype aircraft system, and a modification of the prototype system, which essentially reduced the overall gain for the takeoff and landing phase. In general, the overall system gain reduction of the modified flight control system was sufficient to avoid lateral pilot-induced oscillation tendencies. Lowering the system gain reduced the tendency to rate saturate, which resulted in correspondingly higher critical pilot gains for the same control input.

*NASA, Dryden Flight Research Center, Edwards, Calif.

201 *Nissim, E.; and *Lottati, I.: **Active External Store Flutter Suppression in the YF-17 Flutter Model.** Journal of Guidance and Control, vol. 2, Sept.–Oct., 1979, pp. 395–401.

A79-49866#

A single activated trailing-edge (T.E.) control system (spanning 7% of each wing) is applied to the YF-17 flutter model with the object of suppressing the external store flutter of three different store configurations. The control law is derived by the use of the aerodynamic energy concept and its gains are maintained constant for all three configurations. The results obtained show that the activated T.E. control system leads to very significant increases in the flutter dynamic pressures Q(DF) of all three configurations: these increases range between 160–240% increase in Q(DF). These increases in Q(DF) are maintained over a very wide range of flight altitudes and flight velocities.

*Technion-Israel Institute of Technology, Haifa, Israel

Grant NSG-7072

202 *Re, Richard J.; and *Reubush, David E.: **Effect of Several Airframe/Nozzle Modifications on the Drag of a Variable-Sweep Bomber Configuration-- Conducted in the Langley 16-Foot Transonic Tunnel.** NASA TM-80129, Oct. 1979, 168 pp.

N80-10106#

A variable sweep bomber aircraft model was investigated to identify modifications for drag reduction. Modifications included simulated two dimensional nozzles, staggered and extended nozzles; short, long, and no interfairings between the nozzles; partial and complete wing-glove fairings; glove-fuselage sidefairing; fuselage underfairing; and wing pods. The variable wing sweep and variable exhaust nozzles of the scale model are discussed.

*NASA, Langley Research Center, Hampton, Va.

203 *Hoffman, S.: **Supersonic Cruise Research (SCR) Program Publications for FY 1977 Through FY 1979 – Preliminary Bibliography.** NASA TM-80184, Nov. 1979, 42 pp.

N80-11029#

This bibliography was prepared for the November 13–16, 1979 SCR Conference at the Langley Research Center and is a preliminary report. It covers the time period from FY 1977 through FY 1979. A previous bibliography, NASA RP-1003, covers the first five years of the program, 1972 to mid 1977. The present report also includes a few publications that were omitted in the first bibliography and several non SCR papers, which support the program. The bibliography is arranged according to System Studies and the five SCR disciplines, as follows: Propulsion, Stratospheric Emissions Impact, Materials and Structures, Aerodynamic Performance, and Stability and Control.

*NASA, Langley Research Center, Hampton, Va.

204 *Redd, L. Tracy; *Hanson, Perry W.; and *Wynne, Eleanor C.: **Evaluation of a Wind-Tunnel Gust Response Technique, Including Correlations with Analytical and Flight Test Results.** NASA TP-1501, Nov. 1979, 52 pp.

N80-11028#

A wind-tunnel technique for obtaining gust frequency-response functions for use in predicting the response of flexible aircraft to atmospheric turbulence is evaluated by comparing the tunnel test results for a dynamically scaled cable-supported aero-elastic model with analytical and flight data. The wind-tunnel technique, which employs oscillating vanes in the tunnel throat section to generate a sinusoidally varying flow field around the model, was evaluated by use of a 1/30-scale model of the B-52E airplane, for which considerable flight gust response data were available. The studies show good correlation between the wind-tunnel results, flight test results, and analytical predictions for response in the short-period and wing first elastic modes of motion, which are the modes of primary significance for response of flexible aircraft to atmospheric turbulence.

*NASA, Langley Research Center, Hampton, Va.

205 **Mikoyan "FOXBAT"---In Soviet Service-7.** Air International, vol. 17, Nov. 1979, pp. 245-252.

A80-10900

The design, specifications, and performance of the MiG-25 Foxbat are surveyed. Attention is given to the fact that the aircraft was intended to intercept the B-70 supersonic bomber which resulted in a design that placed all emphasis on straight-line supersonic flight at extreme altitudes. The aircraft, publicly introduced in 1967, employs a conservative design which adheres to proven design principles and techniques by using arc-welded nickel steel, and restricting the use of titanium to the most highly heat-stressed areas. Also noted are the aircraft's vacuum tube avionics, and missiles such as the AA-5 Ash, and AA-6 Acrid. The Fox Fire phased array search and tracking radar and the Sirena radar warning system is covered as well as the Tumansky R-31 engines which do not utilize a bypass system or variable compressor geometry. Finally, the latest versions, the MiG 25-R Foxbat B reconnaissance and ELINT version and the Foxbat D, a dedicated ELINT version, are covered.

206 *Pendergraft, O. C., Jr.: **Fuselage and Nozzle Pressure Distributions on a 1/12-Scale F-15 Propulsion Model at Transonic Speeds---Conducted in the Langley 16-Foot Transonic Tunnel.** NASA TP-1521, Nov. 11, 1979, 140 pp.

N80-11036#

Static pressure coefficient distributions on the forebody, afterbody, and nozzles of a 1/12 scale F-15 propulsion model were determined. The effects of nozzle power setting and horizontal tail deflection angle on the pressure coefficient distributions were investigated.

*NASA, Langley Research Center, Hampton, Va.

207 *Heffley, R. K.; and *Johnston, D. E.: **High-Angle-of-Attack Flying Qualities – An Overview of Current Design Considerations.** Presented at SAE Aerospace Meeting, Los Angeles, Calif., Dec. 3–6, 1979, 8 pp.

SAE Paper 791085 A80-26640

An overview is presented on the design for high-angle-of-attack flying qualities by examining the groups of airframe manufacturers, the research community, and the aircraft users. The aircraft manufacturers are restricted by cost and time constraints in their ability to use new design tools, and the user-pilots present factors which the manufacturers and researchers find difficult to address, such as provision of sensory cues or the pilots' discomfort with flight control computers. It is concluded that, taken together, the three points of perspective suggest methods of using design practices and standards to enhance the high-angle-of-attack flying qualities.

*Systems Technology, Inc., Hawthorne, Calif.

Contract F33615-78-C-3604

208 *Price, E. A., Jr.: **An Investigation of F-16 Nozzle-Afterbody Forces at Transonic Mach Numbers with Emphasis on Support System Interference.** Final Rept., Jan.–July 1978. AEDC-TR-79-56; AFAPL-TR-2099, Dec. 1979, 207 pp. (Sponsored by the Air Force.)

AD-A078693 N80-18046#

A comprehensive experimental program was conducted to provide nozzle-afterbody data with a minimum interference support system on a 1/9-scale F-16 model and to determine the interference induced on the afterbody-nozzle region by a sting, a wingtip, and a strut model support system. The investigation was conducted over the Mach number range from 0.6 to 1.5 and at angles of attack from 0 to 9 deg. Interference was evaluated by comparison of nozzle-afterbody axial and normal forces obtained from integrating pressure data. The results include parametric studies of the effects of various components of the wingtip support system (i.e., the support blade axial position, wingtip boom diameter, boom spacing, and boom-tip axial location). High-pressure air at ambient temperature was utilized for exhaust plume simulation. The results indicate that a sting support passing through the nozzle with the jet effects simulated by an annular jet appears to offer a minimum interference support system for the type of nozzle-afterbody test described in this report.

*ARO, Inc., Arnold Air Force Station, Tenn.

209 *Hesketh, A. A.: **Mutual Interference of Multiple Bodies in the Flow Field of the F-4C Aircraft in the Transonic Speed Range.** Final Rept., Nov. 12–21, Nov. 1979, 90 pp. AEDC-TSR-79-P79.

AD-A084704 N80-27296#

A wind tunnel test was conducted to study the mutual interference of multiple bodies in the flow field of the F-4C aircraft. The test utilized 1/20 scale models of the F-4C aircraft, the MK-83 bomb (with and without fins) and the triple ejector rack (TER) to obtain aerodynamic loads on the MK-83 at, and near, the carriage position on the wing inboard pylon. Flow field data in the vicinity of the TER were also obtained. Test variables included aircraft angle of attack from -3 to 17 deg freestream Mach number from 0.60 to 0.95, and aircraft configuration. Freestream aerodynamic loads data were also obtained on the MK-83 bomb model.

*Arnold Engineering and Development Center, ARO, Inc., Arnold Air Force Station, Tenn.

210 *Carr, P. C.; and **Gilbert, W. P.: **Effects of Fuselage Forebody Geometry on Low-Speed Lateral-Directional Characteristics of Twin-Tail Fighter Model at High Angles of Attack.** NASA TP-1592, Dec. 1979, 73 pp.

N80-13002#

Low-speed, static wind-tunnel tests were conducted to explore the effects of fighter fuselage forebody geometry on lateral-directional characteristics at high angles of attack and to provide data for general design procedures. Effects of eight different forebody configurations and several add-on devices (e.g., nose strakes, boundary-layer trip wires, and nose booms) were investigated. Tests showed that forebody design features such as fineness ratio, cross-sectional shape, and add-on devices can have a significant influence on both lateral-directional and longitudinal aerodynamic stability. Several of the forebodies produced both lateral-directional symmetry and strong favorable changes in lateral-directional stability. However, the same results also indicated that such forebody designs can produce significant reductions in longitudinal stability near maximum lift and can significantly change the influence of other configuration variables. The addition of devices to highly tailored forebody designs also can significantly degrade the stability improvements provided by the clean forebody.

*NASA, Dryden Flight Research Center, Edwards, Calif.

**NASA, Langley Research Center, Hampton, Va.

211 **Air Force Technical Objective Document, Air Force Flight Dynamics Laboratory, Fiscal Year 1981.** AFFDL-TR-79-3133, Dec. 1979, 87 pp.

AD-A078973 N80-20020#

The document presents an overview of the four Technical Planning Objectives (TPO) and supporting data for each. These are extracted from the technical plan of the Air Force Flight Dynamics Laboratory (AFFDL). Information is largely based on AFFDL fiscal 1981 technology plan omitting specific funding and timing information of an "Official Use Only" nature. Technical objectives are described for the technical areas of Structures and Dynamics, Vehicle Equipment/Subsystems, Flight Control and Aeromechanics. Points of contact for more information in each of the areas are identified.

