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WADC TECHNICAL REPORT 54-170



T-1 ALTITUDE SUIT EVALUATION IN THE F-86D FLIGHT SIMULATOR

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APRIL 1954

WRIGHT AIR DEVELOPMENT CENTER

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April 1954

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Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

McGregor & Werner, Inc., Dayton, O.
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FOREWORD

This investigation was conducted at Tyndall Air Force Base, Florida, in the F-86D Flight Simulator to determine the feasibility of using flight simulators to train pilots in the use of high altitude suits. The project engineers responsible for this study were Capt Ben R. Games, USAF Project Officer, F-86D Training Devices, and Charles C. Lutz, Aero Medical Laboratory, Directorate of Research, WADC. The work was performed in support of SEO 660-141, "Emergency High Altitude Suits," under the direction of Edwin G. Vail, Capt, USAF, Chief, Respiration Section, Physiology Branch.

ABSTRACT

It is possible for a pilot to maintain controlled flight in the F-86D simulator while wearing the T-1 altitude suit in the pressurized condition. All controls in the F-86D are accessible with the T-1 suit uninflated. Some controls at the aft ends of the console are impossible to reach while pressurized, but will not adversely affect emergency descent procedures. It is possible to continue a radar intercept problem while wearing an inflated T-1 altitude suit for periods of time within the limits of the emergency oxygen supply. Installation of equipment necessary for using the T-1 altitude suit in F-86D simulators requires no major structural changes to the simulator.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:



JACK BOLIERUD
Colonel, USAF (IC)
Chief, Aero Medical Laboratory
Directorate of Research

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INTRODUCTION

The original idea and plans for the use of the T-1 altitude suit in the F-86D Flight Simulator Program began when Captain Ben R. Games, (USAF Project Officer, F-86D Training Devices) of Tyndall Air Force Base, Florida, attended a demonstration of the suit. After the briefing he questioned all those who had been issued this suit regarding its use and methods of operating the F-86D aircraft should the suit become inflated during flight. He found that they were uncertain as to exactly what could be expected if inflation occurred. Thus, the idea was born to determine the feasibility of using flight simulators to train pilots in the use of a high altitude suit, and to determine whether it would be economically practical to modify the F-86D Flight Simulator, so that the effects of cockpit decompression at high altitude could be simulated.

Captain Games contacted personnel of the Aero Medical Laboratory to discuss using the T-1 altitude suit in the F-86D Flight Simulator. Feeling that it was a sound idea, this Laboratory was interested in having it developed.

After the first phase of this program was completed (indoctrination of Captain Games in the use of the suit), a T-1 suit and associated equipment were supplied for the tests. On receiving approval of the project from Headquarters, Air Materiel Command, Aero Medical Laboratory supplied the valves and gages needed for the modification of the flight simulator and the project was begun at Tyndall.

