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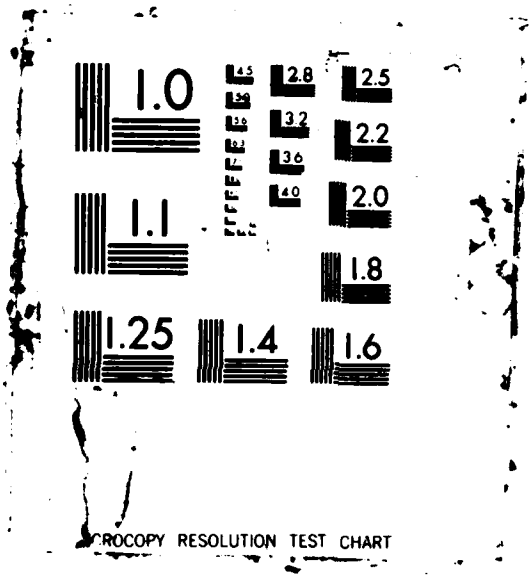
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AD-A179 263

BIRD IMPACT QUALIFICATION TEST FOR A-10 WINDSHIELD

T. L. Buchanan
Calspan Corporation/AEDC Division

April 1987

Final Report for December 9, 1986

ARNOLD ENGINEERING DEVELOPMENT CENTER
ARNOLD AIR FORCE STATION, TENNESSEE
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

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APPROVAL STATEMENT

This report has been reviewed and approved.

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One shot was made on the A-10's left side windshield for this program. The objective of this shot was to qualify the windshield. The shot was at a nominal velocity of 360 knots using a 4-lb bird. Descriptions of the test facility, test articles, and test procedures are presented.

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11. TITLE

Bird Impact Qualification Test for A-10 Windshield

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Table

1.0 INTRODUCTION

The work reported herein was performed by the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC), under Program Element 921A4D, Control Number 9A4D at the request of Sacramento Air Logistic Center (SM-ALC), McClellan Air Force Base, CA. The project manager for the sponsoring agency was Mr. Greg Steuer, SM-ALC/MMIEA. The results were obtained by Calspan Corporation/AEDC Division, operation contractor for the Aerospace Flight Dynamics Testing effort at AEDC, AFSC, Arnold Air Force Station, TN. This test was performed in the Bird Impact Test Unit (Range S-3) in the von Karman Gas Dynamics Facility (VKF) during the period December 9, 1986 under Project Number CI09VJ (V41J-1E).

The objective of this test was to qualify the bird impact resistance of a left side windshield for the A-10 aircraft. One shot was made using a 4-lb bird at a nominal velocity of 360 knots.

The final data package was transmitted under separate cover to Mr. Greg Steuer, SM-ALC/MMIEA, the sponsor of the test program. Request for copies of these data should be addressed to the sponsor, McClellan Air Force Base, CA 95652-5609. A copy of the final data package is on file on microfilm at AEDC.

2.0 APPARATUS

2.1 TEST FACILITY

The Range S-3 test facility is comprised of a compressed air-driven launcher, a sabot stripper, an X-ray system, a high-speed photographic system, and a universal mounting platform. The test facility and test area arrangement are shown in Figs. 1 and 2 and a detailed description of the test unit and its capabilities is contained in Refs. 1 and 2.

2.2 PROJECTILE AND SABOT

The projectile launched during this test program was a 4-lb chicken carcass. The bird was asphyxiated, placed inside a polyethylene bag, quick-frozen, and stored at 0°F until needed. Prior to testing, the carcass was thawed in still air at room temperature (75°F) for approximately 24 hours or until the body cavity temperature was 70 ±10°F. Adjustments to the bird carcass weight were required to achieve the desired weight tolerance of ±0.1 lb. The adjustments were accomplished by clipping carcass appendages. The adjustment did not exceed 10 percent of the carcass weight.

The packaged bird was mated to the launch tube using a balsa wood sabot. The sabot material density was nominally 10 lb/ft^3 providing a combined bird/sabot launch weight of 5.7 lb. Separation of the bird

and sabot was accomplished by a tapered and grooved sabot stripper section attached to the vent section of the launch tube (Fig. 2).

2.3 TEST ARTICLE

The test article was an A-10 windshield assembly consisting of a three panel windshield. The windshield tested was the left hand panel fabricated of polycarbonate approximately 0.58 in. thick. The windshield was fabricated and installed in the assembly by TEXSTAR, Inc. The assembly was mounted on a table to simulate an A-10 fuselage.