212 **Mikoyan "FISHBED-N"—In Soviet Service-8.** Air International, vol. 17, Dec. 1979, pp. 291–294.

The MiG-21bis (FISHBED N) is a limited all-weather multirole fighter, the importance of which is likely to be maintained well into the second half of the eighties. The qualities of this Soviet fighter are summarized and its shortcomings are discussed. The really critical factor of this fighter is fuel. Only about 2/3 of the fuel is usable on account of a CG movement which renders the aircraft virtually uncontrollable at low speeds.

213 **The Military Balance 1979/80.** Air Force Magazine, vol. 62, no. 12, Dec. 1979, pp. 61–136.

This is an **annual**, quantitative assessment of the military power and defense expenditure of countries throughout the world. It examines the facts of military power as they existed in July 1979. "The Military Balance," compiled by The International Institute for Strategic Studies, London, England, has been an exclusive feature of each December issue since 1971. The Institute, an independent center for research in defense-related areas, is universally recognized as the leading authority in its field. The section on the US and USSR includes an assessment of the changing strategic and general-purpose force balances between the two superpowers. A separate section assesses the European theater balance between NATO and the Warsaw Pact and summarizes the statistics of forces and weapons in Europe that are in position or might be used as reinforcements. The table on characteristics of military helicopters has been abridged to include only the US and USSR.

(For the 1980/81 update see #279 in this bibliography.)

214 *Nguyen, L. T.; *Ogburn, M. E.; *Gilbert, W. P., *Kibler, K. S.; *Brown, P. W.; and *Deal, P. L.: **Simulator Study of Stall/Post-Stall Characteristics of a Fighter Airplane With Relaxed Longitudinal Static Stability.** NASA TP-1538, Dec. 1979, 226 pp.

N80-14136#

A real-time piloted simulation was conducted to evaluate the high-angle-of-attack characteristics of a fighter configuration based on wind-tunnel testing of the F-16, with particular emphasis on the effects of various levels of relaxed longitudinal static stability. The aerodynamic data used in the simulation was conducted on the Langley differential maneuvering simulator, and the evaluation involved representative low-speed combat maneuvering. Results of the investigation show that the airplane with the basic control system was resistant to the classical yaw departure; however, it was susceptible to pitch departures induced by inertia coupling during rapid, large-amplitude rolls at low airspeed. The airplane also exhibited a deep-stall trim which could be flown into and from which it was difficult to recover. Control-system modifications were developed which greatly decreased the airplane susceptibility to the inertia-coupling departure and which provided a reliable means for recovering from the deep stall.

*NASA, Langley Research Center, Hampton, Va.

215 Geddes, J. Phillip: **F-16 European Test and Evaluation.** Interavia, vol. 34, no. 12, Dec. 1979, pp. 1177–1179.

This report is based on an interview with the USAF F-16 program director, Major General James F. Abrahamson by "Interavia" U.S. Director, J. Philip Geddes. A 4-month series of flight tests was undertaken using four development models of the F-16 fighter. The object of these tests was to evaluate the aircraft's handling qualities and performance in marginal weather conditions. This report describes these tests and gives an assessment of the tests and their results.

216 *Plant, T. J.; *Nugent, J.; and *Davis, R. A.: **Flight-Measured Effects of Boattail Angle and Mach Number on the Nozzle Afterbody Flow of a Twin-Jet Fighter.** 18th AIAA Aerospace Sciences Meeting, Pasadena, Calif., Jan. 14–16, 1980, 13 pp.

AIAA Paper 80-0110 A80-23009#

The paper presents the flight-measured nozzle afterbody surface pressures and engine exhaust nozzle pressure-area integrated axial force coefficients on a twin-jet fighter for varying boattail angles. The objective of the tests was to contribute to a full-scale flight data base applicable to the nozzle afterbody drag of advanced tactical fighter concepts. The data were acquired during the NASA F-15 Propulsion/Airframe Interactions Flight Research Program. Nozzle boattail angles from 7.7 deg to 18.1 deg were investigated. Results are presented for cruise angle of attack at Mach numbers from 0.6 to 2.0 at altitudes from 20,000 to 45,000 feet. The data show the nozzle axial force coefficients to be a strong function of nozzle boattail angle and Mach number.

*NASA, Dryden Flight Research Center, Edwards, Calif.

217 *Maddox, Arthur R.: **Store Separation Trajectory Analysis, Progress Rept., 1972–1978.** NWC-TP-6067, Jan. 1980, 25 pp.

AD-A086704 N80-30284#

A series of store drops was made at moderate to high subsonic speeds with the same configuration on the center position of a triple ejector rack on an F-4 inboard pylon. The data were compared with wind tunnel and mathematical simulations. Both estimation techniques predicted the general nature of the motion, especially at low speeds, but failed to predict a minor collision observed at high speed.

*Naval Weapons Center, Ordnance Systems Dept., China Lake, Calif.

218 *Maddalon, Dal V.: **Military Aircraft and Missile Technology at the Langley Research Center—A Selected Bibliography.** NASA TM-80204, Jan. 1980, 41 pp.

N80-19024#

A compilation of reference material is presented on the Langley Research Center's efforts in developing advanced military aircraft and missile technology over the past twenty years. Reference material includes research made in aerodynamics, performance, stability, control, stall-spin, propulsion integration, flutter, materials, and structures.

*NASA, Langley Research Center, Hampton, Va.

Note: The above publication, covering a longer time period (1960–1979), should be considered as being complementary to the present bibliography and would provide a useful source of additional references on Langley Research Center's work on military aircraft and missiles.

219 Interavia's Review of World Air Forces – 1980. Interavia, vol. 35, Jan. 1980, pp. 67–89.

This (yearly) comprehensive tabular survey of the aircraft operated by the air forces of 130 states not only provides a breakdown of aircraft held in Air Force, Army, and Navy inventories but also in auxiliary or law enforcement agencies such as the national Coast Guard services. In each case the aircraft's operational role is specified and, where applicable, the manufacturer's designation or the NATO code name.

220 Gibson, Charles M.: **F/A-18 HORNET–A Status Report.** Interavia, vol. 35, Feb. 1980, pp. 139–146.

Headings for this comprehensive article are:

Project history and requirements
Airframe structure and production
Pioneering in composites
System overweight
Powerplant status
Problems minimal
Weapon system
Missile armament
Reliability growing
Flight-test program build-up
Take-off and landing
Continuing flight development
Future program

A 3-view drawing and other drawings and illustrations are included. For earlier articles on the F-18 from this journal see the issues for Aug. 1975, July 1976, and July 1978.

221 Warwick, Graham: **Military Aircraft of the World.** Flight International, March 1, 1980, pp. 643–694.

This compilation includes a short paragraph describing each aircraft and tables giving specifications and performance. The countries are alphabetically arranged as are the company names under each country.

222 *Hawkins, J. E.: **Experimental Investigation of a 0.15-Scale Model of a Conformal Variable-Ramp Inlet for the F-16 Airplane.** Final Rept. NASA CR-159640; ERR-FW-2014; March 1980, 219 pp.

N80-24263#

A 0.15 scale model of a proposed conformal variable-ramp inlet for the Multirole Fighter was tested from Mach 0.8 to 2.2 at a wide range of angles of attack and sideslip. Inlet ramp angle was varied to optimize ramp angle as a function of engine airflow, Mach number, angle of attack, and angle of sideslip. Several inlet configuration options were investigated to study their effects on inlet operation and to establish the final flight configuration. These variations were cowl sidewall cutback, cowl lip bluntness, boundary layer bleed, and first-ramp leading edge shape. Diagnostic and engine face instrumentation were used to evaluate inlet operation at various inlet stations and at the inlet/engine interface. Pressure recovery and stability of the inlet were satisfactory for the proposed application. On the basis of an engine stability audit of the worst-case instantaneous distortion patterns, no inlet/engine compatibility problems are expected for normal operations.

*General Dynamics, Fort Worth, Texas

223 *Niedling, L. F.: **The F-15 Wing Development Program.** Presented at AIAA Symposium on "The Evolution of Aircraft Wing Design," Dayton, Ohio, March 18–19, 1980, (A80-31001), pp. 125–129.

AIAA-80-3044 A80-31012#

The McDonnell Aircraft Company (MCAIR) development of an aerodynamically efficient maneuvering wing for the F-15 is reviewed. The diverse performance requirements and the integrated system trade studies that were used to guide the wing development are described. The wing design trade study results which led to the selected configuration and the geometric and aerodynamic properties of the F-15 wing are presented.

*McDonnell Aircraft Co., St. Louis, Mo.

224 *Patierno, J.: **Evolution of the Hybrid Wing – YF-17/YF-18 Type.** Presented at AIAA Symposium on "The Evolution of Aircraft Wing Design," Dayton, Ohio, March 18–19, 1980, (A80-31001), pp. 131–139.

AIAA-80-3045 A80-31013#

The hybrid wing concept was developed by Northrop in the late 1960's and applied to the YF-17 prototype development program in 1972. The wing concept is now entering production on the F-18. The evolution of the concept was motivated by a specific set of design objectives related to Northrop's fighter design philosophy. The significant benefits in lift, drag, and stability and control characteristics compared to a conventional planform have been verified in flight tests of the YF-17 Lightweight Fighter Prototype.

*Northrop Corp., Aircraft Division, Hawthorne, Calif.

225 Hewish, Mark: **Air-to-Air Missiles of the Western World.** Interavia, March 1980, pp. 209–214.

Historical background and status of specific air-to-air missiles make up the major part of this article. Much information is included in a table which compares Western missiles with Soviet missiles.

226 Harvey, David: **The Missile Tables.** *Defense and Foreign Affairs, vol. VIII, March 1980, pp. 29–38.

There are eight pages of tabulated, current missile systems divided into 9 groups:

1. Strategic, Land-based
2. Strategic, Sea-based
3. Strategic, Cruise Missiles

4. Anti-Skip Missiles
5. Air-to-Ground Missiles
6. Surface-to-Air Missiles
7. Anti-Armor Missiles
8. Ballistic, Battlefield Support
9. Air-to-Air Missiles

The missiles in each group are arranged alphabetically by country. Much specific information on each missile is included in 14 columns.