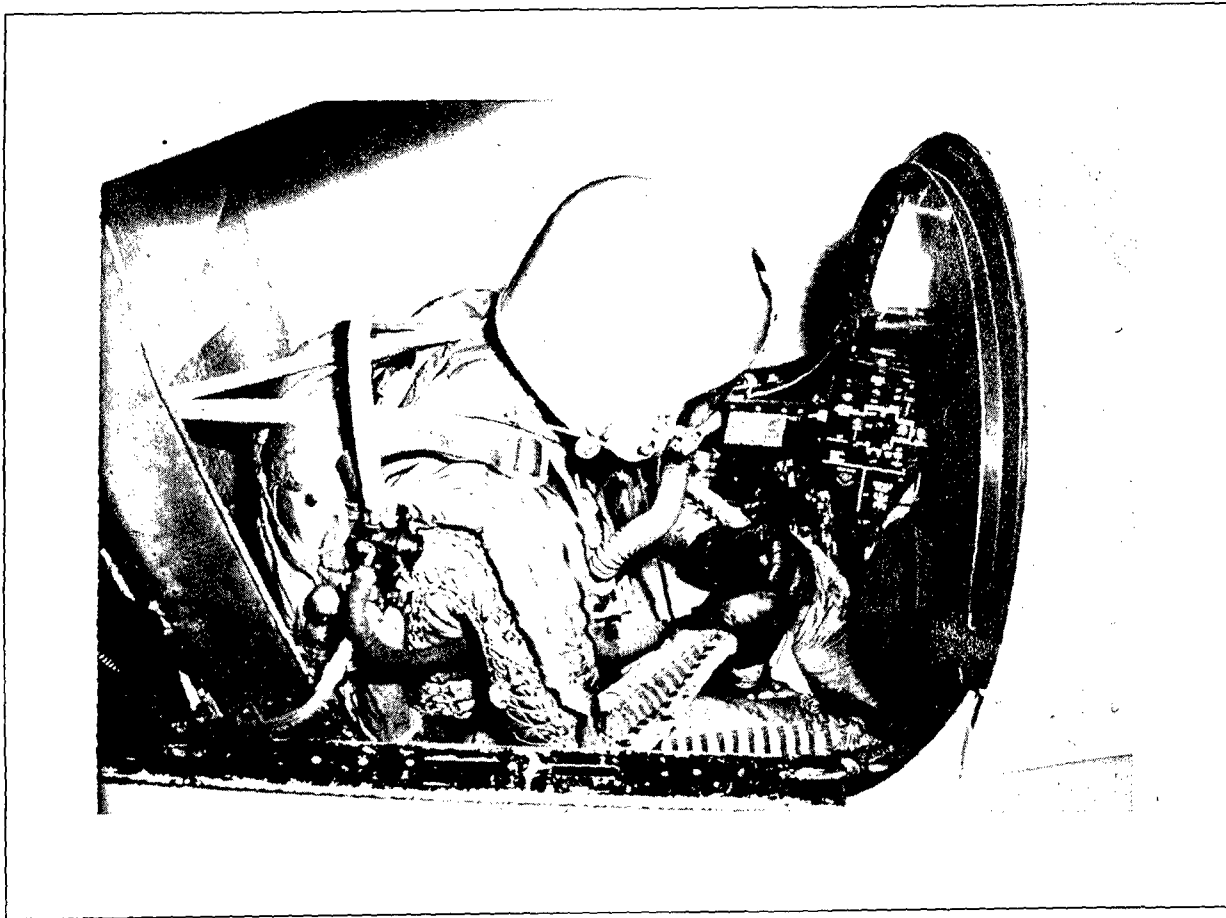


Figure 1. Subject Wearing T-1 Altitude Suit (Uninflated)

Shows placement of modified bailout assembly
on side flap of back pack parachute

MODIFICATION OF THE F-86D FLIGHT SIMULATOR AND THE T-1 ALTITUDE SUIT

Only minor modifications of standard equipment were necessary on the suit regulator and simulator to provide for use of the suit in the training device.

The regulator and cylinder assembly, Type C-1 (Bailout assembly for T-1 altitude suit) was modified for these tests as follows:

The large cylinder (AN6025AX53) was replaced by the smaller 22 cubic inch bottle from an H-2 bailout assembly, to allow placement of the assembly on the side flap of a back pack parachute (Fig. 1). (This assembly is now designated - Cylinder and Regulator Assembly, Breathing Oxygen Type MA-2) An adapter was added to this assembly to permit pressurization from an external source. A 244 cubic foot oxygen cylinder with a reducing regulator was located outside the simulator and was connected to the bailout assembly. A line valve controlling the flow of oxygen to the suit regulator was mounted on the instructor's console panel.

A flexible oxygen line was run through the cockpit structure to the inlet of the D-1 regulator which was maintained in its normal location. Figure 2 presents a diagram of the equipment installation on the F-86D Flight Simulator as it was used on these tests.