2.4 TEST INSTRUMENTATION

Bird position, orientation, and velocity prior to impact were determined using the bird velocity measuring system. This system uses three 105 KV X-ray shadowgraph units and three electronic chronographs. The X-ray stations were nominally 3.5 ft apart with the first station located approximately 3 feet from the muzzle of the sabot stripper. Each X-ray pulser and electronic chronograph was triggered by a delay amplifier which was activated when the bird flew through break wires which were located under each X-ray unit (see Fig. 3).

Photographic coverage of the impact event and resulting transparency response was recorded by 16-mm motion picture cameras (Hycam Model No. 41-004) operating at 5000 frames per sec. Four cameras were used and the configuration is shown in Fig. 4. Each camera was started two seconds prior to launch and operated for a duration of five seconds. During operation, the 16-mm color film was marked with an event light (activated by the third breakwire of the X-ray system) and timing marks at 1 ms intervals providing a time base for analysis of the dynamic response.

Test area temperature was measured using two copper-constantan thermocouples positioned to monitor air temperature at points near the transparency. Temperature data were obtained manually from remote digital readouts.

3.0 TEST DESCRIPTION

3.1 TEST PROCEDURE AND CONDITIONS

The procedure used for bird impact testing during this test consisted of launching the bird carcass at a specified velocity into a predefined impact location on the test article. Prior to the shot, the test article was positioned angularly and transversely relative to the bird flight path. Following the shot, the test article was inspected for damage, still photographs were taken, and the test article and test area were thoroughly cleaned and disinfected.

Figure 5 shows the impact location used during this test. The shot was made on this location with the windshield frame at zero pitch and yaw angles. A test summary of the shot is given in Table 1.3.2
DATA REDUCTION

Pre- and posttest still photographs were obtained for the shot. Motion picture film was processed and available for viewing within 24 hours after the shot. The film was then edited, titled, and duplicated in quantities specified by the SM-ALC test director.

Bird velocity values were computed from displacement-time measurements obtained from in-flight X-rays and the chronograph system.

3.3 MEASUREMENT UNCERTAINTY

Measurement uncertainty is a combination of bias and precision errors defined as (Ref. 3):

$$U = \pm \ (B + t_{95}S)$$

where B is the bias limit, S is the sample standard deviation, and t_{95} is the 95th percentile point for the two-tailed Student's "t" distribution and depends on the sample size. Estimates of the measured data uncertainties for this test are given in Table 2.

4.0 DATA PACKAGE PRESENTATION

The final data package for this project was assembled under separate cover. The data package includes a test summary log listing test conditions and posttest observations along with pre- and posttest still photographs. High speed motion picture film was provided to the sponsor following the shots. A sample of the still photography is shown in Fig. 6.

5.0 REFERENCES

1. Test Facilities Handbook (Twelfth Edition), "von Karman Gas Dynamics Facility, Vol. 3." Arnold Engineering Development Center, March 1984.

2. Sanders, E. J. "The von Karman Gas Dynamics Facility Range S3 - Description and Capabilities." AEDC-TR-76-9, January 1976.

3. Abernethy, R. B., and Thompson, J. W., Jr., et. al. "Handbook of Uncertainty in Gas Turbine Measurements." AEDC-TR-73-5 (AD755356), February 1973.