*Defense & Foreign Affairs, Suite 602, 2030 M Street, NW, Washington, D.C.

227 **Annual Soviet Aerospace Almanac.** March issues of the *Air Force Magazine since 1975. (Contents for 1978, 1979, and 1980 are given here.)

March 1978, vol. 61, no. 3, pp. 33–114

FOURTH ANNUAL SOVIET AEROSPACE ALMANAC

pages

March 1979, vol. 62, no. 3, pp. 39–115

FIFTH ANNUAL SOVIET AEROSPACE ALMANAC

pages

March 1980, vol. 63, pp. 41–135

SIXTH ANNUAL SOVIET AEROSPACE ALMANAC

pages

The **Soviet Aerospace Almanac** is a feature which has appeared each March since 1975 in the AIR FORCE Magazine. It includes the **Gallery of Soviet Aerospace Weapons** by John W. R. Taylor, Editor of Jane's All the World's Aircraft. New information on aircraft is included as available.

*AIR FORCE Magazine is published monthly by the Air Force Association, Suite 400, 1750 Pennsylvania Ave., N.W., Washington, D.C.

228 *Tuttle, Marie H.; and *Maddalon, Dal V.: **Supersonic Cruise Military Aircraft Research—An Annotated Bibliography.** NASA TM-81781, April 1980, 18 pp.

N80-21316#

This bibliography, with abstracts, consists of 69 publications arranged in chronological order. The material may be useful to those interested in supersonic cruise fighter/penetrator/interceptor airplanes. Two pertinent conferences on military supercruise aircraft are considered as single items: one contains 37 papers and the other 29 papers. In addition, several related bibliographies are included which cover supersonic civil aircraft and military aircraft studies at the Langley Research Center. There is an author index.

*NASA, Langley Research Center, Hampton, Va.

229 **IL-86 — The Russian Airbus.** Interavia, May 1980, p. 426.

The first prototype of the IL-86 was displayed at the Paris Air Show in 1977. Since then three prototypes have flown over 1,000 flight hours. The wide-body transport was scheduled to start regular services in April 1980. Special features of the design are described. State-of-the-art technology has been used in its construction and equipment. A 3-view drawing and basic performance data are included.

230 *Kelly, W. W.; and *Brown, P. W.: **Simulator Results of an F-14A Airplane Utilizing an Aileron-Rudder Interconnect During Carrier Approaches and Landings.** Progress Rept., Jan. 1979—Feb. 1980. NASA TM-81833, May 1980, 92 pp.

N80-29368#

A piloted simulator study was conducted to evaluate an aileron-rudder interconnect (ARI) control system for the F-14A airplane in the landing configuration. Effects on pilot performance and handling characteristics were investigated. Two ARI configurations were tested and compared to the standard F-14 fleet control system. A nonlinear aerodynamic model of the F-14 was used in conjunction with a six degree-of-freedom motion base simulator. The evaluation task, which utilized three subject pilots, consisted of a night carrier approach and landing. Results of the study showed that both ARI configurations produced improved pilot performance and pilot ratings when compared to the standard control system. Sideslip due to adverse yaw as considerably reduced by the ARI systems and heading control was more stable and precise. Lateral deviation from centerline was reduced during the approach and lateral touchdown dispersion on the carrier deck was reduced with the ARI control systems.

*NASA, Langley Research Center, Hampton, Va.

231 *Desmarais, R. N.; and *Reed, W. H., III: **Wing/Store Flutter with Nonlinear Pylon Stiffness.** Presented at the AIAA 21st Conference on Structures, Structural Dynamics, and Materials, Seattle, Wash., May 12–14, 1980. Technical Papers, Part 2, 1980. (A80-34993), pp. 748–753.)

AIAA-80-0792 A80-35075#

Recent wind tunnel tests and analytical studies show that a store mounted on a pylon with 'soft' pitch stiffness provides substantial increase in flutter speed of fighter aircraft and reduces dependency of flutter on mass and inertia of the store. This concept, termed the decoupler pylon, utilizes a low-frequency control system to maintain pitch alignment of the store during maneuvers and changing flight conditions. Under rapidly changing transient loads, however, the alignment control system may allow the store to momentarily bottom against a relatively stiff backup structure in which case the pylon stiffness acts as a hardening nonlinear spring. Such structural nonlinearities are known to affect not only the flutter speed but also the basic behavior of the instability. This paper examines the influence of pylon stiffness nonlinearities on the flutter characteristics of wing-mounted external stores.

*NASA, Langley Research Center, Hampton, Va.

232 *Peloubet, R. P., Jr.; *Haller, R. L.; and *Bolding, R. M.: **F-16 Flutter Suppression System Investigation.** Presented at the AIAA 21st Conference on Structures, Structural Dynamics, and Materials, Seattle, Wash., May 12–14, 1980. Technical Papers, Part 2, 1980, pp. 620–634, 17 refs.

AIAA-80-0768 A80-35060#

A study was conducted to determine the feasibility of employing active controls on the F-16 to suppress wing/store flutter for several external store configurations. It was determined that the existing flaperons, with modifications to the integrated servoactuators, were effective in suppressing flutter. A separate analog computer study was conducted to examine the feasibility of measuring the flutter suppression system open-loop frequency response function (FRF). It was determined that the function could be successfully measured below the unaugmented flutter speed, where the feedback loop can be physically opened, and above the flutter speed, where it cannot. The F-16 flutter model was tested with active flaperons. Open-loop FRFs were successfully measured in the wind tunnel environment both with the feedback loop physically opened and with the loop closed. These measurements provided guidance in the selection of sensor locations and feedback control laws to suppress flutter. Control law variations were made to obtain the desired FRF characteristics. A 100% increase in dynamic pressure above the flutter dynamic pressure was demonstrated.

*General Dynamics Corp., Fort Worth, Texas

Contract F33615-77-C-3081

233 *Hwaang, C.; *Johnson, E. H.; and *Pi, W. S.: **Recent Development of the YF-17 Active Flutter Suppression System.** Presented at the AIAA 21st Conference on Structures, Structural Dynamics, and Materials, Seattle,

Wash., May 12–14, 1980. Technical Papers, Part 2, 1980, pp. 635–648, 5 refs.

AIAA-80-0769 A80-35061#

Active wing/store flutter suppressing systems were demonstrated in 1977 in a series of wind tunnel tests on a YF-17 scale model. In order to substantially improve the suppression system performance, new control laws were developed based on multiple feedback loops, multiple control surfaces, or both. For test safety, a flutter sensing unit and a new store, functioning as a flutter stopper, were designed and fabricated. Test monitoring programs were organized on a Hewlett-Packard 5451C Fourier Analyzer that permitted a real time assessment of the control law effectiveness. One of the monitoring programs generated the aircraft open loop transfer function and Nyquist plots in the supercritical region while the flutter suppression loop was closed. In the tests performed in late 1979, the new control laws were applied to suppress a severe flutter condition to 70% above the uncontrolled flutter dynamic pressure. Postanalysis of the test data indicated the potential to increase the dynamic pressure to an even higher level.

*Northrop Corp., Aircraft Group, Hawthorne, Calif.
Contract F-33615-78-C3221

234 *Johnson, E. H.: **Active Flutter Suppression Control Law Definition via Least Squares Synthesis.** Presented at the AIAA 21st Conference on Structures, Structural Dynamics, and Materials, Seattle, Wash. May 12–14, 1980, Technical Papers, Part 2, 1980. (A80-34993), pp. 595–603.

AIAA-80-0765 A80-35057#

A technique is described whereby an arbitrary number of transfer functions of sensor outputs to a control surface input can be blended to form a feedback signal that is suitable for controlling a flutter mode. An attractive feature of the technique, which couples the concepts of the Nyquist criterion with a least squares fit procedure, is that it utilizes data which are readily measurable, thereby allowing for the rapid improvement of the control law once the empirical results are available. A theoretical description of the method is presented and its relationship to alternative methods is discussed. An analytical example is presented which depicts a 70 percent improvement in the flutter dynamic pressure of the YF-17 flutter model. Further results obtained during an analog simulation and a wind tunnel test of the same model are also presented.

*Northrop Corp., Aircraft Group, Hawthorne, Calif.

Contract F33615-78-C-3221

235 *Sisk, T. R.; and *Matheny, N. W.: **Precision Controllability of the YF-17 Airplane.** NASA TP-1677, May 1980, 34 pp.

N80-23327#

A flying qualities evaluation conducted on the YF-17 airplane permitted assessment of its precision controllability in the transonic flight regime over the allowable angle of attack range. The precision controllability (tailchase tracking) study was conducted in constant-g and windup turn tracking maneuvers with the command augmentation system (CAS) on, automatic maneuver flaps, and the caged pipper gunsight depressed 70 mils. This study showed that the YF-17 airplane tracks essentially as well at 7 g's to 8 g's as earlier fighters did at 4 g's to 5 g's before they encountered wing rock. The pilots considered the YF-17 airplane one of the best tracking airplanes they had flown. Wing rock at the higher angles of attack degraded tracking precision, and lack of control harmony made precision controllability more difficult. The revised automatic maneuver flap schedule incorporated in the airplane at the time of the tests did not appear to be optimum. The largest tracking errors and greatest pilot workload occurred at high normal load factors at low angles of attack. The pilots reported that the high-g maneuvers caused some tunnel vision and that they found it difficult to think clearly after repeated maneuvers.

*NASA, Dryden Flight Research Center, Edwards, Calif.

236 *Flax, Alexander H.: **Military Aerospace to 2000.** Astronautics and Aeronautics, vol. 18, May 1980, pp. 30–39.

A80-32510#

The article presents observations and interpretations of military trends covering such topics as technology, strategic forces, tactical air forces, naval forces, and space. Emphasis is given to the tendency of established systems to persist and the leverage of cost in design and innovation. Discussion examines trends in aircraft and a shift in emphasis to the weapon rather than its carrier.

*Institute for Defense Analyses (IDA), Washington, D.C.

237 Boyle, Dan: **New Developments in U.S. Military Fighter Engines.** Interavia, May 1980, pp. 415–417.

The high performance of the latest generation of fighter aircraft is due to a considerable extent to the dramatic improvements in the engines that are available today. In terms of thrust to weight ratio, the Pratt & Whitney F100 engine has gone higher up the scale than any other. While this has brought considerable rewards in terms of the performance of the McDonnell Douglas F-15 and General Dynamics F-16 aircraft, it has also brought a number of problems in terms of reliability and durability. The new General Electric engine is based on the technology developed for the F101 engine for the Rockwell B-1 strategic bomber, from which it uses the core engine. This new engine, the F101X or F101 DFE (Derivative Fighter Engine), is intended as a replacement for the TF30 engines of the Grumman F-14 although the F-16 is clearly seen as another possible home for this new development.