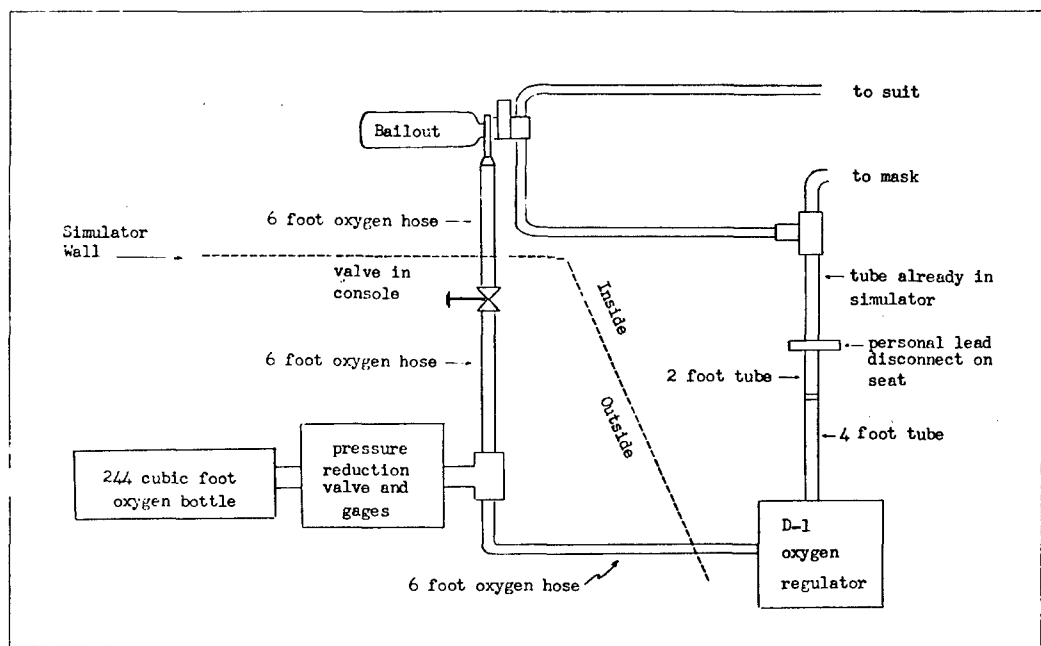


Figure 2. Schematic Drawing of Equipment Installation for Testing Use of T-1 Altitude Suit in F-86D Flight Simulator

A more elaborate installation including pressure-sensitive safety switches and indicator lights on the instructor's console is suggested for any future and more permanent installation for the use of the T-1 altitude suit in flight simulators.

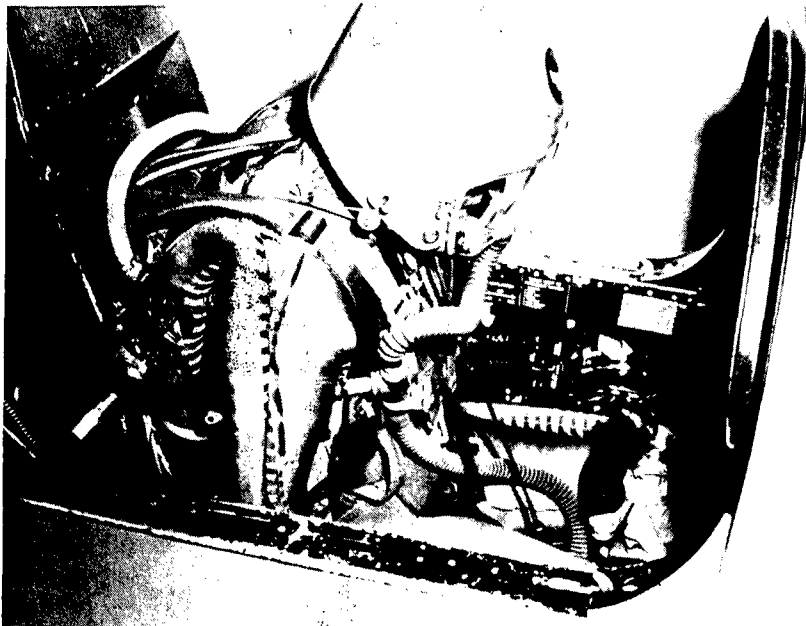


Figure 3. Pilot Wearing Pressurized T-1 Suit in the F-86D Simulator

FLIGHT SIMULATION WITH THE T-1 SUIT

After installation and preliminary test of the altitude suit components in the flight simulator, the first operational tests were made with canopy open and observers standing by in case of accidental disconnect. Pressurization of the suit was accomplished satisfactorily and short simulated flights were made. These flights consisted of simulated dives, turns, and other normal procedures with and without suit pressure, while the pilots became familiar with the feel of the equipment. Flight while pressurized was satisfactory and a successful simulated landing was made while pressurized.