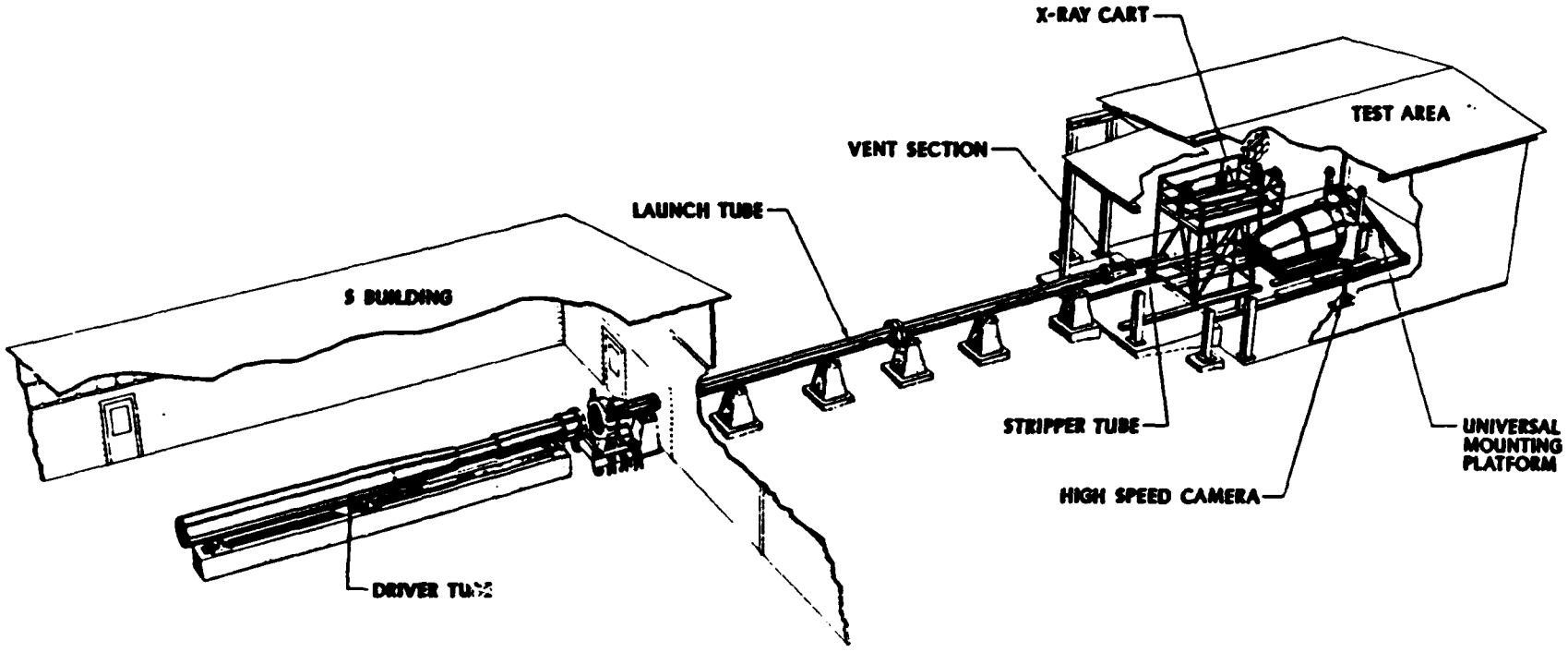


Figure 1. AEDC Birdstrike