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Report of Test

USATECOM Project No.s 5-4-3001 and -02

Integrated Engineering Service Test

of an

Interim Defoliant System

Conducted Jointly by the US Army and USAF

Part I - Service Test, USATECOM Project No. 5-4-3001-02

DA Proj. No. IC5436030432

28 May 65

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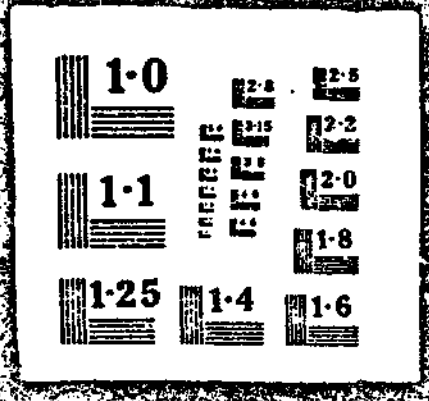
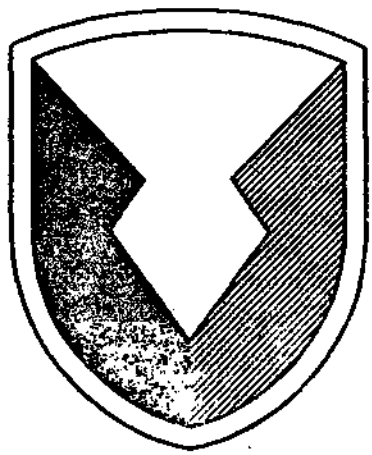


US ARMY TEST & EVALUATION COMMAND



REPORT OF TEST

USATECOM PROJECT NUMBERS 5-4-3001-01 and -02

INTEGRATED ENGINEERING/SERVICE TEST

OF AN

INTERIM DEFOLIANT SYSTEM

CONDUCTED JOINTLY BY THE US ARMY AND US AIR FORCE

PART I - SERVICE TEST, USATECOM PROJECT NO. 5-4-3001-02

DA PROJECT NO. 1C543603D432

28 MAY 1965

U S ARMY

AVIATION TEST BOARD

FORT RUCKER, ALABAMA

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DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY TEST AND EVALUATION COMMAND
Aberdeen Proving Ground, Maryland 21005

AMSTE-NB 17 Jun 1965

SUBJECT: Final Report of ES Test of an Interim Defoliant System Conducted Jointly by U. S. Army and U. S. Air Force, USATECOM Project 5-4-3001-01/02, DA Project 1B543603D432

TO: Commanding General, U. S. Army Materiel Command, ATTN: AMCPM-AI, Washington, D. C. 20315
Commanding General, U. S. Army Combat Developments Command, ATTN: USACDC LnO, USATECOM, Aberdeen Proving Ground, Md. 21005

1. References:

a. Report of Test Project 5-4-3001-01/02, ES Test of Interim Defoliant System, Conducted Jointly by U. S. Army and U. S. Air Force Part I, Service Test, USATECOM Project 5-4-3001-02, 28 May 1965, U. S. Army Aviation Test Board. (Incl 1).

b. Appendix II to above, classified CONFIDENTIAL. (Incl 2)

c. Final Report of ES Test of Interim Defoliant System Conducted Jointly by U. S. Army and U. S. Air Force, Part II, Physical and Climatic Tests, USATECOM Project 5-4-3001-01, May 1965, Dugway Proving Ground. (Incl 3)

d. Final Report of ES Test of Interim Defoliant System Conducted Jointly by U. S. Army and U. S. Air Force, Part III, Dissemination Tests, May 1965, Dugway Proving Ground, classified CONFIDENTIAL. (Incl 4)

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AMSTE-NB 17 Jun 1965

SUBJECT: Final Report of ES Test of an Interim Defoliant System Conducted Jointly by U. S. Army and U. S. Air Force, USATECOM Project 5-4-3001-01/02, DA Project 1B543603D432

2. The final report consisting of three parts, reference 1, has been reviewed by this Headquarters and the USATECOM evaluation of the Interim Defoliant System is as stated in the following paragraphs.

3. Tanks were filled using gravity flow from 55 gallon drums in the absence of standard filling equipment. It is not expected that the use of hand pump (FSN 4930-255-9132) will create any problems.

4. Standardized ground equipment of the type necessary for handling and mounting the spray tank did not exist in the Army inventory at the time of this ES test.

5. The maintenance package, which consisted of Review Manuscripts MP 3-1040-240-12 and -20P, was evaluated and considered unsuitable. The system was not operated long enough to give adequate data for determination of the spare parts list requirements.

6. Two (2) deficiencies were found during engineering and service tests, as follows:

a. Rupture of forward coupling hose during a high internal pressure condition.

b. Rupture of rear coupling hose during a high internal pressure condition.

Corrective modifications were incorporated into the systems prior to their delivery to U. S. Air Force for the service test.

7. The system, as tested, complied with the operational characteristics of the approved SDR, except for reliability.

8. The modifications incorporated in the Defoliant Systems delivered to the U. S. Air Force for their service test should correct the

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deficiencies and shortcomings found in this test. The U.S. Air Force testing should be monitored closely to determine the suitability of these corrections and to compile data to complete the maintenance package, to evaluate agent transfer equipment and system reliability. The requirement for a confirmatory or check test should be determined after results of U.S. Air Force testing has been evaluated.

9. Conclusions:

a. The interim defeliant system should be suitable for Army use on the armed OV-1C Airplane after the deficiencies and shortcomings have been corrected.

b. The interim defeliant system was found to be compatible with the armed OV-1C Airplane.

c. The flight time alloted for the service and dissemination tests was insufficient to determine adequately the reliability and life of the system and to compile an adequate spare parts list.

10. It is recommended that:

a. Provided that the reliability requirement is achieved, the interim defeliant system, modified to correct the deficiencies and shortcomings, be considered suitable for Army use on the armed OV-1C Airplane.

b. The results of the U.S. Air Force serivce test of the modified system be reviewed to determine any requirement for further Army testing.

c. The Review Manuscripts MP 3-1040-240-12 and -20P should be revised prior to production procurement of the interim defoliant system.

FOR THE COMMANDER:

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DEPARTMENT OF THE ARMY
UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36362

REPORT OF TEST

USATECOM PROJECT NUMBERS 5-4-3001-01 and -02

INTEGRATED ENGINEERING/SERVICE TEST

OF AN

INTERIM DEFOLIANT SYSTEM

CONDUCTED JOINTLY BY THE US ARMY AND US AIR FORCE

PART I - SERVICE TEST, USATECOM PROJECT NO. 5-4-3001-02

DA PROJECT NO. 1C543603D432

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RAYMOND E. JOHNSON
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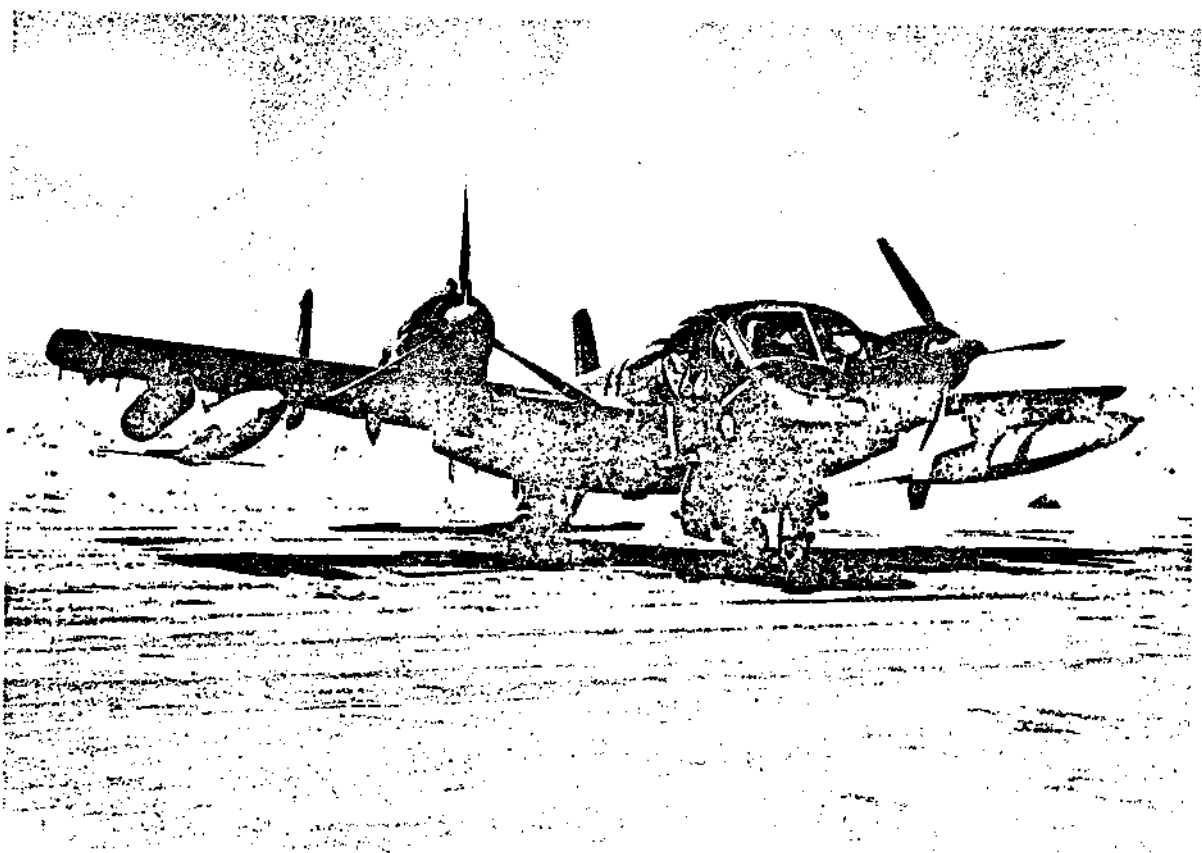

ABSTRACT

This report on the Integrated Engineering/Service Test of the Interim Defoliant System consists of three parts. Dugway Proving Ground is responsible for the Physical Test and the Dissemination Test, and reports of these tests will be submitted later. The Service Test of the Interim Defoliant System on the armed OV-1C was conducted by the USAAVNTBD at Dugway Proving Ground, Utah, during the period 14 September through 6 October 1964. Two deficiencies and three shortcomings were found during this test. It was concluded that the interim defoliant system should be suitable for Army use after correction of the deficiencies and shortcomings, that the system was compatible with the armed OV-1C Airplane, that the Review Manuscripts MP 3-1040-240-12 and -20P should be revised prior to production procurement of the system, and that the time allotted for test was insufficient to compile an adequate spare parts list. It was recommended that the interim defoliant system be considered suitable for Army use on the armed OV-1C when the deficiencies and shortcomings are corrected and that the results of the US Air Force service test be reviewed to determine any requirement for further Army testing.