The usual period of pressurization was about 10 minutes, however, on three simulated flights the pilot was pressurized for 45 minutes during which time a complete mission from takeoff to landing was accomplished. Figures 3 and 4 show a pilot wearing the suit in the F-86D simulator in the pressurized and unpressurized condition.

During these tests the pressures used were 75 mm Hg breathing pressure in the helmet and 7.5 psi in the suit capstans. These are pressures required for survival at 55,000 feet.

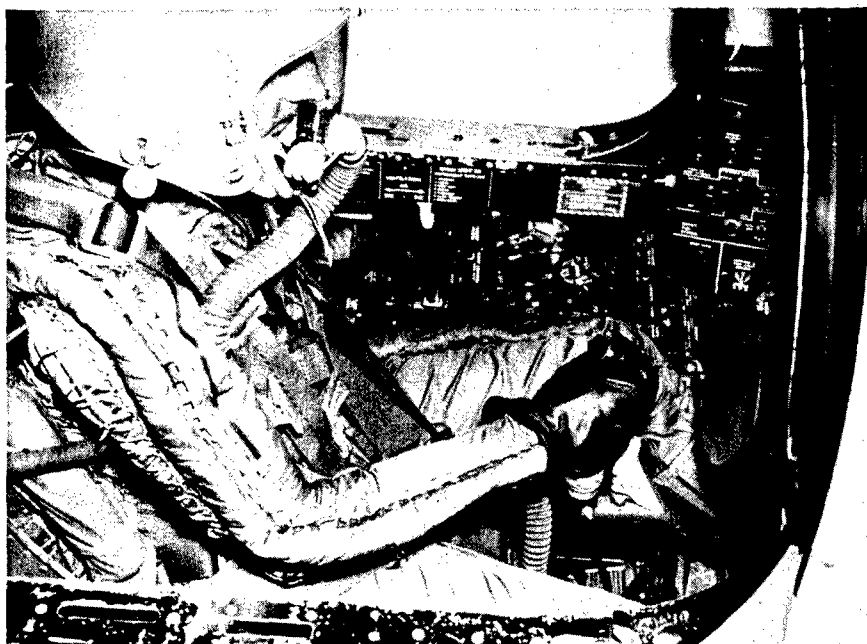


Figure 4. Pilot Wearing Unpressurized T-1 Suit in the F-86D Simulator

A total of 45 hours was flown in the F-86D simulator by pilots wearing the T-1 suit. The suit was inflated 15 hours of this time.

On later flights the possibility of continuing an intercept with the suit pressurized was determined. Suit pressurization was applied at various stages of these intercept problems without warning to the pilot. A sample intercept was as follows: With the simulator at 45,000 feet the intercept was started. Pressurization of the suit was unexpectedly applied during Phase I of the radar attack. The lock-on of radar equipment and interception of simulated enemy aircraft was carried through to successful completion. A second interception was completed while still under pressurization with satisfactory target results. The pilot then descended to 20,000 feet and depressothesized. Because of the inability of the pilot to reach the suit connection or the relief valve, assistance was required in releasing the suit pressure.

ACCESSIBILITY OF CONTROLS

Ability to reach and operate the controls and indicators in the simulator, while the T-1 altitude suit was worn in the pressurized and unpressurized condition was established by the following means:

Four degrees of accessibility, ranging from "Excellent" to "Impossible," were used in this grading. The following is a check list of simulator controls or indicators and the accessibility grade of each, resulting from these tests.

It should be noted that the check list indicates that 22 controls or indicators are impossible to reach with the T-1 suit inflated, 24 as good, and 35 as poor.

ACCESSIBILITY OF CONTROLS AND INDICATORS BY PILOT WEARING T-1 ALTITUDE SUIT

- EXCELLENT: Indicates pilot can operate control as well with suit on as with normal flying gear.
- GOOD: Indicates pilot can operate control without undue difficulty.
- POOR: Indicates that pilot can operate control, but with limitations or change of standard operating procedure.
- IMPOSSIBLE: Indicates that pilot cannot reach or operate control.

