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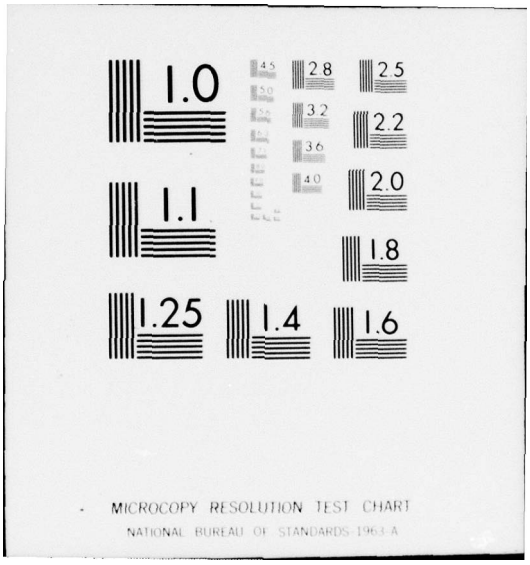
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AIR FORCE
FLIGHT TEST CENTER
TECHNOLOGY NEEDS
Annual Report for CY 1976

May 1977

Final Report

AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

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air-to-ground gunnery	flight test	bomb scoring
automatic bomb scoring	test equipment	target aircraft
exhaust-gas velocity	anthropometry	jet engine

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This document presents all of the 1976 technology needs of the Air Force Flight Test Center in accordance with AFSCR 80-29, Technology Need Program. The technology needs are: engineering anthropometric and biomechanical evaluation of aircraft crew station geometries; vector miss distance indicator; automatic scoring system for air-to-air and air-to-ground gunnery; an automatic bomb scoring system; and an airborne instrumentation system for measurement of jet engine nozzle exhaust-gas velocity.

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This Technology Needs document was submitted under Job Order Number 999000 by the Office of the Technical Director of the Air Force Flight Test Center, Edwards AFB, California 93523.

This report has been reviewed by the Office of Information (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public and foreign nations.

Prepared by:

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INTRODUCTION

The Air Force Systems Command (AFSC) Technology Need Program provides a means of identifying and resolving technological barriers to future Air Force weapon systems. Through this program AFSC organizations can make their technology needs known to the AFSC laboratory responsible for advances in that particular technology. AFSCR 80-29 specifies the procedures and format for submitting and responding to technology needs.

This Technical Report contains the current technology needs (TNs) of the Air Force Flight Test Center (AFFTC). Each TN has been updated to include the changes which occurred in 1976.

Of the six TNs in the original CY 76 program, five have been updated and revalidated as AFFTC requirements. TN "Water Spray/ Icing System" has been deleted based on HQ AFSC staff review. The status of each TN as of the end of 1976 is given in the table at the back of this document.

The categories that are used to classify the importance of the need are defined below:

Category I. A need that must be fulfilled by a given date if a system requirement is to be met and is so critical that the lack of the item will severely constrain planned system capabilities or mission accomplishment.

Category II. A desirable item that will provide an option for planned growth or improvement of systems or capabilities. This category includes technology needs in support of conceptual systems.

Category III. A promising item that will add to the technology base but is not in support of a specific system requirement.

TN AFFTC ADTC 1902 73 01

DATE OF REVISION: 1 November 1976

TITLE: Automatic Bomb Scoring System

OBJECTIVE: Develop an automatic scoring system as an integral part of a conventional weapons delivery range. It should have the following characteristics:

a. Ability to provide immediate bomb score determination.

b. Ability to support multi-aircraft bombing missions with minimum time between consecutive passes, thus providing more efficient use of available range periods.

c. No requirement for manned scoring towers.

d. Ability to score weapons deliveries on multiple run-in headings so as to more fully assess weapon system capabilities.

e. Ability to provide a ± 2.5-foot range and ± 10-degree angular accuracy to 1,000 feet.

PROGRAM ELEMENT: 64215F (B-1), 27218F (F-5F), 64229F (F-16), FMS (USAF/FRG LRU-1)

PRIORITY: II. The automatic bomb scoring system is required to support the B-1, LRU-1, and F-16 weapons delivery system evaluations. The priority II classification is selected because this scoring system is needed to provide timely, relatively inexpensive and more accurate information as to weapons system capability.