238 **Perspectives on Airbreathing Propulsion – A Special Section:** Astronautics and Aeronautics, June 1980, vol. 18, no. 6, pp. 24–67, 74.

Introduction—	F. Blake Wallace
Turbine Engines in the '80s—	J. P. Frignac Frank E. Pickering William Wagner J. W. Witherspoon
Airbreathing Propulsion, Component Technologies	Cecil Rosen
Durable Propulsion Means More Air Power—	Richard J. Hill Robert E. Henderson
Propulsion-System Integration for Tactical Aircraft—	Brian L. Hunt Lewis E. Surber George K. Grant

239 *Hunt, Brian L.; **Surber, Lewis E.; and *Grant, George K.: **Propulsion—System Integration for Tactical Aircraft.** Astronautics and Aeronautics, vol. 18, no. 6, June 1980, pp. 62—67, 74.

Complexities of engine-airframe integration, highlighted by hard experience, have begun to yield to new ideas and knowledge, and are aimed at a new generation of combat aircraft. Includes sections on recent designs and advanced concepts.

*Northrop Corp., Hawthorne, Calif.
**AFWAL, Flight Dynamics Lab., Wright-Patterson AFB, Ohio

240 *Capone, F. J.; and *Berrier, B. L.: **Investigation of Axisymmetric and Nonaxisymmetric Nozzles Installed on a 0.10-Scale F-18 Prototype Airplane Model.** NASA TP-1638, June 1980, 304 pp.

N80-24267#

The Langley 16 foot transonic tunnel was used to investigate the afterbody/nozzle longitudinal aerodynamic characteristics of three different two dimensional nozzles and a base-line axisymmetric nozzle installed on a 0.10 scale model of the F-18 airplane. The effects of thrust vectoring and in-flight thrust reversing were also studied. Horizontal-tail deflections of 0 deg, -2 deg, and -5 deg were tested. Test data were obtained at static conditions and at Mach numbers from 0.60 to 1.20 over an angle-of-attack range from -2 deg to 10 deg. Nozzle pressure ratio was varied from jet off to about 10.

*NASA, Langley Research Center, Hampton, Va.

241 *Monta, W. J.: **Effect of Conventional and Square Stores on the Longitudinal Aerodynamic Characteristics of a Fighter Aircraft Model at Supersonic Speeds.** NASA TM-81791, June 1980, 59 pp.

N80-24266

The effects of conventional and square stores on the longitudinal aerodynamic characteristics of a fighter aircraft configuration at Mach numbers of 1.6, 1.8, and 2.0 were investigated. Five conventional store configurations and six arrangements of a square store configuration were studied. All configurations of the stores produced small, positive increments in the pitching moment throughout the angle-of-attack range, but the configuration with area ruled wing tanks also had a slight decrease in stability at the higher angles of attack. There were some small changes in lift coefficient because of the addition of the stores, causing the drag increment to vary with the lift coefficient. As a result, there were corresponding changes in the increments of the maximum lift drag ratios. The store drag coefficient based on the cross sectional area of the stores ranged from a maximum of 1.1 for the configuration with three Maverick missiles to a minimum of about 0.40 for the two MK-84 bombs and the arrangements with four square stores touching or two square stores in tandem. Square stores located side by side yielded about 0.50 in the aft position compared to 0.74 in the forward position.

*NASA, Langley Research Center, Hampton, Va.

242 *Dix, R. E.; and *Mattasits, G. R.: **Comparison of Wind Tunnel and Flight Test Measurements of Static Aerodynamic Loading of a Captive Store.** AEDC-TR-79-9; July 1980, 117 pp. Final Rept. 18 June 1976—31 Aug., 1978.

AD-A087237 N80-30281#

A coordinated series of experiments was conducted in three wind tunnels and in flight to measure the static aerodynamic loading of an MK 83 store attached to the bottom center station of a triple ejector rack mounted on the left inboard pylon of an F-4 aircraft. Fundamental agreement between wind tunnel and inflight loads data was demonstrated over a range of angle of attack from -2 to 6 deg and a Mach number range from 0.6 to 0.9. Differences that were noted were thought to be attributable either to improper store-to-aircraft alignment or to poor definition of inertial loads during maneuvering flight.

*Arnold Engineering Development Center, Arnold Air Force Station, Tenn.

243 *Kuhn, Richard E.: **Conceptual Study of Modifying an Existing Fighter for V/STOL Capability and Combat Maneuvering Enhancement.** Final Report. DTNSRDC-80/088; DTNSRDC/ASED-AERO-1269; July 1980, 59 pp.

AD-A087657 N80-32380#

The possibility of modifying an existing fighter aircraft to give it V/STOL capability and of incorporating a V/STOL control system that could also be used in conventional flight to improve the aircraft's combat maneuverability is examined. The study indicates that the F-18 could be given a V/STOL capability using either the lift plus lift-cruise or the vertical attitude take off and landing (VATOL) concept. The lift-cruise plus remote burner concept does not appear to be compatible with the F-18 airframe. The ADEN nozzle concept currently under development, with some modification, could be used on either the lift plus lift-cruise or the VATOL concepts to vector the cruise engine thrust and thereby augment the conventional controls for improved high angle of attack combat maneuverability.

*NASA, LaRC retiree, Newport News, Va.
Contract N00167-80-M-0844

244 Bulban, E. J.: **Mach 2.2 F-16 Development Underway.** Aviation Week and Space Technology, vol. 113, July 31, 1980, pp. 20–22.

A80-43739

The paper describes the development of a Mach 2.2 supersonic cruise version of the F-16 aircraft featuring an advanced-technology wing. The improvements include a 125% increase in the air-to-air combat mission radius and doubling of the supersonic cruise radius of action; a 120% increase in air-to-ground mission radius and doubling of payload; a decrease of 33% in takeoff and landing distances; and maneuverability improvement providing tripling of gun-firing opportunities during air-combat. The bolt-on wing concept will allow 93% of the fuselage airframe components and 91% of the avionics subsystems to be utilized. Because of the 1351 lb increase in wing structural weight due to its greater area and thickness, the upper and lower skins will be fabricated from graphite epoxy composites; this will save 574 lb of weight compared to the use of aluminum, and will ease the fabrication of complex contours.

245 Kamov "HORMONE" – In Soviet Service – 9. Air International, vol. 19, no. 1, July 1980, pp. 38–40.

The Ka-25 (HORMONE) was first sighted on a Kresta I class anti-submarine cruiser in 1967. This helicopter is both "backbone and rib cage" of the Soviet shipboard ASW helicopter force. It is competent and compact. It has an overall length of 32+ feet and has a cabin which can accommodate up to 12 persons when not occupied by search equipment. It also has a weapons bay beneath the cabin floor. Production is supposed to have been phased out during 1975–76 but upwards of 275 still remain in the first-line inventory. It is configurationally unique among current service helicopters in having superimposed, counter-rotating rotors.

246 Daschke, Carol E.: **Threat – The HIP Bus, Gunship or Both?** United States Army AVIATION DIGEST, vol. 26, no. 7, July 1980, pp. 42–44.

The Mi-8 HIP was first displayed by the Soviets in 1961; four versions have been developed. These are discussed and described. They are extensively used by Soviet and non-Soviet countries. It is rapidly becoming the primary transport helicopter of the Soviet tactical helicopter regiments.

247 Brindley, John F.: **The General Electric F404 – Driving Force for the F-18.** Interavia, vol. 33, July 1980, pp. 609–610.

Selected to power the McDonnell Douglas/Northrop F-18 Hornet in 1975, the engine is now well advanced in ground testing and will take to the air later this year in this new US Navy fighter. General Electric started to study the concept of a new advanced technology fighter engine in the late 1960s; the key considerations were simplicity, reliability and ease of maintenance, and low cost of acquisition and operation. To power the new aircraft, designated F-18, the service selected a development of the YF101 known as the F404. This article relates the history of this engine and requirements for the finished product.

248 The World's Military Helicopter Fleet. Interavia, vol. 35, July 1980, pp. 621–626.

In this second annual list of the military helicopters of some 120 countries throughout the world the helicopters are broken down by service, number, and operational status. The total strength of the fleet is almost 30,000 rotary-wing aircraft. The USSR and its satellite nations represent about 1/3 of this total.

249 *Sharples, T.: **Application of Carbon Fiber Composites to Military Aircraft Structures.** This was presented as Paper No. 830/1 at a Symposium on Large Scale Composite Structures held at the Royal Aeronautical Society on April 22, 1980. The Aeronautical Journal, vol. 84, no. 834, July 1980, pp. 177–182.

The purpose of this paper is to give a fairly detailed description of where carbon fiber composites are most likely to be used in the structures of future military aircraft together with an indication of the structural configurations.

*British Aerospace Aircraft Group, Warton Division

250 *Price, E. A., Jr.: **The Annular Jet Technique for Nozzle/Afterbody Throttle Dependent Drag Testing.** AIAA, SAE, and ASME 16th Joint Propulsion Conference at Hartford, Conn., June 30–July 2, 1980, 14 pp.

AIAA-80-1163 A80-38945#

Results are reported from several tests conducted in the Arnold Engineering Development Center Propulsion Wind Tunnel (16T) to develop the annular jet technique for obtaining throttle dependent afterbody drag data. The first test utilized an axisymmetric model to parametrically investigate the effects of nozzle pressure ratio, sting-to-nozzle exit diameter ratio, and nozzle area ratio with the annular jet technique. Test results demonstrated that the annular jet technique is a viable method of obtaining afterbody drag and helped define the limits of its use. Tests have since been conducted on two aircraft configurations to determine the degree of correlation between full and annular jet afterbody drag data for single- and twin-jet configurations. Results were obtained for different nozzle configurations over the Mach number range from 0.6 to 1.5. When compared with test data using other support systems, a sting-supported model with annular jet simulation provides a minimum interference support system with reasonable jet simulation.

*ARO, Inc., Arnold Engineering Development Center, Arnold Air Force Station, Tenn.