<u>Control or Indicator</u>	<u>Without Pressurization</u>	<u>With Pressurization</u>
Cockpit Check Pre-starting		
Seat and rudder adj	Excellent	Impossible
Harness and belt adj	Good	Impossible
Throttle closed	Excellent	Good
Batteries off	Excellent	Poor
All circuit breakers "in" except attack breaker "out"	Excellent	Impossible
Left CONSOLE		
Drop Tanks Air Pressure Shutoff valve on	Excellent	Impossible
Emergency speed brake Knob "out"	Excellent	Impossible
Anti-G Suit Regulator	Excellent	Impossible

ACCESSIBILITY OF CONTROLS - Cont'd

<u>Control or Indicator</u>	<u>Without Pressurization</u>	<u>With Pressurization</u>
Rudder Lock Handle	Excellent	Impossible
Engine Dual Fuel Pump Light	Excellent	Impossible
Cabin Pressure Guage	Good	Impossible
Zero Reader Selector Knob	Good	Poor
Zero Reader Alt Switch	Good	Poor
Cockpit Pressure Selector	Good	Impossible
Cockpit Air Switch "Press"	Good	Impossible
Cockpit Air Temp Sw "Auto"	Good	Impossible
Alter. Trim	Excellent	Poor
Flt Control Switch "Normal"	Excellent	Poor
Rocket Switch "Auto"	Excellent	Poor
Arm Master Switch "Off"	Excellent	Poor
Speed Brake "Neutral"	Excellent	Excellent
Flaps "UP"	Excellent	Good
Radar "Off"	Excellent	Impossible
Landing Gear Handle "Down"	Excellent	Poor
Check Ind & Warning Lite	Excellent	Poor
LEFT INSTRUMENT PANELS		
Engine Master Switch "Off"	Excellent	Poor
Generators "On"	Excellent	Poor
Battery "Off"	Excellent	Poor
Airstart Sw "Normal"	Excellent	Poor
Check man nozzle operation	Excellent	Poor
A/B Switch "Normal"	Excellent	Poor
Emerg Fuel System "Normal"	Excellent	Poor
Lndg Lt "Retract" then "Off" test switch	Excellent	Poor
CENTER INSTRUMENT PANEL		
Set Altimeter	Excellent	Impossible
Set Clock	Excellent	Impossible
Zero Reader Adjustment	Excellent	Impossible
Ability to check flights and engine instruments	Excellent	Good
Landing Gear Emergency Handle	Excellent	Impossible
RIGHT INSTRUMENT PANEL		
Fire Warning Lights	Excellent	Excellent
Fuel Bay Purging Switch	Excellent	Good
Check Inverters	Excellent	Good
Windshield & radome anti-ice switch "Off"	Excellent	Good

ACCESSIBILITY OF CONTROLS - Cont'd

<u>Control or Indicator</u>	<u>Without Pressurization</u>	<u>With Pressurization</u>
Check light Pilot Heat "Off"	Excellent	Good
Engine Inlet Screens "In"	Excellent	Good
Alternator Switch "On"	Excellent	Good
Recycle inverters	Excellent	Good

RIGHT CONSOLE

Yaw damper switch "Off"	Excellent	Good
Check oxygen regulator supply	Excellent	Good
Oxygen supply "On"	Excellent	Good
Console light switch	Excellent	Good
Check Auto Pilot	Excellent	Good
Auto Pilot Master Switch "Off"	Excellent	Good
Re-Check trim for Take Off	Excellent	Good
Radio Compass "Off"	Excellent	Good
UHF "Off"	Excellent	Poor
ILS "Off"	Excellent	Poor
IFF "Off"	Excellent	Impossible
Navigation lights "As desired"	Excellent	Impossible
Voltmeter Selector Bus	Poor	Impossible

Note: While pressurized cannot see left or right console, but can reach armrests OK.