DEPARTMENT OF THE ARMY
UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36362

REPORT OF TEST

PART I - SERVICE TEST

OF AN

INTERIM DEFOLIANT SYSTEM

Table of Contents

Table of Contents (Continued)

SECTION 1 - GENERAL

1.1. REFERENCES.

a. Letter, STEDP-CB, Headquarters, Dugway Proving Ground, 20 February 1964, subject: "Dugway Proving Ground Test Plan (DPGTP) C 432, Integrated Engineering/Service Test of an Interim Defoliant System Conducted Jointly by the US Army and US Air Force, USATECOM Project No. 5-4-3001-01 and -02," with one inclosure.

b. Letter, AMSTE-NBC, Headquarters, US Army Test and Evaluation Command, 30 March 1964, subject: "Test Directive, USATECOM Project No. 5-4-3001-03, ED Test of Interim Defoliant System for OV-1 Mohawk," with two inclosures.

c. Letter, CDCMR-U, Headquarters, US Army Combat Developments Command, 4 May 1964, subject: "Department of the Army (DA) Approved Small Development Requirement (SDR) for an Interim Defoliant System," with one inclosure.

d. Letter, AMCRD-SR, Headquarters, US Army Materiel Command, 25 May 1964, subject: "Department of the Army (DA) Approved Small Development Requirement (SDR) for an Interim Defoliant System."

e. Letter, AMSTE-NBC, Headquarters, US Army Test and Evaluation Command, 19 June 1964, subject: "Engineering/Service Test of Interim Defoliant System, USATECOM Project No. 5-4-3001-00."

f. Review Manuscript, MP 3-1040-240-12, "Operator and Organizational Maintenance Manual, Spray Tank, Biological, Airplane, E44 (End Item Code 958)," Department of the Army, June 1964, as corrected 8 September 1964.

g. Summary Report 64-10, "Automatic Spot Counter and Sizer," Dugway Proving Ground, July 1964.

h. Letter, BUWEPS RAAD-131/14: CMM, 31 August 1964, subject: "Model OV-1 Aircraft - Recommended Flight Operating Limitations (Armament Aircraft); Revision to."

i. Review Manuscript, MP 3-1040-240-20P, "Organizational Maintenance Repair Parts and Special Tools Lists for Spray Tank, Biological, Airplane, E44, (FSN_____), (End Item Code 958)," Department of the Army.

1.2. AUTHORITY.

1.2.1. Directive.

Letter, AMSTE-BG, Headquarters, US Army Test and Evaluation Command, 10 December 1963, subject: "Directive for Conducting an Integrated Engineering/Service Test of an Interim Defoliant System for the OV-1 (Mohawk) Aircraft Jointly with the US Air Force, USATECOM Project No. 5-4-3001-00," as amended 30 January 1964.

1.2.2. Purpose.

To determine the suitability of the interim defoliant system on the OV-1 (Mohawk) for the purpose of recommending type classification.

1.3. TEST OBJECTIVES.

1.3.1. Primary.

To determine whether the performance, reliability, maintenance requirements, and suitability of the Army Interim Defoliant System for the OV-1 (Mohawk) Aircraft meet the SDR.

1.3.2. Secondary.

1.3.2.1. To determine whether the interim defoliant system will interfere with the defensive capability of the OV-1 armed with machine guns and rocket subsystems and whether the use of such systems will adversely affect the spray tanks.

1.3.2.2. To obtain data for prediction of contamination densities and area coverages for a variety of release heights and wind velocities.

1.4. RESPONSIBILITIES.

1.4.1. Dugway Proving Ground.

Dugway Proving Ground was responsible for:

1.4.1.1. Consolidating and coordinating the plan of test.

1.4.1.2. Providing support for the Service Test accomplished at Dugway Proving Ground.

1.4.1.3. Conducting the Physical and Dissemination Tests.

1.4.1.4. Providing a representative to monitor the Climatic Test conducted by the US Air Force for the US Army.

1.4.1.5. Providing USATECOM with part II, Physical Test (to include US Air Force Climatic Test) and part III, Dissemination Test, of the report of test.

1.4.2. US Army Aviation Test Board (USAAVNTBD).

The USAAVNTBD was responsible for:

1.4.2.1. Providing support for, and participating in, the Dissemination Test accomplished at Dugway Proving Ground, Utah.

1.4.2.2. Conducting the Service Test.

1.4.2.3. Providing USATECOM with part I, Service Test, of the report of test.

1.4.3. US Army Biological Laboratories.

The US Army Biological Laboratories were responsible for providing the defoliant system for all tests.

1.5. DESCRIPTION OF MATERIEL.

The defoliant system consists of two E-44 biological spray tanks designed to spray chemical agents from an airplane fitted for external wing stores. The system was installed on an armed OV-1C Airplane. A detailed description is contained in appendix IV.

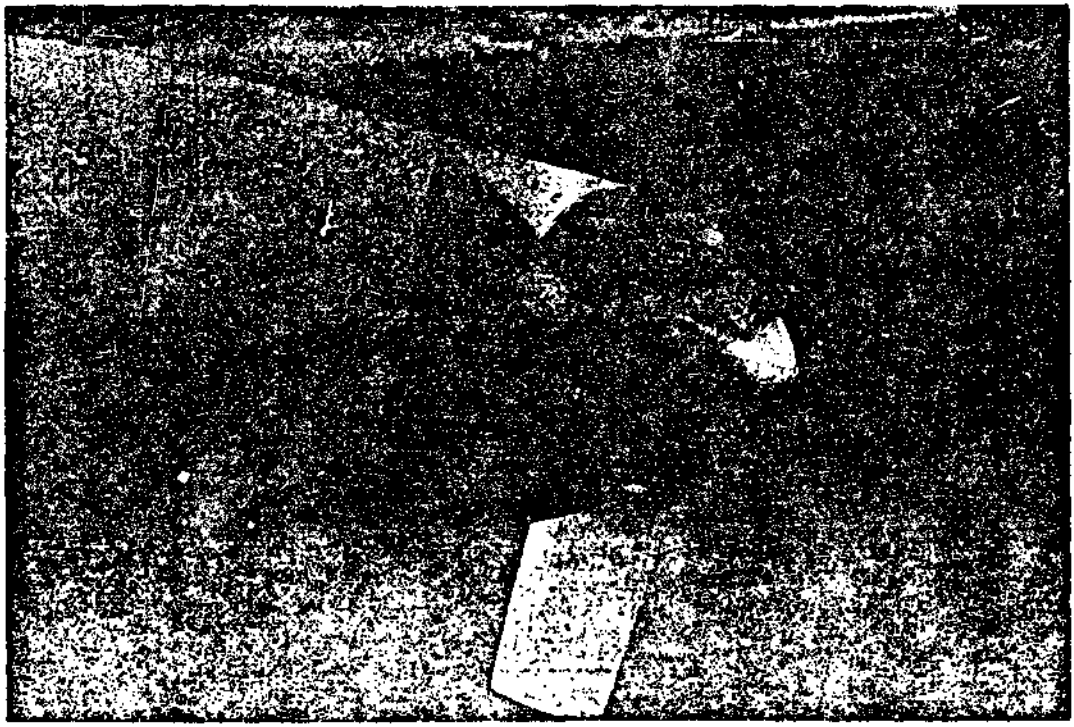

Figure 1. Nose-cone section with four-bladed ram-air drive turbine.