F Facility

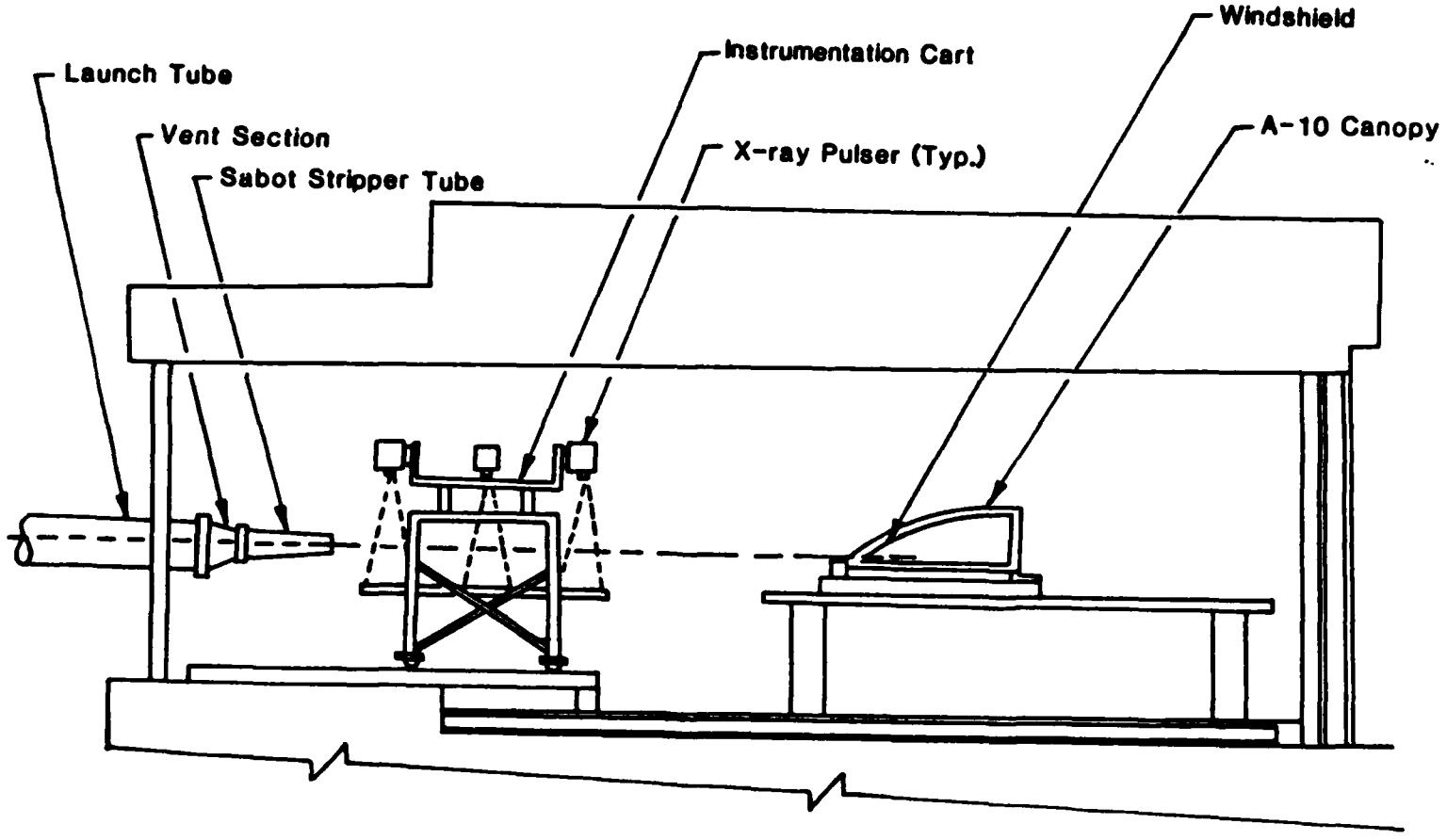