PRE-LANDING

Belt and Harness Fastened	Excellent	Poor
Armament switch "Off"	Excellent	Poor
Check Utility Pressure	Excellent	Impossible
Emerg Fuel Switch to "Normal"	Excellent	Poor
Speed Brakes "Out"	Excellent	Excellent
Gear Down Below 175 K	Excellent	Poor
Wing Flaps Down Below 175 K	Excellent	Good
Check Instruments	Excellent	Good

AFTER LANDING

Screens "In"	Excellent	Good
Wing Flaps "Up"	Excellent	Good
Speed Brakes "Closed"	Excellent	Excellent

STOPPING ENGINES

Speed Brakes "Open"	Excellent	Excellent
Wing Flaps Down	Excellent	Good
Open nozzle manually	Excellent	Poor
Idle at 50% for 2 Min	Excellent	Excellent
Throttle "Off"	Excellent	Excellent
Stop Cock Throttle	Excellent	Excellent

ACCESSIBILITY OF CONTROLS - Cont'd

<u>Control or Indicator</u>	<u>Without Pressurization</u>	<u>With Pressurization</u>
Master Switch off at 10%	Excellent	Poor
Battery "Off"	Excellent	Poor
All Switches "Off" except Gen	Excellent	Poor
AIR START		
Throttle Closed	Excellent	Excellent
Emergency Fuel Switch "On"	Excellent	Poor
Variable Nozzle "Closed"	Excellent	Poor
Restart switch to air start	Excellent	Poor
Descend below 40,000 feet	Excellent	Poor
Advance throttle to desired fuel press	Excellent	Excellent
When ignition is indicated regulate throttle to maintain exhaust temp at approx 400°C	Excellent	Excellent
When stable range is reached, advance throttle to desired power setting. Keep temp below 750°C when gens start operating return air start sw to normal. Wait 2 min after generators are operating, return variable nozzle to normal.	Excellent	Poor
Return emerg Fuel sw to "Normal"	Excellent	Poor
RADAR CONTROLS		
Hand Control Operation	Excellent	Good
Radar Set Control Panel	Excellent	Poor
Intensity Controls	Excellent	Poor

Preliminary studies were conducted in the simulator (although not in simulated flight) to determine how much of the restriction was caused by flight equipment other than the T-1 altitude suit. Figures 5 thru 13 show the three equipment groups that were compared. Group A (Figures 5, 6 and 7) consisted of underwear, shoulder harness, lap belt and parachute. Group B (Figures 8, 9 and 10) consisted of the same equipment as group A, plus the T-1 altitude suit and helmet (uninflated). Group C (Figures 11, 12 and 13) consisted of the same equipment as group B, plus the MK-4 exposure suit. These studies are currently being more thoroughly investigated and will be reported in detail later. However this first preliminary test indicates that the major restrictions to mobility within the cockpit are mainly from sources other than the unpressurized altitude suit per se.