1.5.1. Tank.

The tanks are modified Aero 1C 150-gallon auxiliary fuel tanks. The nose-cone section contains a variable pitch, four-bladed, ram-air drive turbine which is coupled directly to a centrifugal pump (figures 1 and 2). The pump provides the pressure necessary to disseminate the agent at a rate up to 350 gallons per minute. The nose-cone section was protected by an aluminum bulkhead which reduced the tank capacity to 134 gallons. On the armed OV-1C Airplane,

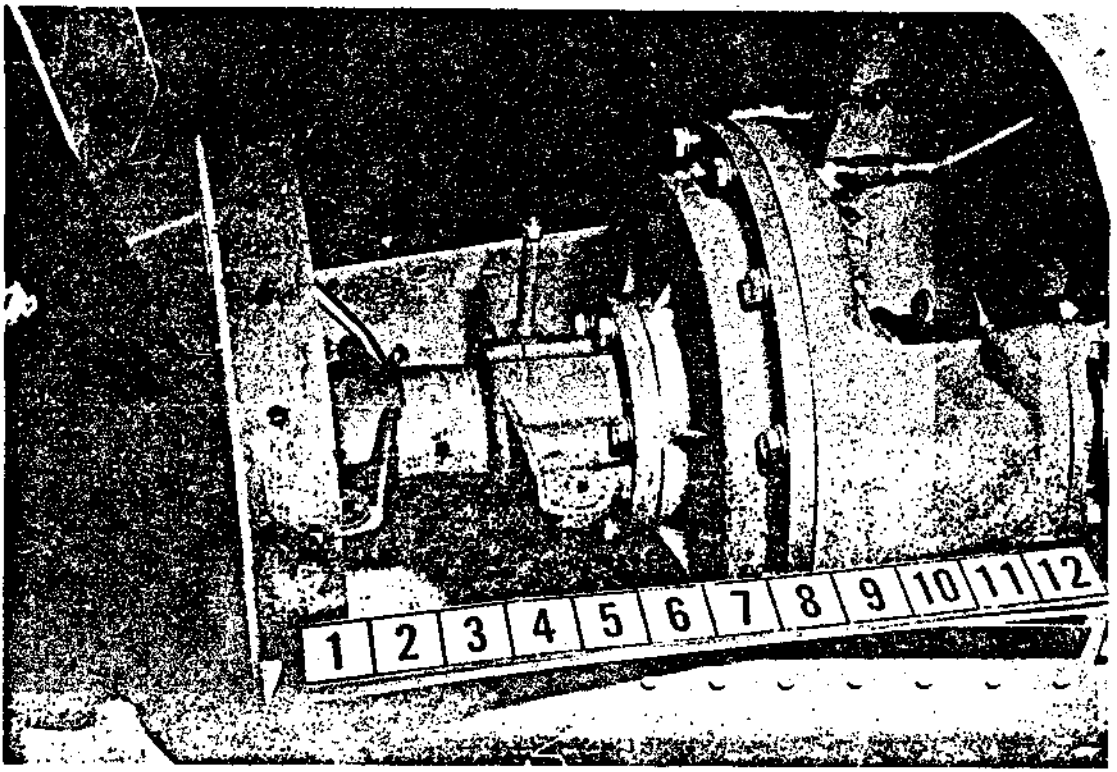

Figure 2. Nose-cone section with upper cowling removed.

the tank was further limited to a capacity of 80 gallons of agent by the store-station weight limitations. The tail section houses a motor-operated gate valve which controls the fluid flow from the chemical transfer line (pump output) to a spray boom horizontally mounted on the rear of the tank. (See figure 3.) The spray boom has 32 tapped outlets which accommodate the number of nozzles for the desired dissemination rate (figures 4 and 5).

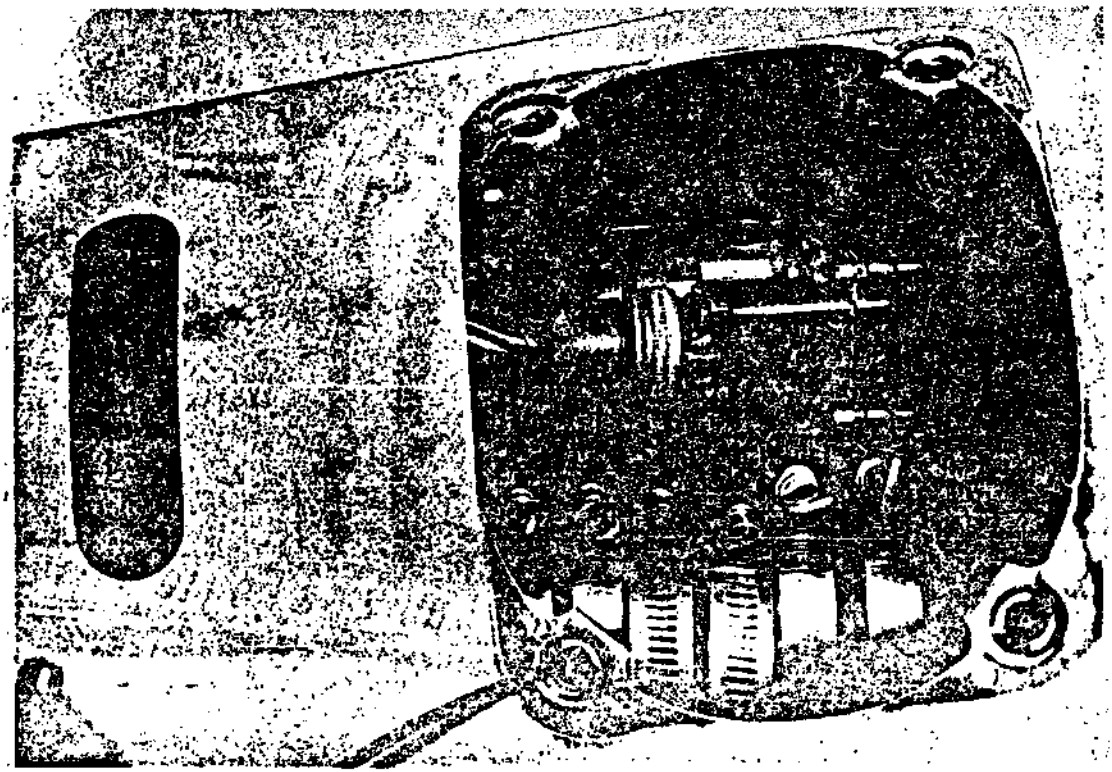

Figure 3. Tail section with inspection plate removed showing motor-operated gate valve.

1.5.2. Agent.

The defoliant agent used during testing consisted of a 50/50 mixture of LNA and LNB called "Orange" (Chemical Corps purchase description: 198-2-47EA, Herbicide Mixture, Orange). The agent was dyed with six grams of Dupont Oil Red (C.I. 258) per liter of agent for test purposes.

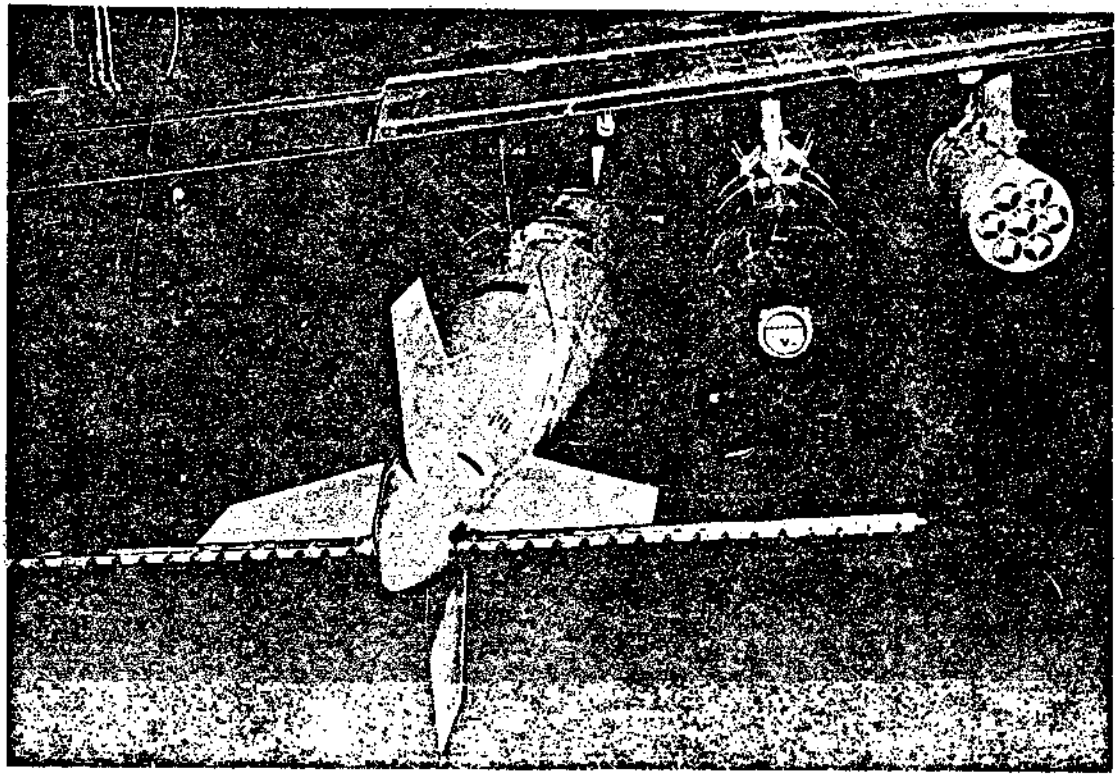

Figure 4. Rear view of the interim defoliant system installed on wing station No. 4, showing the spray boom with 32 nozzles installed. An LAU 32/A 2.75-inch FFAR pod is mounted on wing station 6 with the XM-14 50-caliber machine-gun pod on wing station 5.

1.5.3. Controls.

The gate valve and turbine brake are electrically controlled from the armament panel in the cockpit, utilizing the 28-volt d.c. electrical system.