251 *Burns, B. R. A.: **Fundamentals of Design—I. 'Whys' and 'Wherefores' of Wings.** Air International, vol. 16, no. 2, Feb. 1979, pp. 81–85.

This is the first of a series of articles by the author discussing fundamental aspects of combat aircraft design. This first article is concerned with wing design; others were published at regular intervals in the course of 1979.

*Chief Aerodynamicist, British Aerospace, Warton Division.

252 *Burns, B. R. A.: **Fundamentals of Design—II. VTO for Combat Aircraft.** Air International, vol. 16, no. 4, April 1979, pp. 177–181.

Having covered the aerodynamics of wings, the author proceeds to an examination of the design considerations that influence the selection of VTO for an advanced combat aircraft-such as the RAF is now considering as a potential Jaguar/Harrier replacement. The initials VTO can stand for either Vertical Take-off or Vectored Thrust Operation. The former requires the aircraft to have a vertical thrust/weight ratio greater than 1, which can be achieved by the use of fixed lift engines. The latter implies a variable thrust line, with dual-role engine(s) fulfilling both propulsive and lifting functions. Whether special purpose lift engines, rotating nozzles, swivelling engines, or a mixture of these are employed, the design problems and operational benefits are similar. Some of the pros and cons of separate lift engines and vectored thrust are considered.

253 Burns, B. R. A.: **Fundamentals of Design—III. V-G for Combat Aircraft.** Air International, vol. 17, no. 2, Aug. 1979, pp. 72–75.

In the first article in this series, some of the considerations in the design of a wing for a combat aeroplane were discussed. It was suggested that one way of avoiding the compromise between "big, straight and thick," for efficient subsonic flight and "small, swept and thin" for transonic and supersonic performance is to employ variable sweep. In this article the particular design features and problems of variable sweep combat aeroplanes are described. Readers may also find it useful to refer to the issues for March and April 1975, containing an extensive history of V-G.

254 Burns, B. R. A.: **Fundamentals of Design—IV. Weapon Carriage and Delivery.** Air International, vol. 17, no. 4, Oct. 1979, pp. 176–179.

Much has been learned from flight and wind tunnel tests and from service experience during the past two decades; although there are still notable gaps in the detailed knowledge of aircraft/weapon interactions, the basic rules for minimizing carriage drag, release disturbance and detrimental effects on stability and control are understood. On future combat aircraft we can expect to see much cleaner installations adaptable to a wider range of weapons designed in from the outset, leading to much smaller performance and operational penalties than have been customary in the past.

255 Burns, B. R. A.: **Fundamentals of Design—V. Fin Design for Combat Aircraft.** Air International, vol. 18, no. 1, Jan. 1980, pp. 21–25.

Until recently, successive generations of jet fighters and strike aircraft have exhibited few radical changes in their fin and rudder design. With the exception of the Vampire/Venom/Sea Vixen family, fighters of all nations employed single fins with conventional hinged rudders. Only the TSR-2 featured an all-moving fin, utilizing its control power to provide artificial stability at supersonic speed. In the last few years, the scene has changed. Many fighters of the new generation feature twin fins; some have forward control surfaces; illustrations of project studies exhibit multiple control surfaces. In this article, fifth in the series by B. R. A. Burns, the basic principles of fin design are set down and the pros and cons of alternative layouts are discussed.

256 Burns, B. R. A.: **Fundamentals of Design—VI. Tailplanes, Tailless and Canard Design.** Air International, vol. 18, no. 3, March 1980, pp. 126–129.

In this article the design of the longitudinal stabilizing and control surfaces is explained and the pros and cons of alternative layouts discussed.

257 Burns, B. R. A.: **Fundamentals of Design—VII. Flight Control Systems.** Air International, vol. 18, no. 5, May 1980, pp. 229–232, 260.

Until the advent of large authority stability augmentation systems in the 1960s, the flight controls of combat aeroplanes hardly merited the description of systems. The "system" consisted merely of the mechanical connections between the pilot's controls and the power control actuators; the artificial feel and trimming functions were provided by adjuncts to the mechanical controls. Autostabilization, if any, was merely an added sub-system which could be allowed to fail without serious consequences. Since then the capability and complexity of flight controls has increased enormously, so that now the Flight Control System is designed as a major, fully integrated aircraft system. In this penultimate article in the series by B. R. A. Burns, chief aerodynamicist of British Aerospace Warton Division, the development of flight control systems is traced and the various functions of flight control systems described, leading to a modern full-time fly-by-wire system.

258 Burns, B. R. A.: **Fundamentals of Design—VIII. Efficacious Air Intakes.** Air International, vol. 19, no. 1, July 1980, pp. 21–24.

Since the first jet aircraft appeared about 40 years ago, intake design has become a progressively more complex and specialized subject. On early jet fighters the intakes were sized for high speed flight and shaped for minimum drag, with few concessions to "off-design" performance. Nowadays intake location and detail design has become a major item in configuration design, requiring continued testing and refinement throughout the development programme to achieve optimum performance in all phases of flight. The quality of intake design can make or mar a combat aeroplane. In this final article in the "Fundamentals of Design' series, the considerations affecting intake design and location are reviewed and the reasons for adopting alternative design features explained.

259 **F-18 Demonstration Data Report.** (Loose-leaf) McDonnell Douglas Corp. (St. Louis, Mo.). Rept. no. MDC-A5709, Jan. 15, 1979. (Periodically updated, Latest revision Aug. 1, 1980).

LaRC requestors ask for CN-150,769.

A complete description of the airplane and the various systems is followed by discussion of the demonstration tests: Aerodynamics, Propulsion, Carrier Suitability, Structures, Systems, Avionics, Armament, Reliability, and Human Factors.

Contract N00019-75-C-0424

260 *Gilbert, W. W.: **Development of a Mission Adaptive Wing System for a Tactical Aircraft.** Presented at the AIAA Aircraft Systems Meeting, Anaheim, Calif., Aug. 4–6, 1980, 10 pp.

AIAA-80-1886 A80-43321#

The cruise efficiency of the supercritical airfoil in the transonic range is well known. Adaptation of this technology to a multi-role tactical aircraft system requiring Mach 2+ maximum speed and 7+g maneuver is enhanced by airfoil modification capabilities. This paper describes the hardware design and development of a Mission Adaptive Wing System utilizing variable camber leading and trailing edge mechanisms to optimize wing airfoil for all flight conditions. Development included design and manufacture of a full scale wing test component to demonstrate system capability and reliability.

*General Dynamics Corp., Fort Worth Division, Fort Worth, Texas

261 *Nguyen, L. T.; *Gilbert, W. P.; **Gera, J.; **Iliff, K. W.; and **Enevoldson, E. K.: **Application of High-Alpha Control System Concepts to a Variable-Sweep Fighter Airplane.** In AIAA Atmospheric Flight Mechanics Conference, Danvers, Mass., Aug. 11–13, 1980, Collection of Technical Papers, 1980, 20 pp.

AIAA 80-1582 A80-50098#

The use of control system design to enhance high-angle-of-attack flying qualities and departure/spin resistance has become an accepted and widely used approach for modern fighter aircraft. NASA and the Navy are currently conducting a joint research program to investigate the application of this technology to the F-14. The paper discusses the results of this program within the context of its contributions to advancing high-alpha control system technology. General topics covered include (1) analysis and design tools, (2) control system design approach, and (3) flight test approach and results.

*NASA, Langley Research Center, Hampton, Va.
**Dryden Flight Research Center, Edwards, Calif.

262 *Chambers, J. R.: **Overview of Stall/Spin Technology.** In AIAA Atmospheric Flight Mechanics Conference, Danvers, Mass., Aug. 11–13, 1980, Collection of Technical Papers, 1980, 44 pp., 59 refs.

AIAA-80-1580 A80-50099#

A general overview of the current state of the art in stall/spin technology for highly-maneuverable military configurations and light general aviation configurations is presented. The key areas of predictive methods, aerodynamics, and flight controls are discussed, using illustrations of results obtained during recent studies. In addition, some of the more pertinent near-term and future challenges and opportunities in stall/spin technology are discussed. This survey of the existing technology shows that rapid progress has been achieved in each of the key technical areas during the last decade, especially for military airplanes. However, a significant amount of innovative research is urgently required in order to improve the productivity and capabilities of existing predictive techniques, and to provide the technology required for advanced, unconventional configurations.

*NASA, Langley Research Center, Hampton, Va.

263 *Schwanz, R. C.; and **Grimes, G. L.: **Parameter Identification of B-52E CCV Flight Test Data Including Aeroelastic Effects.** In AIAA Atmospheric Flight Mechanics Conference, Danvers, Mass., Aug. 11–13, 1980, Collection of

Technical Papers. (A80-45855), 1980, pp. 662–676.

AIAA-80-1635 A80-45923#

The paper summarizes the results of identifying aerodynamic and aeroelastic parameters of the B-52E CCV aircraft from the flight test data. The identification is accomplished using a recursive sequential least squares method and assumes that the aircraft dynamics reflect either perfect rigidity, static elasticity or residual elasticity. With the residual elastic assumption, the possibility of a nonlinear, limit cycle dynamic motion is considered. It is shown that the critical aeroelastic parameters associated with static longitudinal stability and control and structural dynamic damping and control may be identified from flight data.

*USAF, Flight Dynamics Lab., Wright-Patterson AFB, Ohio
**USAF, ASD Computer Center, Wright-Patterson AFB, Ohio

264 *Nguyen, Luat T.; *Gilbert, William P.; and *Ogburn, Marilyn E.: **Control-System Techniques for Improved Departure/Spin Resistance for Fighter Aircraft.** NASA TP-1689, August 1980, 66 pp.

N80-29244#

Some fundamental information on control system effects on controllability of highly maneuverable aircraft at high angles of attack are summarized as well as techniques for enhancing fighter aircraft departure/spin resistance using control system design. The discussion includes: (1) a brief review of pertinent high angle of attack phenomena including aerodynamics, inertia coupling, and kinematic coupling; (2) effects of conventional stability augmentation systems at high angles of attack; (3) high angle of attack control system concepts designed to enhance departure/spin resistance; and (4) the outlook for applications of these concepts to future fighters, particularly those designs which incorporate relaxed static stability.

*NASA, Langley Research Center, Hampton, Va.