Figure 5



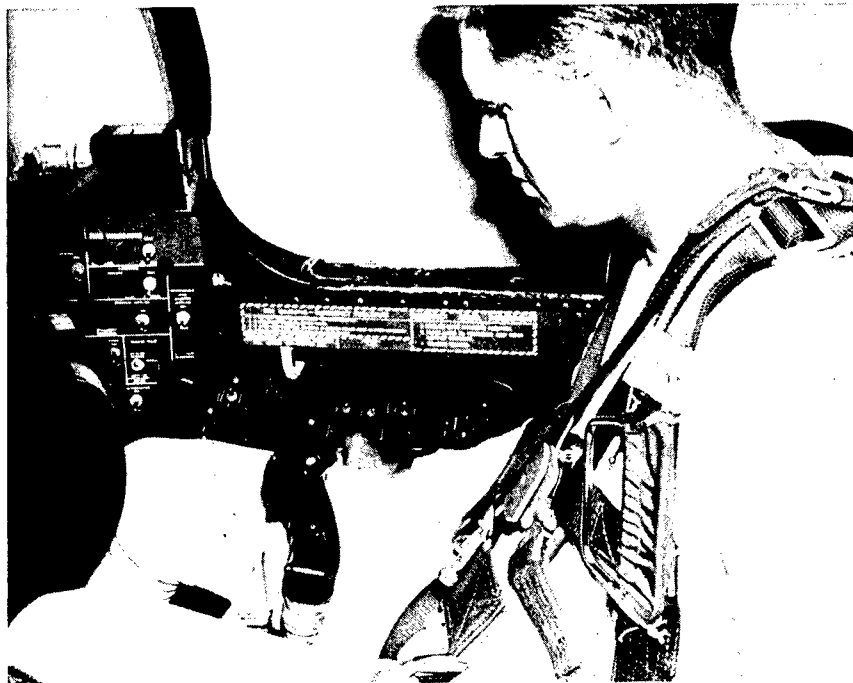
Figure 6

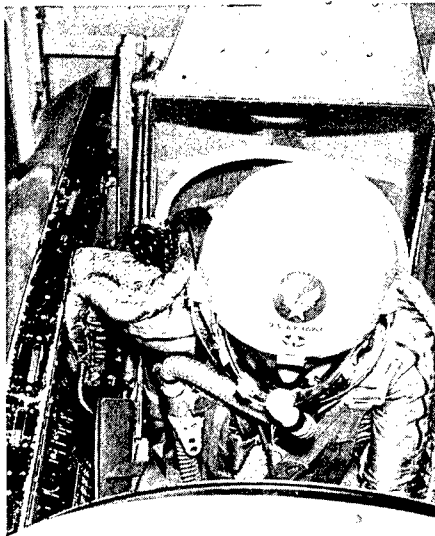


GROUP A EQUIPMENT

Underwear
Shoulder Harness
Lap Belt
Parachute

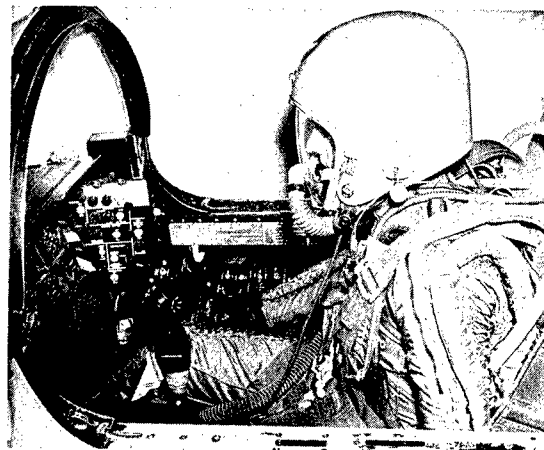
Figure 7





← Figure 8

Figure 9 ↓



GROUP B EQUIPMENT

Underwear
Shoulder Harness
Lap Belt

Parachute
T-1 Altitude Suit
and Helmet (Uninflated)

Figure 10

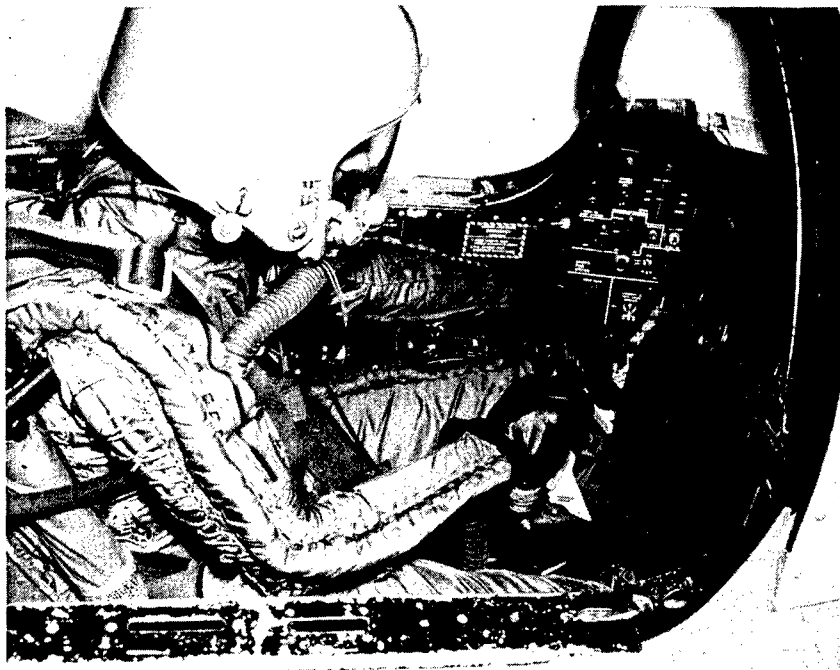
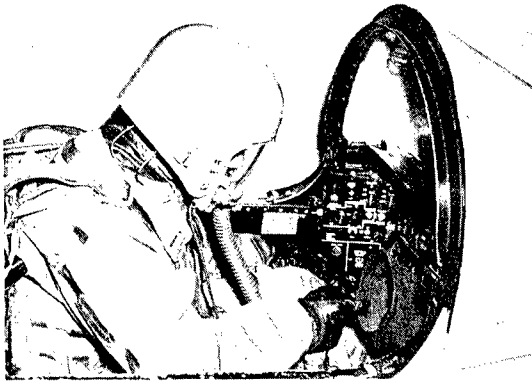