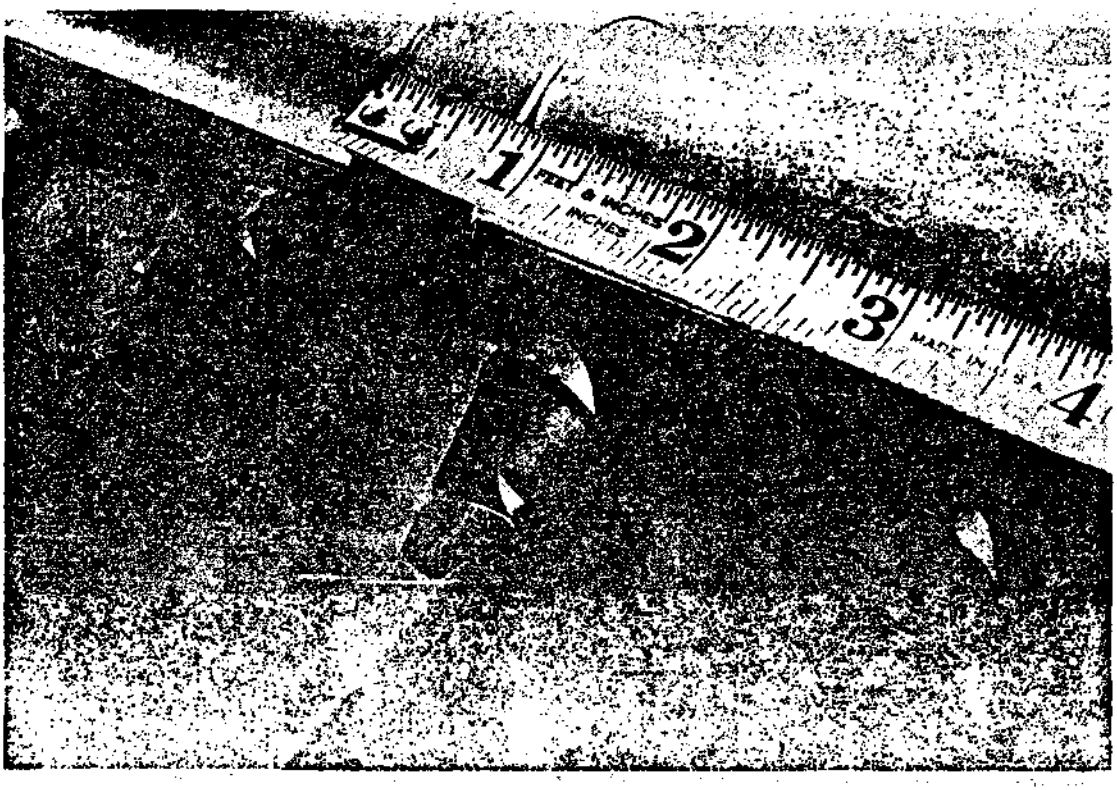

Figure 5. Close-up view of spray boom nozzles.

1.6. BACKGROUND.

1.6.1. The requirement for the defoliant system is contained in subparagraph 129d(4), appendix E, of the Combat Developments Objectives Guide.

1.6.2. The US Army Biological Laboratories were the prime contractor for developing the defoliant system for use by both the US Army and US Air Force.

1.6.3. The defoliant system was given a safety-of-flight release on 31 August 1964 (reference h).

1.6.4. A coordination meeting of all participating agencies was held at Dugway Proving Ground, Utah, on 23 March 1965. The following resulted:

1.6.4.1. The USATECOM representative authorized:

a. Submission of a three-part report of test instead of one integrated report. Part I, the Service Test report, contains a complete "Section I - General" (including findings, conclusions, and recommendations of all the parts of test), and is the responsibility of the USAAVNTBD. Part II, the Physical Test, includes the Climatic Test conducted by the US Air Force. Part III is the Dissemination Test. Dugway Proving Ground is responsible for parts II and III and will submit these parts directly to USATECOM.

b. Use of pertinent data from the US Air Force test with the modified tanks to evaluate the maintenance package and refilling procedures. If possible, previous Dissemination Test data based on prediction will be confirmed.

1.6.4.2. Suitability of the maintenance and refilling data obtained from the US Air Force service test on the modified tanks will determine the requirement for a check test. Two tanks will be modified and made available for a check test if required.

1.7. FINDINGS.

1.7.1. General.

1.7.1.1. The system was installed on the armed OV-1C Airplane with adequate clearances and without exceeding center-of-gravity (c.g.) limits in any configuration. Initial installation and system check-out including filling time required 7.72 man-hours. (Tanks were filled after being mounted on the aircraft.) The only reconfiguration of the airplane was disconnecting the electrical cannon plugs for the Aero 65 racks on wing stations 3 and 4. The spray tank wiring was connected directly into the wing outlet located in the pylon; therefore, only manual jettison was possible.

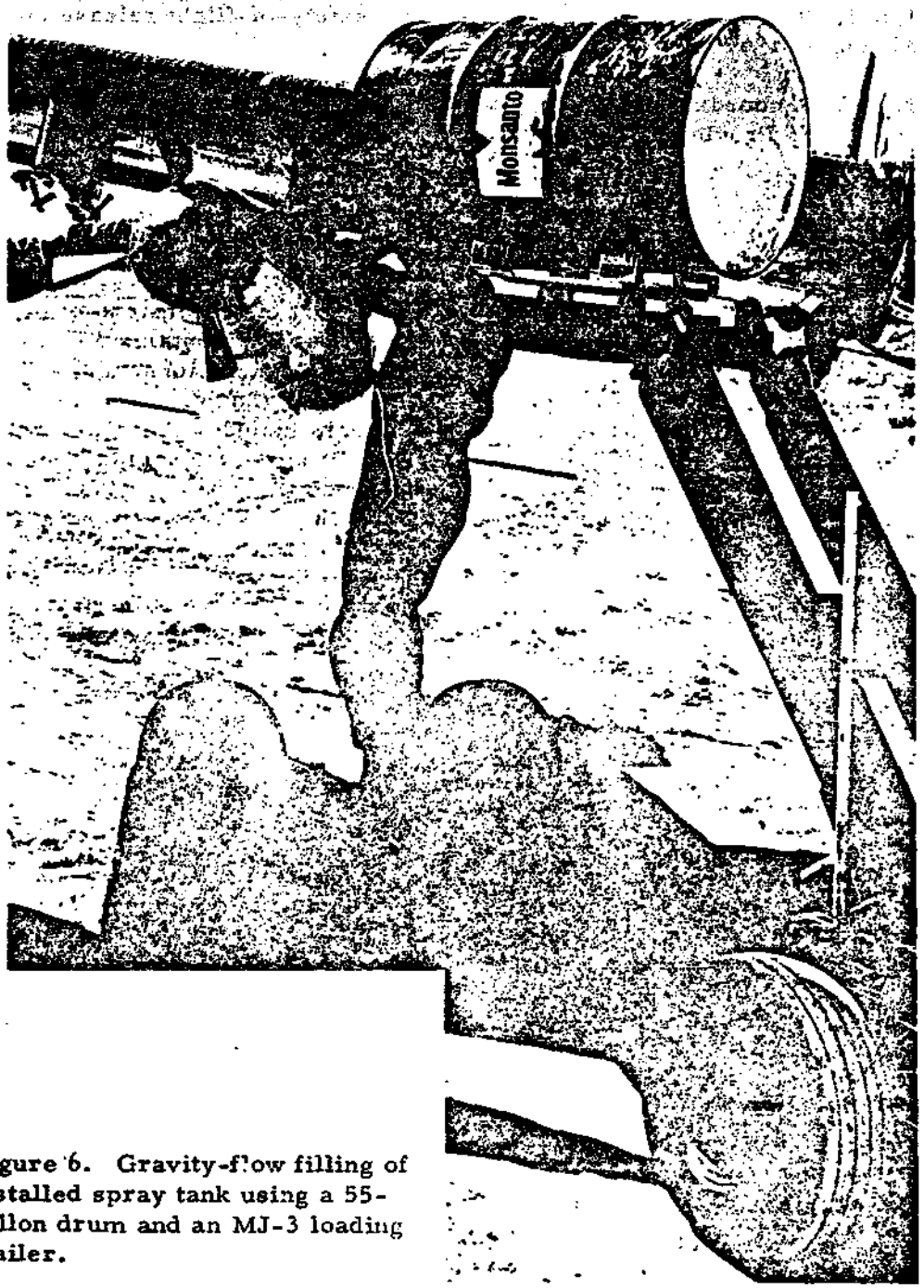

Figure 6. Gravity-flow filling of installed spray tank using a 55-gallon drum and an MJ-3 loading trailer.

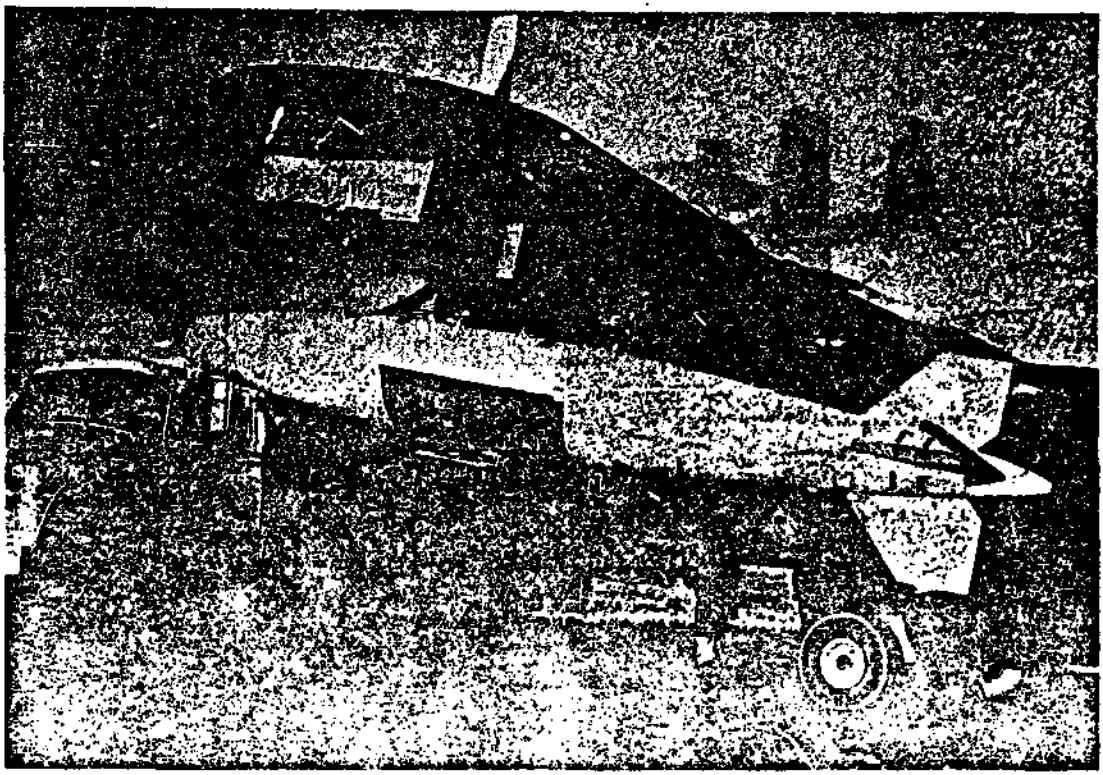

Figure 7. The MJ-3 loading trailer with load spreader supporting a spray tank in position.