265 **Military Helicopter Directory.** Flight International, Aug. 16, 1980, pp. 615–618.

This is a listing of military helicopters from the various countries giving their specifications and brief descriptions.

266 **In Soviet Service-10, Mikoyan "FLOGGER."** Air International, vol. 19, no. 2, Aug. 1980, pp. 70–75, 86, 87.

A80-42825

A family of combat aircraft assigned the name of Flogger in the West now provides the backbone of Soviet TacAir and will fulfill the same role for all major WarPac air arms in the coming years. These aircraft featuring pilot-selected variable wing sweep with NASA-style outboard hinges have been conceived by the Mikoyan-Gurevich design bureau as a flexible combat aircraft combining increased warload and range performance with a field performance no more demanding than that of fighters of the preceding generation. Major design features and performance data are presented for MiG-23 MF Flogger-B optimized for air-air mission, MiG-27 Flogger-D, a dedicated ground-to-air aircraft, and other models of this family.

267 *Loftin, Laurence K., Jr.: **Subsonic Aircraft: Evolution and the Matching of Size to Performance.** NASA RP-1060, Aug. 1980, 443 pp.

N80-29245#

Methods for estimating the approximate size, weight, and power of aircraft intended to meet specified performance requirements are presented for both jet-powered and propeller-driven aircraft. The methods are simple and require only the use of a pocket computer for rapid application to specific sizing problems. Application of the methods is illustrated by means of sizing studies of a series of jet-powered and propeller-driven aircraft with varying design constraints. Some aspects of the technical evolution of the airplane from 1918 to the present are also briefly discussed.

*NASA, Langley Research Center, Hampton, Va.

268 Wheeler, Barry: **Military Aircraft Census.** Flight International, Sept. 6, 1980, pp. 992, 997, 998, 1007–1010.

This annual compilation shows the steady extinction of the Fifties fighters — the Hunter, Sabre, and MiG-19 — and the rise of combat trainers and multirole fighters. Even the Century Series is an endangered species, pushed out by the latest members of the Teen Series – the F-16 and F-18. Types not included in this census can be found in the "World's Air Forces" issue (Oct. 4, 1980) and "Military Aircraft of the World" survey in the March 1, 1980, issue of "Flight International."

269 *Reed, Wilmer H., III; *Cazier, Frank W., Jr.; and *Foughner, Jerome T., Jr.: **Passive Control of Wing/Store Flutter.** NASA TM-81865, 1980, 27 pp. Presented at the 5th JTCG/MD Aircraft Stores Compatibility Symposium, St. Louis, Mo., Sept. 9–11, 1980.

N81-13922#
A80-50100#

This paper presents results for a passive flutter suppression approach known as the decoupler pylon. The decoupler pylon dynamically isolates the wing from store pitch inertia effects by means of soft-spring/damper elements assisted by a low-frequency feedback-control system which minimizes static pitch deflections of the store due to maneuvers and changing flight conditions. Wind-tunnel tests and analyses show that this relatively simple pylon suspension system provides substantial increases in flutter speed and reduces the sensitivity of flutter to changes in store inertia and center-of-gravity location. Flutter characteristics of F-16 and YF-17 flutter models equipped with decoupler pylon-mount stores are presented and compared with results obtained on the same model configurations using active flutter suppression systems. These studies show both passive and active concepts to be effective in suppressing wing/store flutter. Also presented are data showing the influence of pylon stiffness nonlinearities on wing/store flutter.

*NASA, Langley Research Center, Hampton, Va.

270 *Lorincz, D. J.: **Flow Visualization Study of the F-14 Fighter Aircraft Configuration.** NASA CR-163098; NOR-80-150; Sept. 1980, 39 pp.

N80-33350#

Water tunnel studies were performed to qualitatively define the flow field of the F-14. Particular emphasis was placed on defining the vortex flows generated at high angles of attack. The flow visualization tests were conducted in the Northrop water tunnel using a 1/72 scale model of the F-14 with a wing leading-edge sweep of 20 deg. Flow visualization photographs were obtained for angles of attack up to 55 deg and sideslip angles up to 10 deg. The F-14 model was investigated to determine the vortex flow field development, vortex path, and vortex breakdown characteristics as a function of angle of attack and sideslip. Vortex flows were found to develop on the highly swept glove and on the upper surface of the forebody. At 10 deg of sideslip, the windward glove vortex shifted inboard and broke down farther forward than the leeward glove vortex. This asymmetric breakdown of the vortices in sideslip contributes to a reduction in the lateral stability above 20 deg angle of attack. The initial loss of directional stability is a consequence of the adverse sidewash from the windward vortex and the reduced dynamic pressure at the vertical tails.

*Northrop Corp., Aircraft Division, Hawthorne, Calif.

Contract NAS4-2616

271 **FANTAN: A Sino-Soviet Mélange.** Air International, vol. 19, no. 3, Sept. 1980, pp. 135–138.

Based on the MiG-19, the Chinese Nancheng-built KIANG 5 ground attack fighter is the subject of this analysis, accompanied by a detailed three-view color drawing.

272 *Cazier, F. W., Jr.; and *Foughner, Jerome T., Jr.: **NASA Decoupler Pylon Program for Wing/Store Flutter Suppression.** Presented at Tactical Aircraft Research and Technology Conference. Langley Research Center, Hampton, Va., Oct. 21–23, 1980.

Modern fighter aircraft carry many types and combinations of external wing-mounted stores. The carriage of these stores can result in reduced flutter speeds or flutter placards. One method of mounting stores, which makes use of a "decoupler pylon," has been demonstrated in wind-tunnel tests to suppress wing/store flutter and thus overcome these restrictions. The decoupler pylon concept is described and the results of transonic flutter model tests using stores mounted on the decoupler pylon are given. Based on encouraging results of these tests, a program has been initiated which leads to the flight demonstration of the decoupler pylon on a modern fighter. Areas of investigation which are now underway are given.

*NASA, Langley Research Center, Hampton, Va.

273 Wheeler, Barry C. (Compiler): **World's Air Forces-1980.** Flight International, Oct. 4, 1980, pp. 1323–1332, 1337–1352, 1357–1362, 1365–1370, and 1373–1378.

This year's survey covers 133 entries (countries) in alphabetical order and includes tables, details on new orders, bases, strengths, and units. This is an annual feature of this magazine.

274 **BACKFIRE Proliferates.** Air International, vol. 19, no. 14, Oct. 1980, pp. 186–188.

With output – supposedly to have been limited to 30 annually, now reportedly rising from 2.5 to 3.5 monthly – this warplane is posing a significant and growing threat. The general arrangement 3-view drawing supersedes the drawing published in Air International in June 1979. (No. 186 in this bibliography.)

275 *Krings, John E.: **F/A-18 Status Report.** In "Society of Experimental Test Pilots Tech. Review," vol. 14, no. 4, 1980, pp. 1–9 of N80-31305.

N80-31306#

The design and configuration details of the F/A-18 aircraft are summarized. The test programs discussed include envelope expansion, propulsion, controllability, radar, and missile compatibility tests. Problems encountered and subsequent changes and improvements made are cited.

*McDonnell-Douglas Corp., St. Louis, Mo.

276 *McAtee, Thomas P.; and *Timm, Loren: **F-16 European Test and Evaluation.** In "Society of Experimental Pilots Tech. Review," Vol. 14, no. 4, 1980, pp. 37–51 of N80-31305.

N80-31309#

European flight tests on the F-16 were performed to qualify the aircraft for operations in adverse weather and to complete operational tests and evaluations. The results are presented from the following areas: routine operations, air to air effectiveness, and air to surface effectiveness.

*Air Force Flight Test Center, Edwards AFB, Calif.

277 *Plummer, Charles A., Jr.: **YAV-8B Status Report.** In "Society of Experimental Test Pilots Tech. Review," vol. 14, no. 4, 1980, pp. 52–59 of N80-31305.

N80-31310#

The AV-8A was modified into the YAV-8B configuration. The fuselage, cockpit, tail section, and main gear were only slightly changed. The major changes include: a supercritical airfoil to reduce transonic drag, improve maneuvering, and provide 75% more fuel storage; a second row of auxiliary inlet air doors was installed, the inlet lip shape changed, and the inlet radius increased about 1.5 inches; positive circulation is generated by large flaps interconnected with the nozzles such that full flap is obtained with approximately 50 deg of nozzle angle; and lift improvement devices which include strakes fitted to the 30 mm gun pods under the aircraft and a retractable door, or dam, which connects them at the forward end.

*McDonnell-Douglas Corp., St. Louis, Mo.

278 *Arold, Louis J.; and *Hill, William F. (Compilers): **Soviet Air/Land Military Power.** Looseleaf, updated periodically. Based on unclassified sources.

Table of Contents

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*Airlandco, P.O. Box 254, La Puente, Calif.

279 **The Military Balance 1980/81.** Compiled by The International Institute for Strategic Studies, London. (This presentation has appeared in Air Force Magazine each year since 1971.) Air Force Magazine, vol. 63, no. 12, Dec. 1980, pp. 62–136.

(For abstract see No. 213 in this bibliography.)

280 *Hoffman, Sherwood: **Bibliography of Supersonic Cruise Research (SCR) Program from 1977 to Mid-1980.** NASA RP-1063, Dec. 1980, 103 pp.

N81-14973#

The Supersonic Cruise Research (SCR) Program, which was initiated in July 1972, includes system studies and the following disciplines:

Propulsion
Stratospheric emission impact
Structures and materials
Aerodynamic performance
Stability and control

In a coordinated effort to provide a sound basis for any future consideration that may be given by the United States to the development of an acceptable commercial supersonic transport, integration of the technical disciplines was undertaken, analytical tools were developed, and wind-tunnel, flight, and laboratory investigations were conducted. A previous bibliography, NASA RP-1003, covers the first 5 years of the program. The present bibliography covers the time period from 1977 to mid-1980. It is arranged according to system studies and the above five SCR disciplines. There are 306 NASA reports and 135 articles, meeting papers, and company reports cited in this document.

*NASA, Langley Research Center, Hampton, Va.

281 *Polhamus, Edward D.; and *Toll, Thomas A.: **Research Related to Variable Sweep Aircraft Development.** Presented at the Air Force Historical Foundation Meeting at Langley Research Center on March 27, 1981.

