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PROGRESS REPORT

THE CF-105 SPARROW II ARMAMENT INSTALLATION

November 1956

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PROGRESS REPORT

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PROGRESS REPORT

THE CF-105 SPARROW II

ARMAMENT INSTALLATION

1.0 INTRODUCTION

The last progress report on this installation was submitted for approval in March 1956. Since that time work has proceeded on the installation then proposed. Minor differences from the original proposal have resulted from our investigations into all aspects of the design. These differences are outlined in this report.

Throughout the period covered by this review, work has been hampered by the lack of clearances to visit Douglas Aircraft and other companies associated with the development of the missile.

1.1 Design Progress

The installation consists of four Sparrow II Model D missiles stowed semi-submerged in a rapidly replaceable armament package.

1.1.1 Structure

Structural design has proceeded along the lines indicated in the previous report. Schemes of the main structural members are currently in our Stress Office for strength approval. Schemes of roof skinning and outside skins are in work. The remaining work which has yet to be done is on auxiliary structure such as the rear apron.

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1.1.2 Package Attachments to Fuselage

Design of the package attachments to the fuselage is complete. These are of the "quick release" variety and are similar in principle to those demonstrated at the Mock Up Evaluation Conference. However, in detail these have been completely re-designed to incorporate all suggested improvements.

1.1.3 Extension Linkage

Design has continued along the "twin jack" lines indicated in the previous report.

It was the original intention to utilise the two jacks themselves as the main links. Investigation has shown that it is not practical to design jacks with adequate bending stiffness to act as the main links and at the same time keep the hydraulic oil consumption to the minimum. The main links therefore consist of outer telescopic members, which take bending stresses, housing extension jacks which take end loads. Design of the extension linkage has been completed on a static loading basis. The resultant design is being subjected to analysis on a dynamic basis. This analysis will be completed in the near future at which time the mechanism will be released for final manufacturing drawings to be prepared.

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1.1.4 Missile Body Gap

The previous report indicated the intention of sealing the gap left by the missile body, after firing, by means of "Body doors" and two stage wing and fin doors. The resultant design proved to be excessively complicated and was therefore abondoned. In its place we have increased the size of the launcher such that in plan view it is approximately the same shape as the missile body. After firing of a missile, the launcher is retracted to the package skin line only, and there serves as a seal for the gap previously occupied by the missile body.

1.1.5 Wing and Fin Doors

The multi-element sliding doors proposed in the previous report have been adhered to. Because of the method used to seal the body gap these doors are now two position doors and no longer three position. This change has markedly simplified the design.

Preliminary schemes of the doors and their actuation have been completed and an analysis of dynamic loading has been carried out. As a result of this work final schemes are now being prepared.

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1.1.6 Missile Launchers

Because of the proximity of adjacent missiles in the extended position it is necessary to restrain the rotation of the missiles on launch for the first 60 inches of their travel. This means an extension in length of the launcher rails over the length currently provided on the Douglas launcher. Together with the increased length of the launcher to fill the body gap this effectively means that a special launcher is required for the CF-105 installation. In addition the launcher attachments to the links require re-design as does the umbilical connection.

The means by which suitable launchers will be made available for the installation is presently uncertain.

1.1.7 Hydraulic System

The hydraulic system has been designed to utilise the aircraft utility system delivery at 4,000 psi. dispensing with accumulators.

The missile extension jacks operate exactly as described in the previous report. The design for these jacks is complete and drawings have been prepared to permit their procurement. Damping at the end of the stroke will be accomplished by progressively reducing the return port area by causing the

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(Cont'd) 1.1.7 piston to pass over it. The jacks will not contain any integral locks, but are intended to be pressurized either up or down at all times during flight.

The force available in the missile extension jacks is not adequate to hold a missile in the stowed position at + 7.33g. An up lock picking up on the launcher over the missile C.G. is therefore used. This up lock is hydraulically actuated by a small jack.

All door jacks are identical and as in the case of the missile extension jacks do not have integral locking but are pressurised at all times.

All sequencing is electrical and care has been taken to ensure that any electrical failure will not cause an unsafe condition to exist.

The design of the hydraulic system and all components is well advanced and procurement of bought out items will shortly commence. Arrangements have been made to simulate this system electronically in order to obtain preliminary experience of its dynamic characteristics.

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1.1.8 Electrical System

The order in which certain functions are performed within the missile prior to achieving lock on are currently obscure, but indications are that changes to the missile and auxiliaries may be necessary with a semi submerged installation. As a result of this obscurity the demarcation line between RCA and AVRO is also indefinite.