DESIRED DATE FOR TECHNOLOGY VALIDATION: The automatic bomb scoring system would be installed at AFFTC and is required now. There is an expected continuous requirement for this capability.

PROBLEM: The method presently used to score conventional bomb deliveries is expensive, time consuming, weather dependent, and often inaccurate. The triangulation of a bomb's smoke charge from range towers provides only a bomb score accuracy within ± 10 feet to the impact point. The more accurate method is to physically locate the bomb and then survey its position. This latter method is extremely time consuming, is expensive in terms of added manpower, and can be very inaccurate if the original triangulation were incorrect.

RELATED EFFORTS: Current emphasis on bomb scoring is centered in TV triangulation by sensor placement on a split-screen array. Nellis AFB has such a system and China Lake has a TV ordinate scoring system. The TV triangulation system appears adequate for tactical range use (± 10 feet accuracy) but is not adequate for AFFTC DT&E utilization. Efforts were underway at China Lake to achieve accuracy in the ± 3 feet range but are currently in abeyance due to a lack of funding. The U.S. Navy received 3 bids on their procurement package - an augmented radar system, a laser system, and a TV system. They selected the TV systems which did not provide the accuracy we need. ADTC/SD-102M has a TV system under development which appears promising. ADTC/SD-102M (Mr George Weiss/872-3418) is monitoring these efforts.

SUGGESTED APPROACH: Continue to monitor efforts in this field.

SUPPORT: None

REFERENCES: None

KEYWORDS: Automatic Bomb Scoring System

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TN AFFTC ADTC 1604.1 73 02

DATE OF REVISION: 1 November 1976

TITLE: Vector Miss Distance Indicator (VMDI)

OBJECTIVE: Develop a VMDI which can be installed in present and future targets.

PROGRAM ELEMENT: 27130F (F-15), 27218F (F-5F), 27161F (AIM-9L), 64229F (F-16)

PRIORITY: II. The VMDI is required now to be installed in targets in support of the above test programs. There is an expected continuous requirement for this capability. The Priority II classification is selected because this system will greatly improve the capability to evaluate missile systems in an operational environment.

DESIRED DATE FOR TECHNOLOGY VALIDATION: This capability is needed now; F-15/AIM-9L launches will occur mid 1977.

PROBLEM: Present missile miss distance determination requires the use of a system tracking telescope which is expensive to purchase, operate and maintain. The requirement of this system for visual contact with the target makes the missile launch weather-dependent and operationally restrictive, while the time needed to process and analyze the film to determine missile miss distance causes severe program delays.

RELATED EFFORTS: The VMDI development is in progress for the High Altitude Supersonic Target (HAST) and the PQM-102 target drone with development completion currently forecasted for 1979 time period. The prime contractor is Motorola, Inc, Scottsdale, Arizona. The design phase has been completed and brassboard prototype fabrication accomplished. The unit is currently undergoing anechoic chamber tests. Exterior ground tests are planned for accomplishment at the Eglin range in December 1976. Airborne tests are planned for the 1977-78 time period. The VMDI project engineer is Mr. Frank Wallace, ADTC/SD-102M, 872-3418.

SUGGESTED APPROACH: Current approach is satisfactory.

SUPPORT: None.

REFERENCES: None.

KEYWORDS: VMDI Missile Scoring

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TN AFFTC ADTC 1901 73 03

DATE OF REVISION: 1 November 1976

TITLE: Conventional Gunnery Scoring Systems

OBJECTIVE: Develop an automatic scoring system for air-to-air and air-to-ground gunnery. The scoring system must exhibit the following characteristics:

a. Ability to score near misses.

b. Ability to determine bullet dispersion patterns.

c. Ability to generate real-time data for immediate analysis of gun system performance.

d. Ability to score bullets which pass within 25 feet of the target.

e. Ability to survive recovery of the aerial target and be reusable with minimum repair.

PROGRAM ELEMENT: FMS (USAF/FRG LRU-1), 27130F (F-15), 64229F (F-16)

PRIORITY: I. This priority is required for the air-to-air portion of the technology need. The Babcock scorer proved so unreliable as to be unusable for air-to-air scoring. Visually counting holes in towed targets is inadequate for the evaluation and analysis of air-to-air systems since no accounting can be made for complete target misses. A viable air-to-air scoring capability does not represent an "improvement"; it is a basic need, which is not being met. Competent air-to-air gunnery systems analysis cannot be conducted without a scoring system.