Figure 11

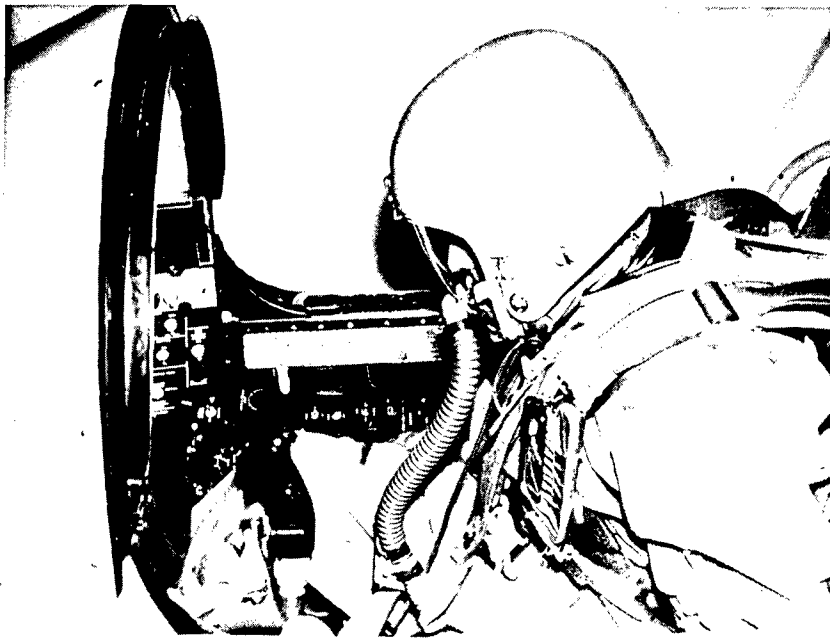
Figure 12



GROUP C EQUIPMENT

Underwear	Parachute
Shoulder Harness	T-1 Altitude Suit
Lap Belt	and Helmet (Uninflated)
MK-4 Exposure Suit	

Figure 13



SUMMARY OF FINDINGS

1. It is possible for a pilot to maintain controlled flight in the F-86 D simulator while wearing the T-1 altitude suit in the pressurized condition.
2. All controls in the F-86 D simulator are accessible with the T-1 altitude suit uninflated. Some controls at the aft ends of the console are impossible to reach with the suit pressurized. Those controls which are impossible to reach while pressurized will not adversely affect emergency descent procedures.
3. It is possible to continue a radar intercept problem while wearing an inflated T-1 altitude suit for periods of time within the limits of the emergency oxygen supply.
4. It was found impossible to release suit pressure, following an inflation because of the inability of the pilot to reach the pressure release valve on the suit connection. (Laboratory models of a relocated relief valve are now undergoing tests.)
5. Installation of equipment necessary for using the T-1 altitude suit in F-86 D simulators requires no major structural changes to the simulator.
6. When instruction in the use of the T-1 altitude suit or other high altitude suits is desirable in the pilot training program, it will be feasible to incorporate a portion of this training into the simulator program.

CONCLUSIONS

Based on the reported tests it is concluded that:

1. Attempts should be made to increase arm mobility of the suit while in the pressurized condition.
2. That similar studies in other type aircraft simulators be conducted to evaluate the limitations of the T-1 altitude suit with various console controls. Information thus obtained should serve as a guide on future control console lay-outs.
3. That as a part of the future pilot training program, cockpit familiarization with an inflated altitude suit be accomplished in the simulator trainer.

*data
WADP
T-1
5-4*