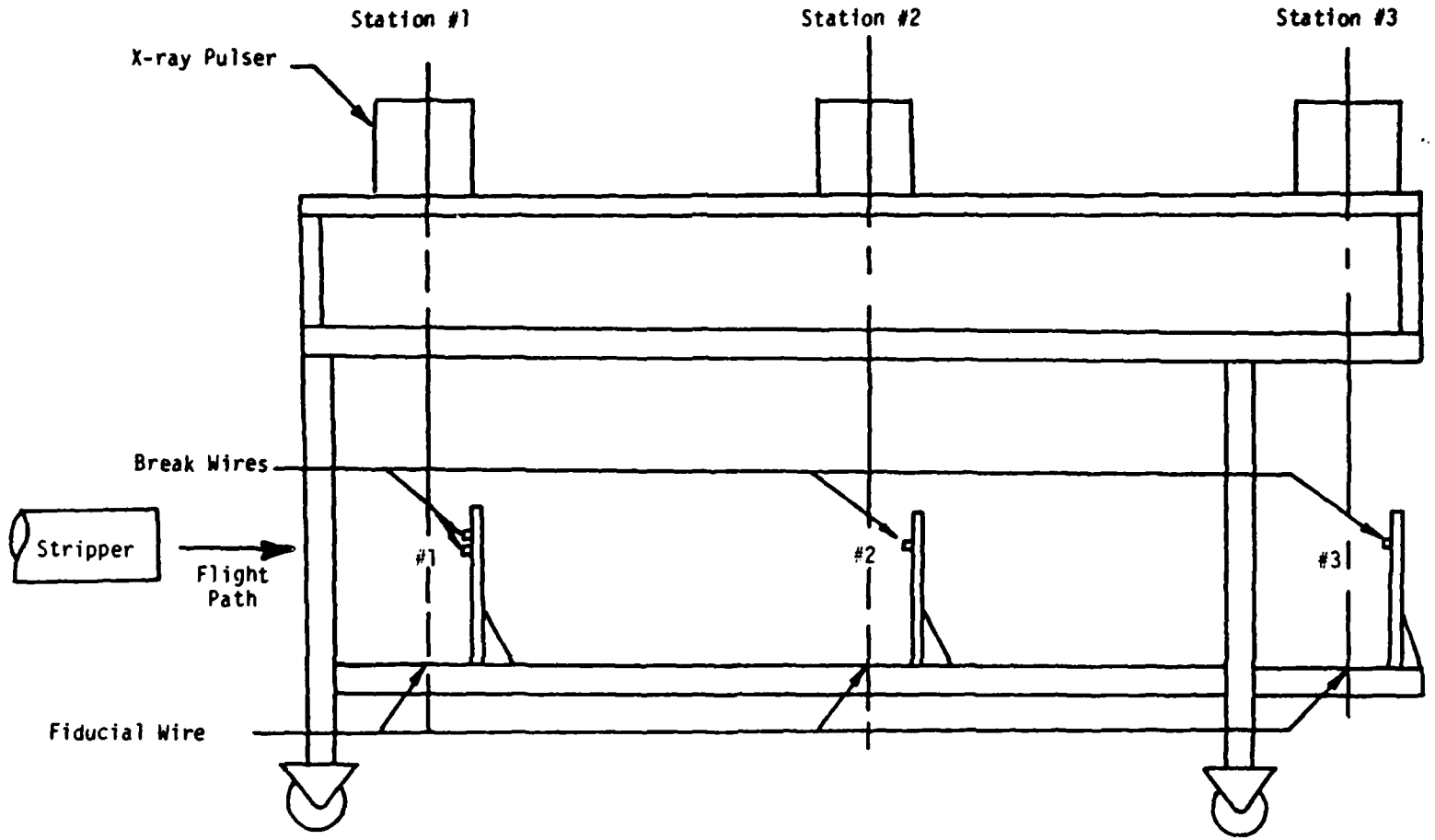
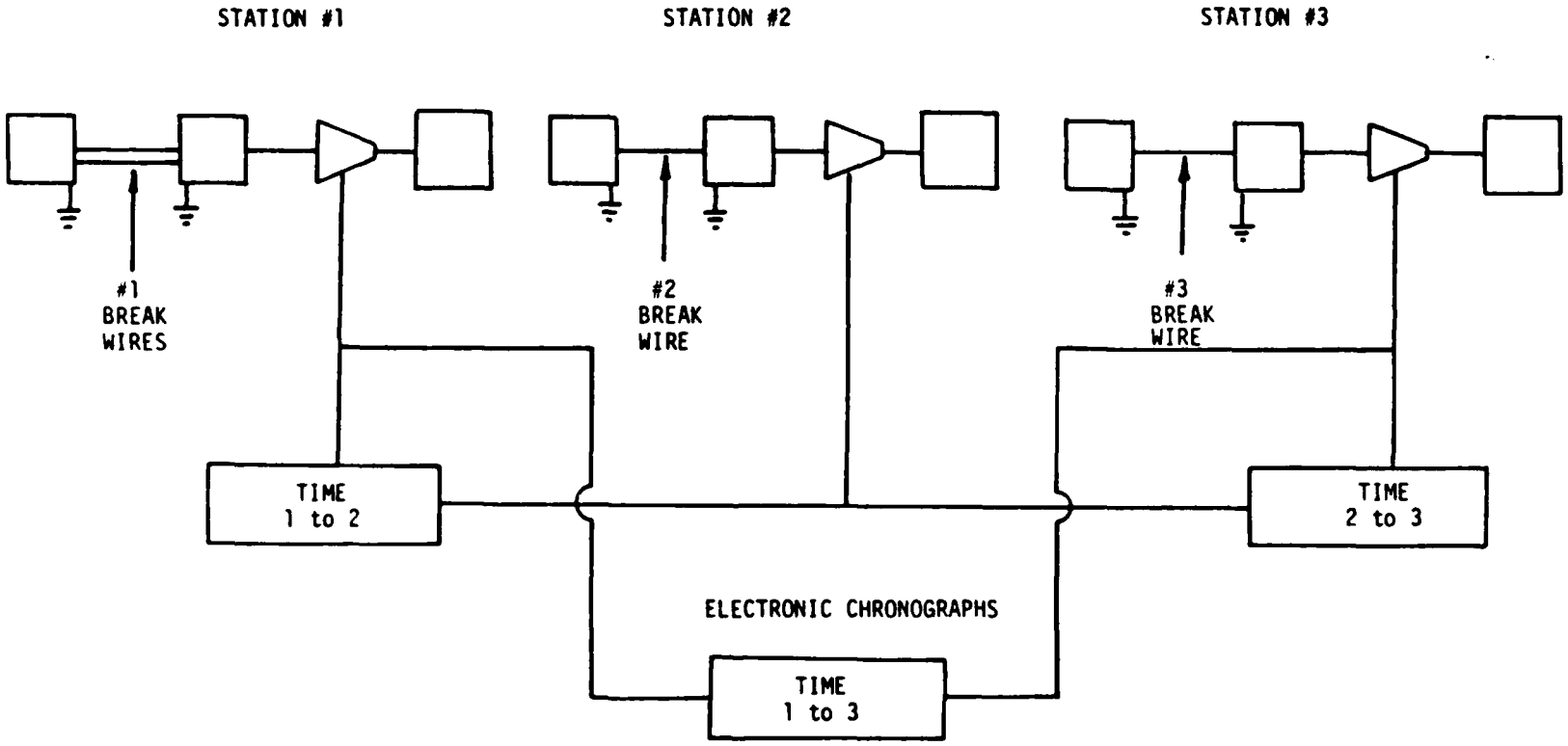