DESIRED DATE FOR TECHNOLOGY VALIDATION: A scoring capability will be required for the LRU-1 by July 1977. The F-15 and F-16 will require a scorer shortly thereafter.

PROBLEM: A Babcock electronic gunnery scoring system has previously been used at the AFFTC. The system was not usable due to erratic and unpredictable operation. The Babcock was designed to count rounds which passed in proximity to the towed target. A similar "bullet counting" system would be adequate for near term needs. A system which provides azimuth and range in relation to the target will be required for accurate input to computer simulation and analysis programs. Air-to-ground gunnery needs are similar.

RELATED EFFORTS: An interim scoring capability is being procured from Esterline Corporation. This will be a bullet counting system similar in capability to the Babcock system. Estimated ready date is October 1977. An azimuth/range scoring system is under development and should

be operational in February 1981. There are no known efforts currently for an air-to-ground system. The laboratory contact is Mr. Charles Craig (ADTC/SD-102M, 872-3418).

SUGGESTED APPROACH: The current approach is satisfactory in everything but schedule (estimated ready date of October 1977 vs need date of July 1977).

SUPPORT: AFFTC will support interim scorer ground/flight tests pending PID submittal and Center workload.

REFERENCES: None.

KEYWORDS: Automatic Scoring Systems

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TN AFFTC AMRL 0508 74 01

DATE OF REVISION: 1 November 1976

TITLE: Engineering Anthropometric and Biomechanical Evaluation of Aircraft Crew Station Geometries

OBJECTIVE: Develop techniques and equipment for evaluating the adequacy with which aircraft cockpits and other crew stations are sized and designed to conform to the anthropometric and biomechanic characteristics of the existing or intended flying population. End products should have applicability for measurement in two areas:

1. Control activation force requirements

2. Field of view

PROGRAM ELEMENT: 64215F (B-1), 64229F (F-16)

PRIORITY: This technology is required currently and following. A priority II is assigned because the results have an immediate application to on-going and upcoming test programs but its lack will not severely constrain mission accomplishment. The techniques and equipment for evaluating reach, control activation forces, and field of view will:

1. speed up the evaluation procedure,

2. improve the accuracy of test results, and

3. make test results more useful in designing aircraft and support equipment.

DESIRED DATE FOR TECHNOLOGY VALIDATION: 1 July 1977, F-16 Anthropometric Evaluation

PROBLEM: For optimal and safe performance of the aircraft pilot and crewmember, it is imperative that the relationship between the physical characteristics of the operator and his interface with the vehicle be such that the operator can conveniently utilize the full capabilities of the aircraft. One important aspect of the relationship is the extent to which the many features of the crew station accommodate to the anthropometric and biomechanical characteristics of the operator. Human Factors offices at test centers (such as AFFTC/DOEEH) are responsible for conducting Human Factors Test and Evaluation (HFT&E) in support of aerospace systems development. Among HFT&E responsibilities are the two areas of concern outlined in the above objective. At the present time there is no codified procedure whereby these relationships are examined and evaluated. This being one of several very important aspects of aircraft evaluation, it is essential that techniques and devices for their evaluation undergo research and development.

RELATED EFFORTS: Operational Performance Branch (6570 AMRL/HEO) has the responsibility to acquire engineering anthropometric and biomechanical data on the USAF flying population and to interpret and utilize such data to derive criteria for the sizing and design of aircraft cockpits and other crew stations. AMRL has completed a cockpit evaluator and has provided blueprints for construction of an evaluator at AFFTC. A cockpit evaluator will be supplied to AFFTC.

SUGGESTED APPROACH: The Aerospace Medical Research Laboratory should continue a program of research to meet the objectives of this Technology Need. They should conduct the necessary research to develop and validate the basic rationale, techniques, and equipment to fulfill the needs of HFT&E. The following capabilities should be achieved.

1. Control activation force requirements, accurate to less than 0.5 pound, and adjusted for biomechanical variability.

2. Horizontal and vertical field of view, accurate to less than one degree. Prototype field of view evaluator will be provided to AFFTC.

3. Leg reach evaluator which will relate leg functional reach to seat reference point and control activation force requirements.