1.7.1.2. Gravity-flow filling of the system (used to fill tanks mounted on the airplane) required 1.5 man-hours. No special transfer equipment was provided. Equipment used was a 55-gallon drum with attached nozzle (figure 6). A simpler and faster method of filling the tank is needed. No difficulty was encountered in filling the tank when external stores were carried on wing stations 1, 2, 5, and 6.

1.7.1.3. The use of MJ-3 loading trailers which incorporate a lift platform expedited mounting and filling operations (figure 7). The only other ground-handling equipment utilized was a utility transport

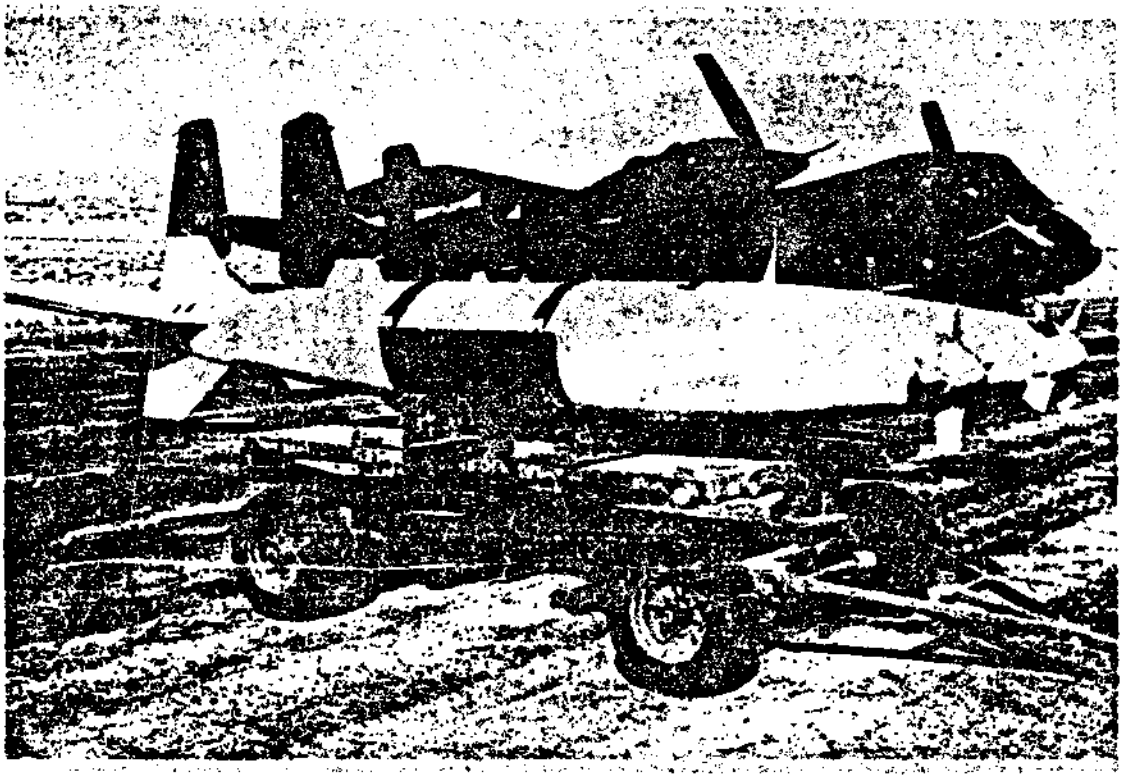

Figure 8. Utility transport trailer with two spray tanks installed.

trailer (figure 8) capable of carrying two full tanks. This equipment is not Army standard. Mounting empty tanks on the wing stations and then filling them with agent was faster and safer than mounting full tanks.

1.7.1.4. The tank and packaging were not damaged and had not deteriorated, and the tank was functional after exposure to the following tests (details are contained in part II, Physical Test):

a. High temperature

b. Low temperature

c. Temperature shock

d. Rain

e. Humidity

f. Salt spray

g. Sand and dust

h. Incline impact (except for splitting of cleats in shipping crate)

i. Corner-wise drop

j. Rough road haul

k. Slosh

l. Ground transportation vibration

m. Air transportation vibration (packaging was damaged but the tank was operable)

1.7.1.5. Safety features of the system were considered adequate; however, there was no device to prevent spillage through the overflow tube during ground handling and accelerations. The agent was a mild skin irritant and harmful to macadam surfaces. Spills on a sod field would cause discoloration which could be an undesirable tactical feature as it would invite attention to the area by aircraft.

1.7.1.6. The maintenance package, which consisted of Review Manuscripts MP 3-1040-240-12 and -20P, was evaluated and considered unsuitable. The system was not operated long enough to give adequate data to determine a spare parts list required. No special skills or tools were required for maintenance performed during this test.

1.7.2. Effects of the System on the Airplane Performance.

1.7.2.1. Degradation of airplane performance was minimal. No agent impinged on the airplane surfaces during spraying runs utilizing either maximum or lesser flow rates. All electrical controls in the system operated satisfactorily (see appendix I).

1.7.2.2. Armament firing during spraying was satisfactory. There was no significant effect on the system operation from the firing of machine guns and rockets. When rockets were fired from stations 2 and 5, a thin layer of rocket waste material was deposited on one side of the spray boom. Also, a fin-retainer button released when the rockets fired made a small dent in the spray boom. Neither of these impingements affected the operation of the system.

1.7.3. Dissemination Performance. (See part III, Dissemination Test, for details.)

1.7.3.1. The maximum flow rate of the system was approximately 700 gallons per minute. Lower flow rates were obtained by decreasing the number of spray nozzles prior to takeoff.

1.7.3.2. During 200-knot spraying runs utilizing the maximum flow rate, the system produced a particle-size distribution having a mass medium diameter of 250 to 300 microns.

1.7.3.3. A deposit rate of three gallons per acre over an area greater than or equal to 20 acres can be attained under most operational conditions.

1.7.4. Deficiencies.

Two deficiencies were found during the Service and Dissemination Tests:

a. Rupture of the forward coupling hose during a high internal pressure condition (figure 9).

b. Rupture of the rear coupling hose during a high internal pressure condition (figure 9).

These deficiencies have been corrected and the modifications incorporated in the systems delivered to the US Air Force for their service test. A complete list of deficiencies and shortcomings is contained in appendix III.

1.7.5. Compliance with the Small Development Requirement (SDR).

The system as tested complied with the operational characteristics of the approved SDR.

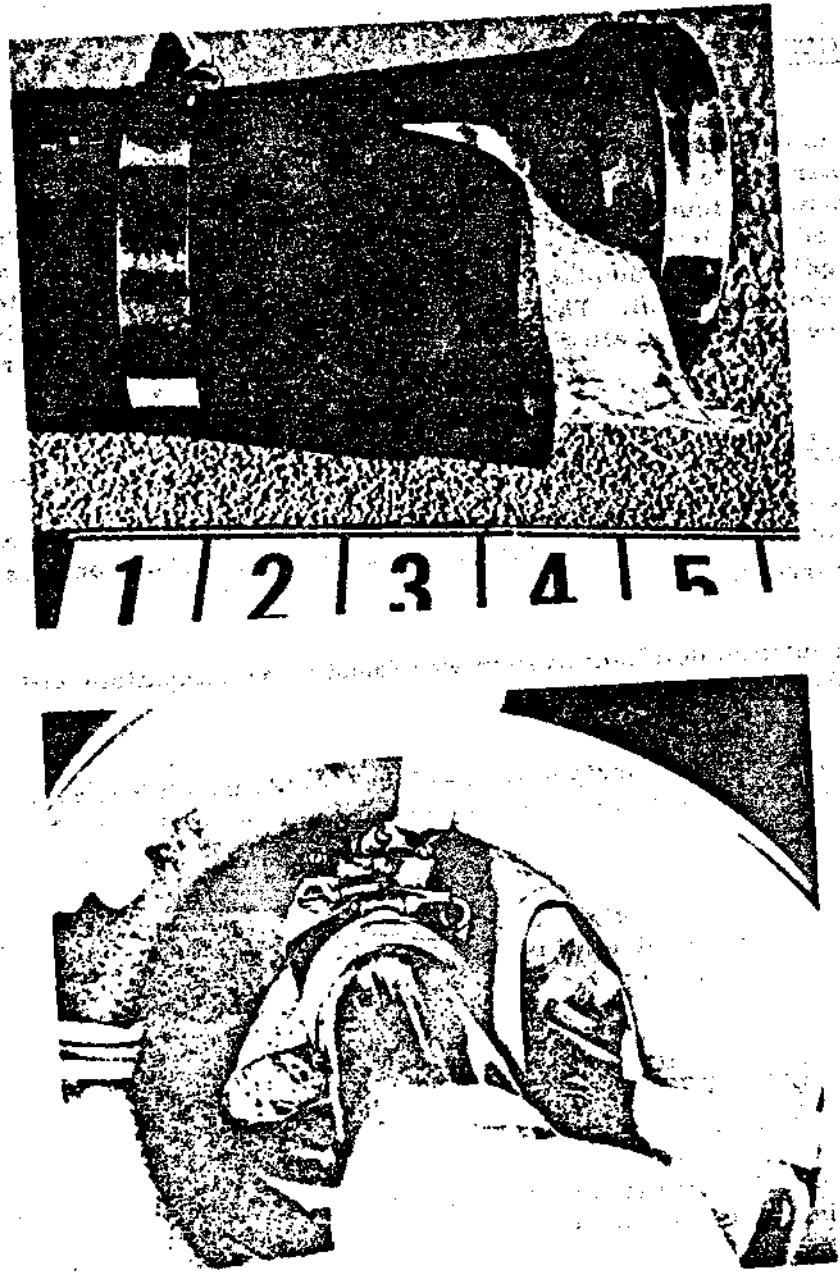

Figure 9. Ruptured forward coupling hose with torn teflon line (above) and ruptured rear coupling hose prior to removal (below).