Figure 2. Test Area Arrangement



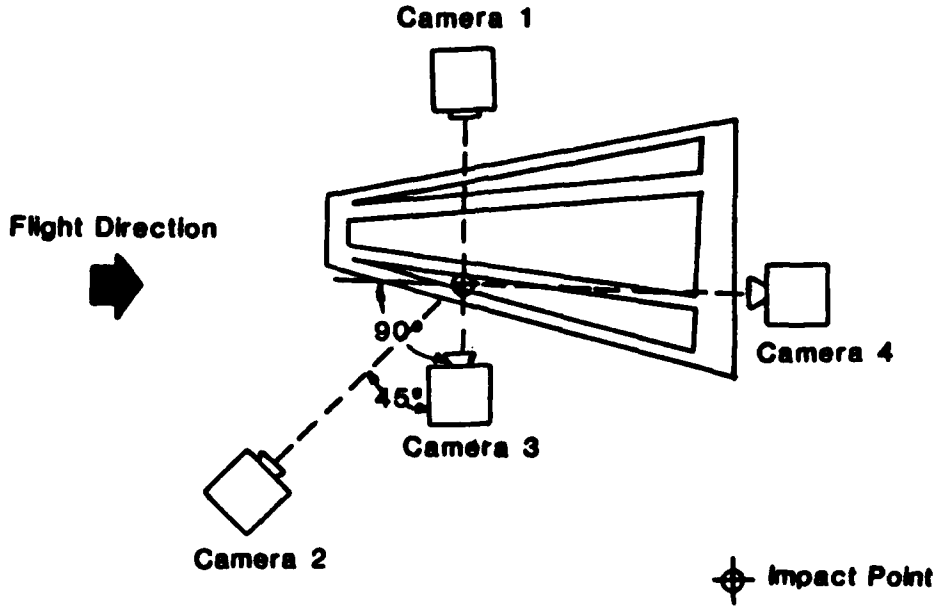
a. X-ray Cart

Figure 3. Bird Velocity Measuring System

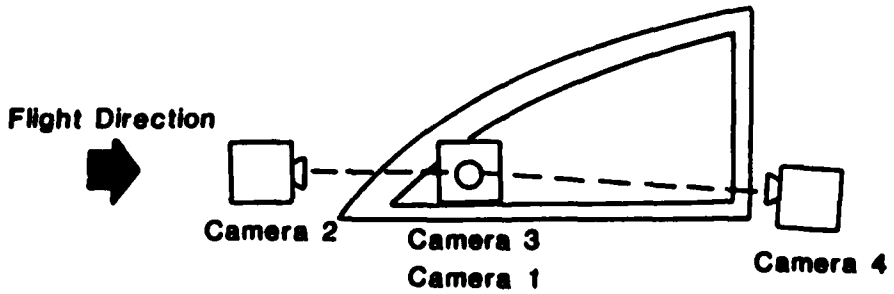


b. System Block Diagram

Figure 3. Concluded