4. Further develop computer validation model, COMBIMAN, of cockpit geometry to be expanded to include F-15, F-16, B-1, A-10, YC-14, and YC-15 crew stations.

Such a capability will also serve to expand and refine the normative base of anthropometric and biomechanical data on the USAF population, particularly for interactions between body dimensions, proportions, biomechanics, and personal clothing.

SUPPORT: AFFTC/DOEEH can provide approximately 0.05 man-year of technical consultation and coordination with the Aerospace Medical Research Laboratory and other Air Force agencies, as necessary, to accomplish this Technology Need. Additional support may be available at a later date depending on the needs of AMRL and availability of Center resources.

KEYWORDS: Workspace, accommodation, anthropometry

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TN AFFTC AFOSR 2105 76 02

DATE OF INITIATION: 1 November 1976

TITLE: Exhaust-Gas Velocity Measurement of Jet Engines

OBJECTIVE: Develop airborne instrumentation which can accurately measure jet engine nozzle exhaust velocity. The proposed instrumentation should have accuracy of ±1 percent of the measured value. The system configuration would be required to operate over the total aircraft flight envelope, including supersonic flight and afterburner operation and would need to be adaptable to both turbojet and turbofan engines, both afterburning and non-afterburning. Installation of the equipment should not change the basic configuration of the aircraft, nor alter the engine operation.

PROGRAM ELEMENT: 21730F (F-15), 64225F (A-10), 64215F (B-1), 64229F (F-16)

PRIORITY: II. A priority II is selected because the results have an immediate application to ongoing and upcoming test programs; however, its lack will not severely constrain mission accomplishment in that no program will be halted in its execution because of this equipment not being available.

DESIRED DATE FOR TECHNOLOGY VALIDATION: 31 December 1979
The equipment for measurement of exhaust velocity will have its primary effect by improving the accuracy and validity of test results.

PROBLEM: In order to determine aircraft performance, a measurement of jet engine thrust is required. Current methods do not measure this directly but depend upon engine-manufacturers-supplied computer programs, or other computation techniques which calculate thrust based on measurement of parameters (pressures, temperatures, etc) that are indirectly related to thrust. These methods cannot be readily validated in flight and contribute considerable uncertainty to the flight test results. However, net thrust can be determined directly by measuring mass flow through the engine and the change in velocity between the entering and existing mass (change in momentum). The velocity measurement instrumentation would be installed on test aircraft at the AFFTC. There is an expected continuous requirement for this capability.

RELATED EFFORTS: Work has been done by the Sperry Gyroscope Company on the use of a traveling-wave ring laser as a flow sensor. The Aero-Astro Dynamics Laboratory has also conducted research using a laser-doppler heterodyne technique for measuring the velocity and turbulence in supersonic jets and wind tunnel flows. Both Arnold Engineering Development Center and the General Electric Company have used laser for measurement of gas velocity in ground applications.

Some work was also reported, to have been done in France, by the European Office of Aerospace Research and Development. Past efforts in determining jet exhaust gas velocity have been centered around measurement of temperatures and pressures and nozzle area. These have proven to be unusable in most cases due mainly to the severe temperature environment and accuracy problems.

SUPPORT: None

KEYWORDS: Gas Velocity Measurement
Net Thrust
Jet Engines
Performance Flight Testing

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STATUS OF TECHNOLOGY NEEDS

TN NUMBER	STATUS	PRIORITY CATEGORY	TOTAL LEVEL OF SUPPORT	SUPPORTING ORGN	REMARKS
AFFTC-ADTC-1902-73-01	Active	II	Significant	ADTC/SD-102M	Monitoring effort by Nellis AFB (TAC) and China Lake (NWC), plus ADTC development.
AFFTC-ADTC-1604.1-73-02	Active	II	Significant	ADTC/SD-102M	Current approach is satisfactory.
AFFTC-ADTC-1901-73-03	Active	I	Full	ADTC/SD-102M	Strong ADTC effort. AFFTC supporting interim system tests.
AFFTC-AMRL-0508-74-01	Active	II	Moderate	AMRL/HEO	Suggested capabilities to be achieved are presented in TN description.
AFFTC-AFOSR-2105-76-02	Active	II	To Be Determined	AFOSR/NA	Reassigned from AFAPL to AFOSR by HQ AFSC/DLXP