Design of the electrical control system is therefore currently centred around the provision of a system which will permit the firing of unguided test vehicles only. The design of this abridged control system is well in hand.

In this abridged system the trigger on the hand grip will be the initiating signal. On receipt of this signal, doors will be opened and missiles will be lowered. Upon reaching the fully extended position the wing and fin doors will be energised to the closed position and an intervalometer will be started. This intervalometer will be a component especially designed for this abridged system. One half second after being energised it will generate the first firing signal and further firing signals will be generated at half second intervals thereafter. These signals will be routed to missiles in a pre-arranged order. Failure of a missile to fire will result in it being automatically jettisoned

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(Cont'd) 1.1.8 immediately after the last firing signal has been routed to a missile.

After all missiles are clear the empty launchers will be retracted.

Provision is made for the automatic jettison feature to be disabled, if desired, for training missions when it can be guaranteed that 4 g on the aircraft will not be exceeded after lowering. In the event of hangfire on such a mission the launcher would remain extended for the pilot to manually retract it as, and if, he desired.

Provision is made for the extension and retraction of the missiles by means of switches located at the ground service panel at the side of the pack. This panel is opened to provide access to the safety plug through which all firing and jettison leads pass. It is intended that this plug will be disconnected at all times when the aircraft is on the ground. When open the panel releases a push button switch through which all power leads other than firing leads pass. Thus, as long as the panel is open no power of any kind is on the pack and there is no possibility of inadvertant actuation of any kind. In order to function missile and door actuation, the power switch button must therefore be kept depressed while the desired selection is made.

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1.1.9 Missile Bay Cooling

The missile bay will be maintained within the temperature limits of $0^{o}F$ and + $160^{o}F$ by cockpit discharge air.

1.1.10 Protection of Exposed Portions of Missile Body

Protection of the radome against ice, stones etc., will be accomplished by a small fairing which will blow clear on missile extension. A design for this fairing is currently in our Aerodynamics Department for approval.

Currently we are doing no work on any fairing intended to protect the missile body from the temperature effects of flight at Mach 2.0. This is because we understand that a missile suitable for semi submerged carriage at this speed will be available by the time that the CF-105 goes into squadron services. It is believed that this missile will be liquid cooled and an allowance has been made for the estimated heat load in the design of the Air Conditioning System.

1.1.11 Electrical Connections to Package, Firing Circuit Safety, Etc.

Electrical connections to the package, firing circuit safety plug, access to hydraulic disconnects etc., will be similar to those previously demonstrated. However, improvements have been incorporated to improve and speed access.

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1.1.12 Missile Auxiliaries

Because space provision for missile auxiliaries does not exist outside the package it is the intention to make space available for carriage of the auxiliaries inside the pack between missiles.

1.1.13 Sealing

Particular attention has been paid to ensuring a good seal around the missile bodies and the doors.

From the leading edge of the wing doors aft a fixed rubber seal of special design is used to seal around the missile body. Forward of the wing doors, because of the larger tolerances on this portion of the missile, we have had to use retractable seals worked by the wing door actuating mechanism. Seals along the transverse edges of the wing and fin doors are also retractable and are actuated by the doors themselves.

Schemes of these seals are almost ready for formal approval by our Aerodynamics Department.

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1.1.14 Installation Weight

The installation as outlined without auxiliaries and with the abridged control system is currently estimated to weigh 3650 lbs broken down as follows:-

Structure	850 lbs
Hydraulics	350 lbs
Mechanisms	625 lbs
Electrics	100 lbs
Missiles	1725 lbs
	3650 lbs

1.1.15 Design Schedule

The Engineering estimate in the previous report called for design completion in October 1956, with pack construction complete in May 1957. Subsequent discussions within the Company indicated that a more comprehensive drawing presentation would be desirable, thus extending the length of time required by the Design Office. In addition a slow down was enforced by lack of adequate information on the characteristics of the missile. It is now estimated that design will be completed in April 1957, and that the first package will be available for test in October 1957.

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1.2 OPERATION OF THE INSTALLATION

1.2.1 Operating Envelope

The operating envelope outlined in the previous report has been adhered to.

1.2.2 Attack Modes

Provision will be made to attack with either the rear two missiles or the forward two missiles, or to attack with all four missiles. In operational aircraft, provision will be made to attack manually or under the control of the F.C.S.

1.2.3 Cockpit Controls

Cockpit controls will be as called for in AIR 7-6 and as outlined in the previous report, except that we would no longer recommend the fitment of a "Spent Available" indicator.

1.2.4 Attack Sequence

The attack sequence will be carried out exactly as described in the previous report.