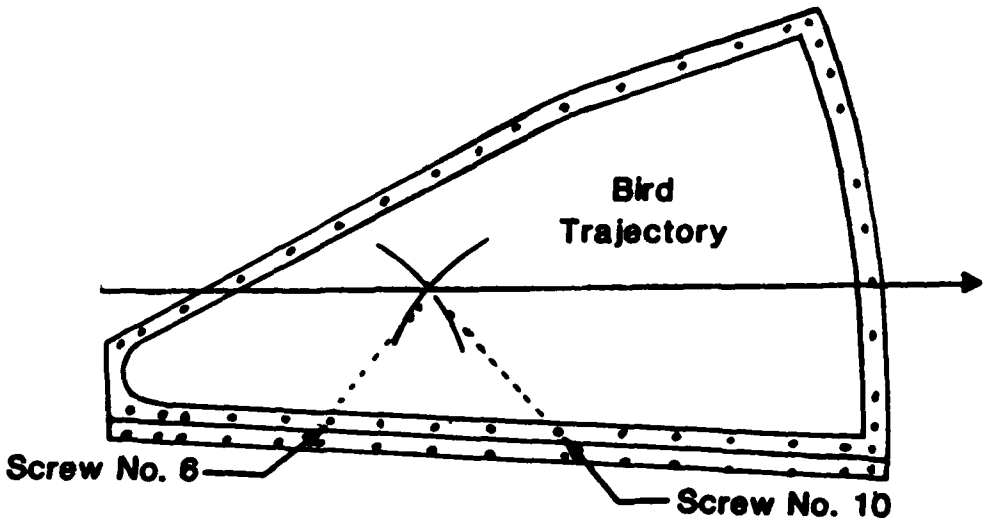


a. Top View



b. Side View

Figure 4. Camera Locations

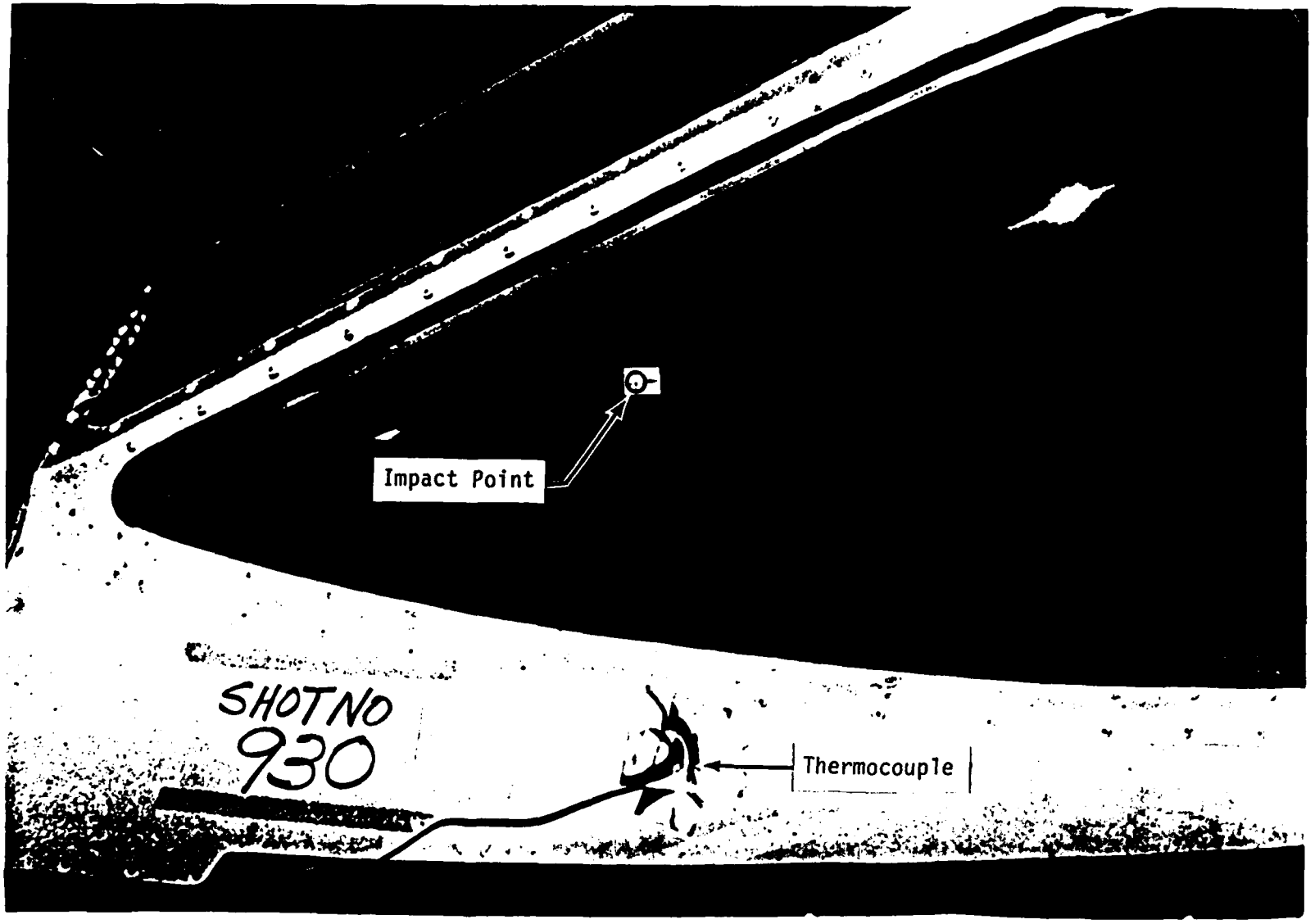


Impact point is the intersection of two arcs:

(a) From screw no. 6, strike an 11.5-inch radius arc.