This paper briefly reviews the research carried out, at the NACA/NASA Langley Research Center, related to the development of high speed, variable sweep aircraft. The variable sweep research is prefaced by a short summary of the early German and Langley research on fixed swept wings. The review begins with the 1946 wind tunnel studies, covers the lessons learned from the X-5 and the XF10F variable sweep aircraft and then outlines a joint program with the British, evaluation of the British "Swallow," development of the "outboard-pivot" concept by Langley and the applied research program that followed. This program provided the technology for the current, variable sweep military aircraft. The paper closes with a brief discussion of possible future trends in variable sweep aircraft.

*NASA, Langley Research Center, Hampton, Va.

APPENDIX A – SERIAL PUBLICATIONS

1 Jane's All the World's Aircraft. Compiled and edited by John W. R. Taylor. Annual publication. Jane's Yearbooks, Franklin Watts Inc., New York, N.Y.

Sections on Aircraft, Air-Launched Missiles and Aero-Engines would probably be of most interest to persons using this bibliography.

2 Jane's Weapon Systems. Edited by R. T. Pretty. Annual publication. Jane's Yearbooks, Franklin Watts, Inc., New York, N.Y.

Two sections of interest to users of this bibliography are:

3 Jane's Defence Review. Published by Jane's Publishing Co. Ltd., 238 City Road, London EC1V2PU. 6 issues a year, provides current reports and analytical reviews of global defense subjects.

Note: There are several (4-6) abstracting and indexing periodicals that should be consulted by persons wishing to remain current on the topic of this compilation. They are:

4 "STAR," Scientific and Technical Aerospace Reports, an announcement bulletin published semi-monthly by NASA, Scientific and Technical Information Facility, Box 8757, Washington-Baltimore Airport, Maryland 21240. Unclassified report literature is announced in this publication. Author, subject, source, and report number indices are included.

5 International Aerospace Abstracts, an announcement bulletin published semi-monthly by the American Institute of Aeronautics and Astronautics, Technical Information Service, 750 Third Avenue, New York, N.Y. 10017. Unclassified journal articles, papers presented at conferences and other meetings, and some books are announced in this publication. Author, subject, source, and paper number indices are included in this bulletin.

6 Aeronautical Engineering; A Special Bibliography With Indexes. This is a compilation containing only the citations from the above two periodicals that pertain to aeronautical engineering. It is compiled by NASA, published monthly, and is much smaller and less costly. Annual indexes are included in the subscription price. NTIS, Springfield, Va. 22161.

Note: The following periodical publications (7–18) frequently contain articles of interest on U.S. and U.S.S.R. aircraft and missile weapon systems, and are included here as sources of information often worth checking. For a more complete list, check your library's list of periodicals.

7 AIR FORCE Magazine, published monthly by the Air Force Association, Suite 400, 1750 Pennsylvania Ave., N.W., Washington, D.C. 20006

8 AIR International, a monthly publication by AIR International, De Worde House, 283 Lonsdale Road, London, SW 13 9OW; or P.O. Box 353, Whitestone, N.Y. 11357

9 **Aviation Week & Space Technology,** a weekly magazine published by McGraw-Hill, Inc., 1221 Ave. of the Americas, New York, N.Y. 10020

10 **Flight International,** a weekly magazine published by IPC Transport Press, Ltd., Dorset House, Stamford St., London SE1 9LU, England.

11 **Flug Revue,** published monthly by Vereinigte Motor-Verlage GmbH und Co. KG, Leuschnerstr. 1, Postfach 1042, 7000 Stuttgart 1, West Germany. (In German)

12 **Interavia: World Review of Aviation–Astronautics–Avionics,** (Editions in English, French, German, and Spanish). Published monthly by Interavia S.A., 86 Av. Louis Casai, 1216 Cointrin-Geneva, Switzerland.

13 **International Defense Review,** (a sister journal to "Interavia").

14 **Military Aircraft & Missile Data Sheets,** Quarterly, from Aviation Studies International, Sussex House, Parkside, Wimbledon, London S.W. 19, England.

15 **U.S.A.F. Fighter Weapons Review,** published quarterly. U.S. Air Force, 57 Fighter Weapons Wing (Don), Nellis AFB, Nev. 89191.

16 **Aerospace Facts and Figures 1979–1980,** Aerospace Industries Association of America, Inc., July 1979.

This is an annual publication.

17 **U.S. Army Aviation Digest,** an official Dept. of the Army periodical published monthly. CDR, AG Publications Center, 2800 Eastern Boulevard, Baltimore, Md. 21220

18 **Air Defense Magazine,** published quarterly by the U.S. Army Air Defense School Custodian, U.S. Army Air Defense Magazine Fund, USAADS, ATTN: ATSA-TD-LIT, Fort Bliss, Texas 79916

APPENDIX B — BOOKS

This list of books is not comprehensive. It consists of some which are in the Langley Research Center Technical Library, and some which could be ordered and would be useful in providing a historical background for present day military aircraft and missiles.

1 **Soviet Aviation and Air Power — a Historical View.** Edited by Robin Higam and Jacob W. Kipp.--London, Brassey's; and Westview Press, Boulder, Colorado. 1978, 328 pp. Includes index. UG635.R9S596

Chapters:

The Beginnings of Russian Air Power, 1907–1922: David R. Jones

NEP and the Industrialization to 1928: Neil M. Heyman

Soviet Aviation and Air Power under Stalin, 1928–1941: Kenneth R. Whiting

The Great Patriotic War, 1941–1945: John T. Greenwood

The Development of Naval Aviation, 1908–1975: Jacob W. Kipp

Soviet Civil Aviation and Modernization, 1923–1976: Kendall E. Bailes

The Lessons of World War II and the Cold War: Joseph P. Mastro

The Soviet Strategic Air Force and Civil Defense: Alfred L. Monks

Strategic Missile Forces and Cosmic Research: Phillip A. Petersen

Patterns in the Soviet Aircraft Industry: Otto Preston Chaney, Jr., and John T. Greenwood

The Peacetime Air Force at Home and Abroad, 1945–1976: Kenneth R. Whiting

2 **United States Military Aircraft Since 1909** by F. G. Swanborough. Historical research by Peter M. Bowers Putnam, London & New York, 1963, 596 pp.

Includes information on every aircraft type designated by the USAF or its predecessors since 1919. Index in alphabetical order is a quick guide, 1963.

UG633.S88

3 **United States Navy Aircraft Since 1911** — by Gordon Swanborough and Peter M. Bowers. Funk and Wagnalls, New York, 1968, 518 pp.

VG93.S92

Includes information on every Navy (including Marine Corps & USCG) aircraft since 1911. Index covers aircraft since 1922 when a logical designation system was introduced.

4 **U.S. Fighters** — by Lloyd S. Jones. Aero Publishers, Inc., 329 West Aviation Road, Fallbrook, Calif. 92028, 1975, 352 pp.

UG1242.F5J66

5 **U.S. Naval Fighters** — by Lloyd S. Jones. Aero Publishers, Inc., 329 West Aviation Road, Fallbrook, Calif. 92028, 1977, 352 pp.

UG93.J65

6 **SOVIET Air Power** — An Illustrated Encyclopedia of the Warsaw Pact Air Forces Today. By Bill Sweetman and Bill Gunston. Published 1978 by Crescent Books, 1 Park Ave., New York, N.Y. 10016, by arrangement with Salamander Books, Ltd. Includes an assessment of relative strengths and weaknesses and a technical directory of aircraft, color photographs, drawings, and line diagrams. Has an index, 192 pp.

7 **The Soviet War Machine** — An encyclopedia of Russian military equipment and strategy. The 248 page book published in 1976 has many full color photos, line drawings, comparative tables, and charts. Published by Chartwell Books, Inc., and distributed by Book Sales, Inc., 110 Enterprise Ave., Secaucus, N.J. 07094.

8 **The U.S.S.R. in World War II:** An Annotated Bibliography of Books Published in the Soviet Union, 1945–1975. By Michael Parrish, Garland Publishers, New York, 1980.

This bibliography organizes, classifies, and annotates more than 7,500 items, and provides encyclopedic coverage of Soviet books, pamphlets, theses, pictorial collections, and dissertations published since 1945, which treat the Great Patriotic War. Important titles published in non-Russian languages of the U.S.S.R. that were translated into Russian are also included. Items are classified into five major divisions: The Military Campaigns; The Soviet Armed Forces; Geographic Areas (including the Baltic States, the Caucasus, Central Asia, Russian Soviet Federal Socialist Republic (RSFSR), and Ukraine and Moldavia); Subject Divisions; and Economic Divisions. Each of these main sections is further subdivided; in all, there are 59 separate chapters. Addenda cover works published from 1975 to 1980, and there is an index.

9 **Soviet Aircraft and Rockets.** By N. A. Zhemchuzin--et al. New Deli: Amerind Pub. Co.; Washington, D.C. Published for NASA and the National Science Foundation. 1977, 271 pp. Translated from the Russian.

NASA TT-F-770 TL670.Z5413

10 **Fifty Years of Soviet Aircraft Construction,** by A. S. Yakovlev, Izdatel'stvo "Nauka," Moskva, 1968, 186 pp.

Translated from the Russian by Israel Program for Scientific Translations.

NASA TT-F-627

11 AEROFLOT — Soviet Air Transport Since 1923. By Hugh MacDonald. 1975, 323 pp. and index. Putnam, London and New York.

HE9855.A4 M33

This book tells in detail the story of Soviet civil air transport and in particular the contribution of the Soviet airline Aeroflot. Aeroflot, although responsible for a much wider range of duties than airlines elsewhere, is without question the world's biggest carrier of air passengers and cargo — its 1973 target was 87 million passengers and 2,100,000 tons of cargo to be carried over a route network of some 820,000 km. Its fleet runs into thousands and ranges from light single-engined aeroplanes and helicopters up to large three- and four-engined jet transports and some of the world's largest and heaviest helicopters. The Soviet Union has maintained strict secrecy over much of its air transport operations, but painstaking study of published facts, mostly in Soviet publications, does reveal much of this massive air transport undertaking. This work is comprehensively illustrated with photographs, but of even greater value are the more than 30 tables and numerous appendices.