1.8. DISCUSSION.

The modifications incorporated in the defoliant systems delivered to the US Air Force for their service test should correct the deficiencies and shortcomings found in this test. The US Air Force testing should be monitored closely to determine the suitability of these corrections and to compile data to complete the maintenance package and evaluate agent transfer equipment. The requirement for a confirmatory or check test could be determined after the results of the US Air Force test are evaluated.

1.9. CONCLUSIONS.

1.9.1. The interim defoliant system should be suitable for Army use on the armed OV-1C Airplane after the deficiencies and shortcomings have been corrected.

1.9.2. The interim defoliant system was found to be compatible with the armed OV-1C Airplane.

1.9.3. The Review Manuscripts MP 3-1040-240-12 and -20P should be revised prior to production procurement of the interim defoliant system.

1.9.4. The flight time allotted for the Service and Dissemination Tests was insufficient to determine adequately the life of the system and to compile an adequate spare parts list.

1.10. RECOMMENDATIONS.

It is recommended that:

1.10.1. The interim defoliant system, modified to correct the deficiencies and shortcomings, be considered suitable for Army use on the armed OV-1C Airplane.

1.10.2. The results of the US Air Force service test of the modified system be reviewed to determine any requirement for further Army testing.

SECTION 2

DETAILS AND RESULTS OF SUBTESTS

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SECTION 2 - DETAILS AND RESULTS OF SUBTESTS

2.0. INTRODUCTION.

The service test was conducted at Dugway Proving Ground, Utah, during the period 14 September through 6 October 1964. A total of 13 spraying missions were attempted with the interim defoliant system installed on the armed OV-1C Airplane; ten missions were successfully accomplished.

2.1. INSTALLATION REQUIREMENTS.

2.1.1. Objective.

To determine installation requirements.

2.1.2. Method.

The defoliant system was installed using both empty and full tanks. The time and equipment required to uncrate the system and install it were determined. The tanks were installed using the MJ-3 loading trailers. After a full spray tank was mounted on the Aero 65A rack on one wing, the MJ-3 loading trailer platform was lowered slightly to insure that the rack-mounting lugs had locked. The trailer platform left in this position precluded a high wing condition on the opposite wing and assisted in mounting the second full spray tank.

2.1.3. Results.

2.1.3.1. A total of 6.22 man-hours was required for initial installation and checkout. Time and equipment required for uncrating and initial installation is as follows:

a. Uncrating -

Time: 6 men @ 25 minutes = 2.5 man-hours
Equipment used: MJ-3 loading trailer

b. Installation on aircraft -

(1) First spray tank empty, minus spray boom:

Time: 4 men @ 20 minutes = 1.33 man-hours
Equipment used: MJ-3 loading trailer

(2) Second spray tank empty, minus spray boom:

Time: 4 men @ 16 minutes = 1.06 man-hours
Equipment used: MJ-3 loading trailer

c. Electrical check -

Time: 2 men @ 10 minutes = 0.33 man-hour
Equipment used: Airplane electrical system and armament stores controls

d. Spray boom installation - (two tanks)

Time: 4 men @ 15 minutes = 1.0 man-hour

2.1.3.2. Average time to install defoliant system empty:

Time: 4 men @ 36 minutes = 2.4 man-hours
Equipment used: Two MJ-3 loading trailers

2.1.3.3. Average time to install defoliant system full:

Time: 4 men @ 40 minutes = 2.67 man-hours
Equipment used: Two MJ-3 loading trailers

2.1.3.4. Initial installation and system checkout including filling time required 7.72 man-hours. The only reconfiguration of the airplane was disconnecting the electrical cannon plugs for the Aero 65 racks on wing stations 3 and 4.

2.1.4. Analysis.

Not applicable.

2.2. FLIGHT SAFETY ASPECTS AND DIMENSION DATA.

2.2.1. Objective.

Determine flight safety aspects and dimension data.

2.2.2. Method.

2.2.2.1. Weight and balance were computed for takeoff weight with full internal fuel, a two-man crew, and each spray tank filled to 80

gallons. Landing weight was computed for a 30-minute fuel reserve, two-man crew, and empty spray tanks.

2.2.2.2. Weight and balance were computed for takeoff weight full internal fuel, a two-man crew, the spray tank full (80 gallons each), and two XM-14 machine gun pods and two LAU 32/A rocket pods all with full complements of ammunition. Landing weight was computed for a 30-minute fuel reserve, a two-man crew, empty spray tanks, empty machine gun pods, and empty LAU 32/A pods.

2.2.2.3. The installation was measured to determine applicable dimensions.

2.2.2.4. The system was weighed empty and filled (80 gallons of agent per tank).

2.2.3. Results.

2.2.3.1. Both configurations were within takeoff and landing c.g. and gross-weight limitations. DD Forms 365F are contained in appendix I.

2.2.3.2. Ground clearances were adequate. Clearance from spray tank to ground was 21.75 inches.

2.2.3.3. Clearance from the spray boom and the closest point on the aircraft, the inboard end of the ailerons was 36.0 inches and was adequate.

2.2.3.4. Weight of the defoliant system empty was 443.52 pounds, and weight with 80 gallons of agent per tank was 2149.12 pounds.

2.2.4. Analysis.

Not applicable.

2.3. OPERATIONAL DATA.

2.3.1. Objective.

To determine operational data on the defoliant system with specified flow rates of 700 (normal) and 350 gallons per minute.

2.3.2. Method.

2.3.2.1. The flow rate was set on the ground at 700 gallons per minute. The airplane proceeded along flight path and altitude designated by DPG test officer at a true airspeed of 200 knots. The spray operation was initiated and discontinued over designated points. The test was performed twice.

2.3.2.2. This test was repeated using a flow rate setting of 350 gallons per minute.

2.3.3. Results.

(For dissemination data, see part III, Dissemination Test.)

2.3.3.1. No agent impinged on the aircraft.

2.3.3.2. ON-OFF control was effective; however, after closure of the gate valve, agent remaining in the spray boom was emitted as a fine mist for approximately eight seconds.

2.3.3.3. Degradation of airplane performance was minimal.

2.3.4. Analysis.

Not applicable.

2.4. ROCKET AND MACHINE-GUN FIRING DURING SPRAY OPERATION.

2.4.1. Objective.

To determine the effect that firing of rockets and machine guns has on the defoliant system and its operation.

2.4.2. Method.

2.4.2.1. Test Configuration 1.

With defoliant system tanks mounted on wing stations 3 and 4, LAU 32/A 2.75-inch FFAR pods mounted on wing stations 1 and 6, and XM-14 50-caliber machine-gun pods mounted on wing stations 2

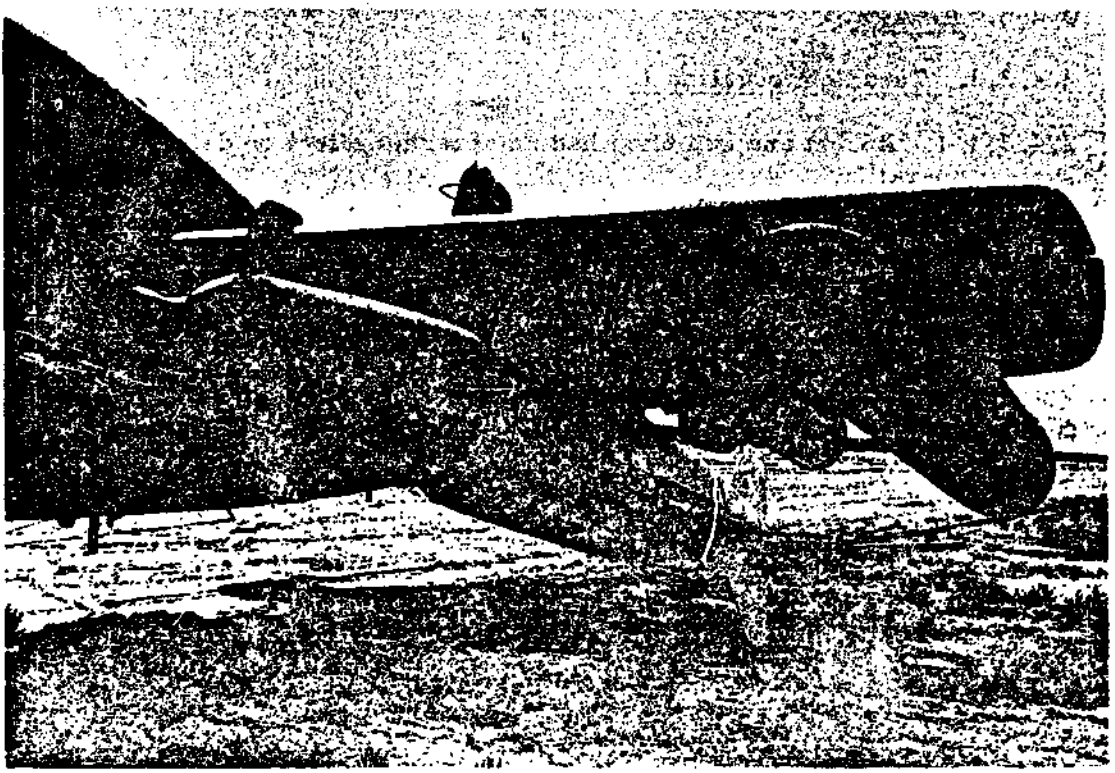

Figure 10. Front view of interim defoliant spray tank mounted on wing station 3, LAU 32/A FFAR pod on wing station 2, and XM-14 50-caliber machine-gun pod on wing station 1.

and 5 (figure 4), delivery of the spray was initiated in the firing range area. Rockets and machine guns were fired during spray delivery.