1.2.5 Firing Order Limitation

In operational use, firing signals will generally be routed to the missiles in the order of "lock on". On a four missile attack however, a firing order limitation exists.

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(Cont'd) 1.2.5 Firing Order Limitation

Because of the proximity of adjacent missiles in the extended position it is necessary to roll restrain a missile on launch until its tail fins have passed the wings of adjacent missiles.

Space limitations prohibit restraint of a rear missile until it is clear of the forward ones. Hence, on a four missile attack, the forward missiles must be fired first.

Initially therefore, firing signals will be routed to forward missiles only. If, for any reason, a forward missile does not achieve lock on within a reasonable period it will be fired as an unguided rocket and the remainder of the attack will then continue. Internal modifications to the missile may be necessary to fire as a rocket with controls locked.

1.3 DEVELOPMENT PROGRAM

Some differences in timing now exist in the development program from that outlined in the previous report. Aircraft Number 8 has now been allocated to weapons development and should be available in August 1958. An earlier aircraft had previously been assumed to be available in December 1957.

The ground development program is therefore aimed at providing a Sparrow II Installation for flight work during the third quarter of 1958.

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1.3.1 Extension Mechanism Test Rig

This test rig is as described in the previous report. It has just recently been completed and preliminary testing has begun.

1.3.2 Door Test Rig

As outlined in the previous report it was the original intention that the door test rig would first be run with a preliminary specimen under test. As the door design developed it became apparent that actuation and sealing played an important part in the design of the door itself. It was therefore decided that only the final design would be tested.

The specimen will consist of the region forward of the trailing edge of the wing doors of an outboard missile. Representative doors, door actuation, seals and seal actuation will be included as will be a dummy missile and launcher on an extension linkage.

The carcase of the specimen, the dummy missile, the launcher and the extension linkages are made. Drawings of the remainder will be issued within one month.

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1.3.3 Mock-Up

As stated in the previous report, no mock up of the installation has been built. In the immediate future the Falcon mock up will be modified to incorporate the latest design of latches, access panels, etc. This package will also be weighted to simulate the full loaded weight of a Sparrow Installation. This work was not tackled earlier because of our desire to incorporate what we hope will be the final design of these items.

1.3.4 Wind Tunnel Tests

A High Speed Wind Tunnel test program has been drawn up and it is intended to carry out this program late in 1956. A low Speed Wind Tunnel test program to check missile jettison is in the course of preparation.

1.3.5 Test Package

As outlined in the previous report the first test package will be built using a minimum of tooling and when complete will be subjected to a development program aimed at determining the necessary modifications to the basic design to give us an airworthy installation for flight testing. As indicated in the previous report, five launchers will be required for the first test package. These launchers are not standard items but special to the CF-105, and will be required in July 1957.

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(Cont'd) 1.3.5 Test Package

Four non fireable dummy missiles will be required in August 1957.

Twelve fireable dummy missiles will be required in September/October 1957 for ground firing tests which we propose to conduct as described in the previous report.

1.3.6 Preflight Testing of the Installation on a CF-105

We would propose to carry out ground shoots on CF-105 aircraft number 8 as described in the previous report. The anticipated time of these trials is August/September 1958. Twelve fireable dummy missiles will be required.

1.3.7 Flight Development of the CF-105 Sparrow Installation

In general the proposed flight development program will be as outlined in the previous report. Because of the change in aircraft, the program will begin some 8 to 9 months later than originally scheduled.

The one change from the original program that is worthy of note is, that in order to utilise the data reduction equipment, maintenance equipment, which will be in action at Malton, we intend to carry out the flight program at Malton, instead of Cold Lake. This will involve using Lake Ontario as a range.

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1.3.8 Requirements for Missiles and Launchers

Our anticipated requirements for missiles and launchers remain at the totals previously stated. However, because of program re-shuffles, these will be required at different dates to those previously stated.

1.3.8.1 Non-Fireable Dummy Missiles

A total of twenty-two non fireable dummies are required; four in August 1957, six in September 1958, and twelve in January 1959.

1.3.8.2 Fireable Dummy Missiles

114 fireable dummy missiles will be required. If high altitude shoots of standard dummies over Lake Ontario are considered to be dangerous these missiles should be equipped with a self destruct feature. They will be required as follows:-

20 in September 1957
12 in July 1958
20 in December 1958
20 in January 1959
20 in March 1959
22 in May 1959

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1.3.8.3 Launchers

At least fifteen launchers, modified for use on the CF-105, will be required as follows:-

5 in July 1957

5 in January 1958

5 in June 1958