12 Soviet Transport Aircraft Since 1945. By John Stroud. Funk & Wagnalls, New York, 1968, 318 pp.

TL526.K9584

The design history, structural layout and features, accommodation and operational history are detailed for each type. The technical data covers dimensions, weights and performance for as many variants as possible of each type. Unfortunately, the data presented is not consistent, and some aircraft are more fully covered than others. For ease of reference aircraft have been arranged alphabetically by design bureaux, and within these sections the aircraft are shown in numerical sequence by type numbers. All measurements are given in metric with English equivalents. The book includes 3-view drawings of many of the transports.

13 Russian Aircraft Since 1940. By Jean Alexander. Published by Putnam, 1975, 555 pp.

TL526.R9A6

This book takes its place in the Putnam series beside those on Aeroflot and Soviet Transport Aircraft to give a complete picture of Soviet aviation during the past thirty-five years. It describes all known powered aircraft and sailplanes designed and produced during that period. The works of such designers as Antonov, Beriev, Chetverikov, Il'yushin, Kamov, Lavochkin, Mikoyan and Gurevich, Mil', Myasishchev, Petlyakov, Sukhoi, Tupolev, and Yakovlev are described. The familiar war-time aircraft such as the MiG, LAGG and Yak piston-engined fighters, the Il'yushin shturmoviks, the twin-engined Pe-2s and four-engined Pe-8s are dealt with, as well as the post-war jet-propelled types which have seen service in many parts of the world and have played decisive roles in the recent wars of the Middle and Far East. Information is given on Soviet helicopters including the very large Mil' types. NATO codenames, a glossary and details of Soviet aero-engines are also included. Although much has been published in the Soviet Union on its early aircraft and quite detailed brochures have been produced giving information on transport aircraft available for export, wide areas of Soviet aviation have been kept under a strict security blackout. This is probably the most comprehensive coverage of Soviet aircraft so far available in English.

14 The Soviet Air Force Since 1918. By Alexander Boyd. Published in 1977 by Stein & Day, Scarborough House, Briarcliff Manor, N.Y. 10510 and contains 259 pages. This is a historical survey which draws upon material, much of it in Russian, which is now difficult, if not impossible, to obtain. A comprehensive, select bibliography is included followed by an index of names.

15 The Illustrated Encyclopedia of the World's Modern Military Aircraft. Published by Crescent Books, 1 Park Ave., New York, N.Y. in 1977. It is a Salamander book consisting of 256 pages of "analyses of the design, development, and capabilities of each aircraft and its variants." Many photos, cutaway drawings, three-view drawings, and data on the major combat aircraft in service today are included.

16 Holder, W. G.; and Siuru, W. D., Jr.: **General Dynamics F-16.** (Book). Fallbrook, Calif. Aero Publishers, Inc. (Aero Series, vol. 26), 1976, 104 pp.

A76-39833

LaRC library users ask for UG1242.F5H64.

The present book describes the F-16 lightweight fighter and recounts how it was developed and tested. Lightweight fighters built since the end of World War I are examined, the specifications of the F-16 are outlined, and its combat capability is evaluated. Flight-test accomplishments of the YF-16 prototype are summarized, the flight-test program is described, and the F-16 development and production schedule is presented. Similarities between the F-16 and NASA's HiMAT research aircraft are noted. The development of the two-seat F-16B is discussed along with the competition among the F-16, the Mirage F1E, and the Swedish Viggen 37E. The U.S. Navy's F-18 air combat fighter is described, and the combat capability of the F-16 is compared with that of the Soviet MiG-21, MiG-23, and MiG-25. Numerous black-and-white and color photographs supplement the text.

17 Iatsunovich, M. S.: **Practical Aerodynamics of the Mi-6 Helicopter.** Moscow. Izdatel'stvo Transport, 1969, 208 pp. In Russian.

A70-31414#

Soviet book on practical aerodynamics of Mi 6 helicopter covering engine/rotor power balance, control, flight characteristics and solutions to in-flight emergencies.

18 Lambermont, P. M.; and Pirie, A.: **Helicopters and Autogyros of the World.** 2nd Edition. Cassell, London, 1970

TL716.L28(1970) V73-11707

19 Varukha, I. M.; Bychkov, V. D.; and Smolenskii, E. L.: **Practical Aerodynamics of the An-12 Aircraft.** (Translation into English of the Russian book "Prakticheskaya Aerodinamika Samoleta An-12," Moscow 1971, 180 pp.) Foreign Technology Division FTD-MT-24-1346-72, Nov. 17, 1972, 286 pp.

For Russian version ask for A72-28343#

For English translation ask for N73-21953#.
AD-756948 (English translation).

The design and aerodynamic features of the An-12 turboprop aircraft, questions of its handling technique and flight safety are discussed in this book. There is shown the effect of the turboprop power plant on stability, aircraft handling, and primary aerodynamic characteristics. The substantiations of a number of design solutions are given. The book is intended for the flying and technical personnel of civil flying and technical personnel of civil aviation. It can be used by flying school cadets and by students of training detachment.

20 Bekhtir, P. T.; and Bekhtir, V. P.: **Practical Aerodynamics of the Il-18 Aircraft.** (Russian book). Moscow. Izdatel'stvo Transport, 1972, 200 pp. In Russian.

A73-15968#

The aerodynamic characteristics of the Il-18 four-engine turboprop aircraft and the operational features of its power plant are reviewed. The technique of piloting the aircraft during level flight, takeoff, climbing, descent, turning, and landing is considered, as well as the stability and controllability of the aircraft and the question of flight safety during these different flight regimes. The problem of flight during failure of one or two engines on one side of the aircraft is discussed, as well as measures to be taken by the crew to restore equilibrium. Finally, the special features of flight in turbulent air and in the presence of icing conditions are summarized.

21 Kuznetsov, A. N.; Pokrovskii, V. IA.; Polikushin, V. M.; and Premet, L. A.: **The Il-18 Aircraft.** (2nd enlarged and revised edition). Russian book. Moscow. Izdatel'stvo Transport, 1974, 348 pp. In Russian.

A75-23421#

The Il-18 is a medium- to long-range transport aircraft powered by four Ai-20 turboprop engines. Five modifications of the basic aircraft, with passenger capacities from 80 to 122, have been developed. The present exposition concentrates mainly on the Il-18C, which can carry 110 passengers and has a maximum takeoff weight of 61,200 kg. Basic information is given concerning the aircraft and the operation of its main systems. The airframe construction, including the fuselage, wings, and tail surfaces, are described. Other systems discussed include the landing gear, the control system, and the hydraulic, fire-control, deicing, and cabin-pressurization systems. Consideration is given to the construction of the engine nacelles and airscrews and to the engine, fuel, and oil control systems.

22 Tishchenko, M. N.; Nekrasov, A. V.; and Radin, A.: **Helicopters: Parameter Assignments in Design.** Moscow Izdatel'stvo Mashinostroenie, 1976, 367 pp. Russian book.

A77-27550#

Design criteria for assignment of optimum parameters and examples of selection of optimum rotorcraft parameters are discussed, with methods for estimating structural weight, fabrication costs, and direct operating costs. Major topics include: criteria for helicopter performance evaluation and optimization, assignment of optimum parameters and designs for a transport/freight helicopter based on maximum payload, weight structure analysis and calculation of rotor blade design weight, methods for calculating operating costs, and assignment of helicopter optimum parameters on the basis of a minimum cost criterion. Various designs of Soviet and other rotorcraft and blades are considered.

23 Chernenko, Zh. S.; Lagosiuk, G. S.; and Gorovoi, B. I.: **The An-26 Aircraft: Construction and Use.** Moscow, Izdatel'stvo Transport, 1977, 342 pp. In Russian.

A78-30273#

The An-26, based on the An-24, is a medium-distance twin-engine turboprop transport aircraft which can transport 5.5 tons of freight 1000 km with a 435 km/h cruising speed at a height of 6000 m. Topics discussed include airframe construction, flight control, the undercarriage, the hydraulic system, the propulsion unit, high-altitude equipment, the deicing system, and transport and accommodations equipment. The operation of some systems is explained.

AIRCRAFT AND MISSILE TYPE INDEX

Airplanes

U.S.A.

Note:

The asterisk indicates airplanes having variable-sweep wings.
The numbers in parentheses indicate books from Appendix B.

U.S.S.R.

Helicopters

U.S.A.

U.S.S.R.

Missiles

U.S.A.

U.S.S.R.

SUBJECT INDEX

NOTE: The following index may be helpful by indicating where material on specific subjects may be found. Summaries, surveys, etc., are not indexed in depth. The numbers in parentheses indicate books from Appendix B.

AUTHOR INDEX

1. Report No. NASA TM-81951	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle U.S. AND U.S.S.R. MILITARY AIRCRAFT AND MISSILE AERODYNAMICS (1970–1980) – A SELECTED, ANNOTATED BIBLIOGRAPHY VOLUME I		5. Report Date August 1981
		6. Performing Organization Code 530-03-13-02
7. Author(s) Marie H. Tuttle and Dal V. Maddalon		8. Performing Organization Report No. L-14392
		10. Work Unit No.
9. Performing Organization Name and Address NASA Langley Research Center Hampton, VA 23665		11. Contract or Grant No.
		13. Type of Report and Period Covered Technical Memorandum
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report is published in three volumes because of the range of classifications: Volume I, Unclassified—Unlimited (NASA TM-81951); Volume II, Unclassified—Limited (NASA TM-83113); and Volume III, Secret (NASA TM-83114).

The purpose of this selected bibliography (281 citations) is to list available, unclassified, unlimited publications which provide aerodynamic data on major aircraft and missiles currently used by the military forces of the United States of America and the Union of Soviet Socialist Republics. Technical disciplines surveyed include aerodynamic performance, static and dynamic stability, stall-spin, flutter, buffet, inlets, nozzles, flap performance, and flying qualities. Concentration is on specific aircraft including fighters, bombers, helicopters, missiles, and some work on transports which are or could be used for military purposes. The bibliography is limited to material published from 1970 to 1980. The publications herein illustrate many of the types of aerodynamic data obtained in the course of aircraft development programs and may therefore provide some guidance in identifying problems to be expected in the conduct of such work. As such, this information may be useful in planning future research programs.

Some general publications are included which contain, for example, data on aircraft geometry and specifications.

17. Key Words (Suggested by Author(s)) Aerodynamics; Military Aircraft; Missiles; Fighter/Bomber/Helicopter/Transport; Bibliography		18. Distribution Statement Unclassified – Unlimited Subject Category 05	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 70	22. Price A04

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