2.4.2.2. Test Configuration 2.

With defoliant system tanks mounted on wing stations 3 and 4, LAU 32/A 2.75-inch Folding Fin Aerial Rocket (FFAR) pods mounted on wing stations 2 and 5, and XM-14 50-caliber machine-gun pods mounted on wing stations 1 and 6 (figure 10), delivery of the spray was initiated in the firing range area. Rockets and machine guns were fired during spray delivery.

2.4.3. Results.

2.4.3.1. Test Configuration 1.

2.4.3.1.1. Rocket and gun blast had no apparent effect on defoliant system operation.

2.4.3.1.2. Rocket and machine-gun blast had no effect on spray system components. Spent rounds and links ejected downward from the machine-gun pods were well clear of the spray boom.

2.4.3.1.3. No difficulties were encountered in using firing controls while disseminating spray. As the ON-OFF controls for the spray tanks are on the BOMB fuze circuit, the rocket and gun-firing circuits are not affected.

2.4.3.1.4. The spray tanks can be installed and filled with the weapon systems mounted in this configuration.

2.4.3.2. Test Configuration 2.

2.4.3.2.1. Rocket and gun blast had no apparent effect on defoliant system operation.

2.4.3.2.2. Gun blast had no effect on spray system components. Rocket blast deposited a thin layer of waste material on one side of the spray boom. One rocket fin-retainer button dented the forward edge of one side of the spray boom.

2.4.3.2.3. No difficulties were encountered in using firing controls while disseminating spray. As the ON-OFF controls for the spray tanks were on the BOMB fuzing circuit, the rocket and gun-firing circuits were not affected.

2.4.3.2.4. The spray tanks can be installed and filled with the weapon systems mounted in this configuration.

2.4.4. Analysis.

Because of impingement on the spray boom of burned material and the fin-retainer button, continued use of test configuration 2 could have a damaging effect on the spray boom.

2.5. SERVICING REQUIREMENTS.

2.5.1. Objective.

To determine time, equipment, and personnel requirements to fill the spray tanks.

2.5.2. Method.

The tanks were installed full 11 times. Twice the tanks were installed empty and filled on the airplane. The time, equipment, and personnel required for each filling operation were observed and recorded. Ease of filling was evaluated. Scales were used for test purposes and would not be required for tactical employment.

2.5.3. Results.

2.5.3.1. Standard filling equipment was not available with the defoliant system during the period of the Service Test. The filling equipment consists of a hand-driven, dispensing pump (FSN 4930-255-9132). Gravity-flow filling using one MJ-3 loading trailer to elevate the supply drum required three men an average of 30 minutes (1.5 man-hours) to fill two spray tanks mounted on the airplane.

2.5.3.2. A comparison between loading filled tanks (80 gallons) using the MJ-3 loading trailer and filling the tanks when installed on the airplane was made. Time required to load filled tanks averaged 2.67 man-hours. Time required to fill the tanks installed on the airplane averaged 1.5 man-hours.

2.5.3.3. The filled spray tank, loaded on the MJ-3 loading trailer, could be moved around without difficulty on smooth terrain by three men. A minimum of two men was required to move the fully-loaded spray tank on the MJ-3. Three men accomplished this task with more ease and efficiency. The lack of baffles within the tank permitted sloshing during movement; therefore, one man stabilized the filled tank while two pulled the trailer.

2.5.3.4. Using two MJ-3 loading trailers to remove the two spray tanks from the airplane, place on scales for measured filling, pick up, reinstall, and hook up on the airplane required an average elapsed time of 47 minutes. This action was accomplished by four men.

2.5.4. Analysis.

Not applicable.

2.6. EVALUATION OF SAFETY ASPECTS.

2.6.1. Objective.

To determine data for compliance with USATECOM Regulation 385-7, "Safety Confirmation."

2.6.2. Method.

Safety aspects were evaluated during system operation. Effects of the system on aircraft operation were qualitatively evaluated.

2.6.3. Results.

2.6.3.1. Safety features were adequate.

2.6.3.2. The spray tanks were jettisoned safely at Patuxent River, Maryland (reference g, section 1).

2.6.4. Analysis.

Not applicable.

SECTION 3 - APPENDICES

APPENDIX I

TEST DATA

WEIGHT AND BALANCE CLEARANCE FORM F

TACTICAL

(USE REVERSE FOR TRANSPORT MISSIONS)

FOR USE IN T. O. 1-1B-40 & AN 01-1B-40

DATE	AIRPLANE TYPE	FROM	HOME STATION
17 September 1964	OV-1C	Michael AAF	Ft. Rucker, Ala.
MISSION/TRIP/FLIGHT NO.	SERIAL NO.	TO	PILOT
Test	62-5851	Michael AAF	Capt. Kirsch

REMARKS: 2 Defoliant Spray Tanks on Wing Station 185 (3 and 4)

REF	ITEM	WEIGHT	* INDEX OR MOM/
1	BASIC AIRPLANE (From Chart C)	10532	179045
2	OIL (5 Gal.)	38	5.8
3	DISTRIBUTION OF LOAD		

COMPT.	CREW NO.	CREW WEIGHT	BAGGAGE	CARGO AND MISC.		
	2	400			400	24.0
185				2 Tanks	444	73.4

COMPUTER PLATE NO. (If used)

Pertinent instructions to the pilot for shifting load and crew during takeoff and landing should be noted above.

CORRECTIONS (Ref. II)

COMPT.	ITEM	CHANGES (+ or −) WEIGHT	* INDEX OR MOM/
TOTAL WEIGHT REMOVED		−	−
TOTAL WEIGHT ADDED		+	+
NET DIFFERENCE (Ref. II)			

4	OPERATING WEIGHT		11541
5	AMMUNITION	COMPT. / ROUNDS / CALIBER	
6	BOMBS, ROCKETS, ETC. — FORWARD		
	EXTERNAL — next 160 gallons spray		1706
	ROCKETS		
7	FUEL — BUILT IN (297 Gal.)		19301
	BOMB BAY (Gal.)		
	EXTERNAL (Gal.)		
8	WATER INJ. FLUID (Gal.)		
9	JATO OR RATO		
10	TAKEOFF CONDITION (Uncorrected)		
11	CORRECTIONS (If required)		
12	TAKEOFF CONDITION (Corrected)		15150
13	TAKEOFF C. G. IN % M. A. C. (@ M.		159.76
14	LESS EXPENDABLES — JATO OR RATO		
	BOMBS		
	AMMUNITION		
	FUEL		1450
	Spray 160 gallons		1706
15	ESTIMATED LANDING CONDITION		11924
16	ESTIMATED LANDING C. G. IN % M. A. C. (@ M.		164.60

LIMITATIONS

* GROSS WT. TAKEOFF (lb.)	* GROSS WT. LANDING (lb.)
15150	11994

	FROM	TO
* PERMISSIBLE C. G. TAKEOFF	156.36	167.14
* PERMISSIBLE C. G. LANDING	156.36	167.14

COMPUTED BY (Signature) /s/ F. J. Kirsch

WEIGHT AND BALANCE AUTHORITY (Signature)

PILOT (Signature)

* Enter constant used.
* Enter values from current applicable T. O.
* Applicable to gross weight (Ref. 13).
* Applicable to gross weight (Ref. 15).

DD FORM 1 SEPT 54 365F

WEIGHT AND BALANCE CLEARANCE FORM F

TACTICAL

(USE REVERSE FOR TRANSPORT MISSIONS)

FOR USE IN T. O. 1-1B-40 & AN 01-1B-40

DATE	AIRPLANE TYPE	FROM	HOME STATION
17 September 1964	JOV-1C	Michael AAF	Ft. Rucker, Ala.
MISSION/TRIP/FLIGHT NO.	**SERIAL NO.**	**TO**	**PILOT**
Test	62-5851	Michael AAF	Capt. Kirsch

REMARKS

2 Defoliant Spray Tanks on Wing Station 185 (3 and 4)

2 XM-14 Caliber .50 Machine Gun Pods on Wing Station 213 (2 and 5)

2 LAU 32/A 2.75" FFAR Rocket Launcher Pods on Wing Station 237 (1 and 6)

REF	ITEM	WEIGHT	* INDEX OR MOM/
1	BASIC AIRPLANE (From Chart C)	106532	179460
2	OIL (5 Gal.)	38	5.3
3	DISTRIBUTION OF LOAD		

COMPT	CREW NO	CREW WEIGHT	BAGGAGE	CARGO AND MISC		
	2	400			400	2.4.0
185				2 Tanks	744	7.3.4
213				2 M.G. Pods	488	5.1.8
237				2 LAU 32/A	811	1.3.5

COMPUTER PLATE NO. (If used)

Pertinent instructions to the pilot for shifting load and crew during takeoff and landing should be noted above.

4	OPERATING WEIGHT	120833	199226
5	AMMUNITION — COMPT. / ROUNDS / CALIBER		
6	BOMBS, ROCKETS, ETC. — FORWARD		
	160 gallons agent	17062	21252
	888 1500 rds. ammo.	4422	7999
	14 2.75" rockets	2522	4215
	EXTERNAL		
	ROCKETS		
7	FUEL — BUILT IN (297 Gal.)	19300	31065
	BOMB BAY (Gal.)		
	EXTERNAL (Gal.)		
8	WATER INJ. FLUID (Gal.)		
9	JATO OR RATO		
10	TAKEOFF CONDITION (Uncorrected)		
11	CORRECTIONS (If required)		
12	TAKEOFF CONDITION (Corrected)	164132	263777
13	TAKEOFF C. G. IN % M. A. C. OR IN.	160.71	
14	LESS EXPENDABLES — JATO OR RATO		
	BOMBS		
	AMMUNITION spray, rockets, 50 cal.	24003	34545
	FUEL	14505	23037
15	ESTIMATED LANDING CONDITION	125624	206196
16	ESTIMATED LANDING C. G. IN % M. A. C. OR IN.	164.73	

CORRECTIONS (Ref. 11)			
COMPT.	ITEM	CHANGES (+ or −) WEIGHT	* INDEX OR MOM/
	TOTAL WEIGHT REMOVED	−	−
	TOTAL WEIGHT ADDED	+	+
	NET DIFFERENCE (Ref. 11)		

LIMITATIONS		
* GROSS WT. TAKEOFF (lb.) 16413	* GROSS WT. LANDING (lb.) 12563	
* PERMISSIBLE C. G. TAKEOFF	FROM 156.36	TO (Forward Limit) (Aft) 167.14
* PERMISSIBLE C. G. LANDING	FROM 156.36	TO (Forward Limit) (Aft) 167.14

COMPUTED BY (Signature) /s/ F. J. Kirsch

WEIGHT AND BALANCE AUTHORITY (Signature)

PILOT (Signature)

* *Enter constant used.*
* *Enter values from current applicable T. O.*
* *Applicable to gross weight (Ref. 12).*
* *Applicable to gross weight (Ref. 15).*

DD FORM 1 SEPT 54 365F

(30)

APPENDIX II

COMPARISON WITH THE SDR

(Classified CONFIDENTIAL; Presented Under Separate Cover)

APPENDIX III

DEFICIENCIES AND SHORTCOMINGS

A. Deficiencies. The following deficiencies were found during the Service and Dissemination Tests:

Deficiency	Suggested Corrective Action	Remarks
1. The forward coupling hose (centrifugal pump to transfer line) ruptured during a 700-gallon-per-minute-dissemination and rocket firing run at approximately 200 knots true airspeed.	Replace with hose which can withstand high pressures generated during spraying.	This suggested modification has been included in the tanks sent to the USAF.
2. The rear coupling hose (gate valve to spray boom) ruptured during 350-gallon-per-minute-dissemination flight at approximately 200 knots true airspeed.	Replace with hose which can withstand maximum pressures generated during spraying.	This suggested modification has been included in the tanks sent to the USAF.

B. Shortcomings. The following shortcomings were found during the Service and Dissemination Tests:

Shortcoming	Suggested Corrective Action	Remarks
1. Removal of the nose cone upper cowling (a structural member of the nose cone) for inspection and/or maintenance caused the lower	Weld the lower half of the cowling to the tank section.	This suggested modification has been included in the tanks sent to the USAF.

Shortcoming	Suggested Corrective Action	Remarks
half of the cowling to displace downward. The resulting misalignment caused difficulty in reinstalling the upper cowling.		
2. There was no method of preventing agent over-flow after filling the tank to 80 gallons in a level attitude, when the tank was tilted, raised, accelerated, transported or during normal ground handling.	Change to a different method of limiting the tank capacity to 80 gallons.	This suggested modification has been included in the tanks sent to the USAF.
3. Wire to the ram air turbine solenoid control separated in flight.	Exercise better quality control in wiring the turbine controls.	The wire was too short and was under tension.
4. The cleats split in the bottom of the shipping crate.	Provide shock-resistant cleats and fastenings for Level-A packaging of the item.	

APPENDIX IV

DETAILED DESCRIPTION OF MATERIEL

1. General.

The defoliant system consists of two F-44 biological spray tanks. The spray tank is a modified Aero 1 .50-gallon auxiliary fuel tank. The capacity was limited to 80 gallons of agent by an overflow stand pipe. The system is operated by the 28-volt d.c. electrical system controlled from the armament panel in the cockpit. The spray unit develops pressure for spraying by means of a centrifugal pump, directly coupled to a variable pitch, four-bladed, ram-air drive turbine. The centrifugal pump transfers fluids from the main tank section through a suction line, and forces the fluids at high pressure through the transfer line to a gate valve control, to the spray boom.

2. Major Components.

The spray tank consists of three major components; the nose-cone section, tank section, and tail section.

a. Nose-Cone Section.

The nose-cone section contains the variable pitch, four-bladed, ram-air drive turbine which is mounted on a support plate. The ram-air drive turbine is directly coupled to the centrifugal pump. The centrifugal pump is connected to the suction line transfer lines by two teflon-lined rubber hoses. Electrical wiring is introduced into the nose-cone section through a conduit line. Access to the nose-cone section is accomplished by removal of the upper cowl.

b. Tank Section.

This section contains the suction line and a check valve to keep the pump primed during intermittent operation. This section also contains the transfer line and an electrical conduit through the tank body. Drainage is provided by a drain plug on the bottom of the tank. Two access plates are provided on the left mid-section of the tank to accomplish maintenance and inspection of the fluid storage area. Suspension lugs with 14-inch spacing are provided. A cable with a quick-disconnect fitting on the tank end provides for electrical control

from the airplane. An attached lanyard on the quick-disconnect fitting allows emergency separation if the spray tank is jettisoned.

c. Tail Section.

The tail section houses an electric-motor-operated gate valve which controls the fluid flow from the transfer line to the spray boom. The spray boom is connected to the gate valve by a teflon-lined hose. The spray boom is attached to the horizontal fins with six mounting clamps. An access door is provided for maintenance and inspection of the aft section. A modified Aero 1C tail cone fairing fits over the spray boom.

3. Details of Operating Components and Operation.

The ram-air drive turbine incorporates a solenoid-operated brake. In the de-energized state, the ram-air drive turbine is in a braked condition with the propellers feathered. When the solenoid is energized, the propellers unfeather and rotate in a counter-clockwise direction until the ram-air drive is in the governed range of 3600 to 4000 r.p.m. at 200 knots. The ram-air drive is directly coupled to the centrifugal pump and at a drive speed of 3800 r.p.m., the pump is capable of delivering 300 gallons per minute, depending on the number of nozzles selected for the spray boom. The slide-terminating motor-operated gate valve is controlled by a stepping solenoid. Controls for operation are on the BOMB fuze circuit on the armament panel in the cockpit. The TAIL position of the BOMB fuze circuit energizes the ram-air drive brake solenoid only, and the NOSE and TAIL position energize the ram-air drive brake solenoid, the gate valve stepping solenoid, and the gate valve motor. After the desired airspeed is attained, the armament circuit breakers are pushed in, armament power is switched on, and the BOMB fuze switch is placed in TAIL position. To begin spraying, the BOMB fuze switch is moved through the SAFE position to the NOSE and TAIL position, which opens the gate valve. The switch is then returned to the TAIL position. To terminate the spraying operation, the switch is again moved to the NOSE and TAIL position, which permits the gate valve to close. The switch is then placed in the SAFE position.

4. Weights and Measurements of the Defoliant Tank.

a. Capacity: 80 gallons

b. Weight:	Empty	221.76 pounds
	Full	1074.56 pounds
c. Overall Length:		166.10 inches
d. Diameter:		21.16 inches (maximum)
e. Center of Gravity:	Empty	77.50 inches
	Full	79.18 inches
f. Spray Boom: Length		73.0 inches
Number of orifices: 32		

APPENDIX V

COORDINATION

The following agencies participated in the review of the final report:

US Army Aviation School

US Army Combat Developments Command Aviation Agency

AD_____Accession No._____

US Army Aviation Test Board, Fort Rucker, Alabama. Report of USATECOM Project No. 5-4-3001-02, Part I - Service Test, of USATECOM Project Numbers 5-4-3001-01 and -02, Integrated Engineering/Service Test of an Interim Defoliant System conducted jointly by the US Army and US Air Force. DA Project No. 1C543603D432, 28 May 1965. 36 pages, 12 Illus. The US Army Aviation Test Board conducted the service test of the Interim Defoliant System on the armed OV-1C Airplane at Dugway Proving Ground, Utah, during the period 14 September through 6 October 1964. Two deficiencies and three shortcomings were found during this test. It was concluded that the interim defoliant system should be suitable for Army use after correction of the deficiencies and shortcomings, that the system was compatible with the armed OV-1C Airplane, that the Review Manuscript MP 3-1040-240-12 and -20P should be revised prior to production procurement of the system, and that the time allotted for test was insufficient to compile an adequate spare parts list. It was recommended that the interim defoliant system be considered suitable for Army use on the armed OV-1C when the deficiencies and shortcomings are corrected and that the results of the US Air Force service test be reviewed to determine any requirement for further Army testing.

AD_____Accession No._____

US Army Aviation Test Board, Fort Rucker, Alabama. Report of USATECOM Project No. 5-4-3001-02, Part I - Service Test, of USATECOM Project Numbers 5-4-3001-01 and -02, Integrated Engineering/Service Test of an Interim Defoliant System conducted jointly by the US Army and US Air Force. DA Project No. 1C543603D432, 28 May 1965. 36 pages, 12 Illus. The US Army Aviation Test Board conducted the service test of the Interim Defoliant System on the armed OV-1C Airplane at Dugway Proving Ground, Utah, during the period 14 September through 6 October 1964. Two deficiencies and three shortcomings were found during this test. It was concluded that the interim defoliant system should be suitable for Army use after correction of the deficiencies and shortcomings, that the system was compatible with the armed OV-1C Airplane, that the Review Manuscript MP 3-1040-240-12 and -20P should be revised prior to production procurement of the system, and that the time allotted for test was insufficient to compile an adequate spare parts list. It was recommended that the interim defoliant system be considered suitable for Army use on the armed OV-1C when the deficiencies and shortcomings are corrected and that the results of the US Air Force service test be reviewed to determine any requirement for further Army testing.

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