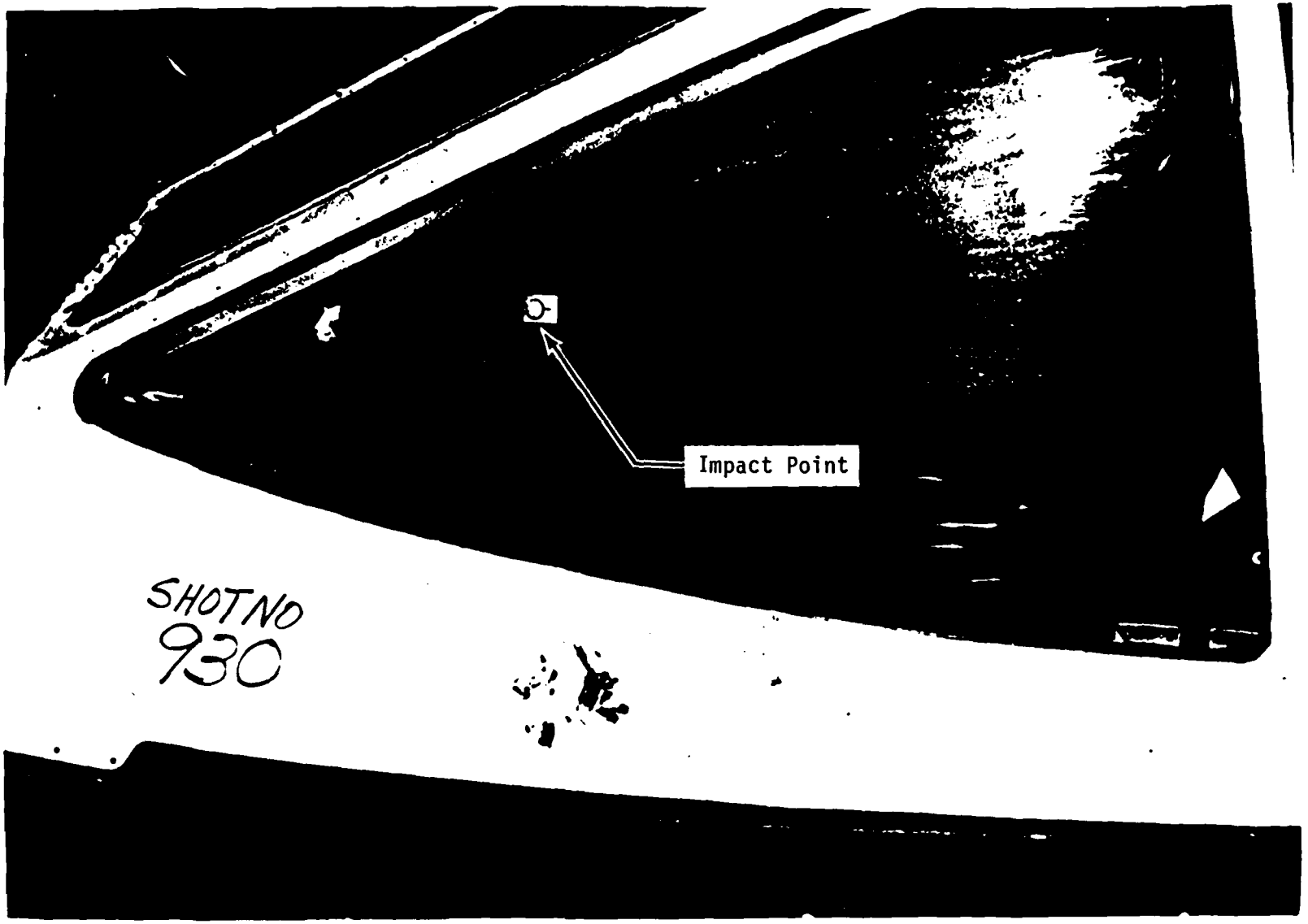
(b) From screw no. 10, strike a 13-inch radius arc.

Figure 5. Bird Impact Location



a. Pretest Photograph

Figure 6. Still Photographs for Shot 930



b. Posttest Photograph

Figure 6. Concluded

Table 1: Test Summary

Shot Number	Date	Test Area Temperature (°F)	Bird Weight (lb)	Velocity (knots)	Test Results
930	12/9/86	66	4.0	360.2	No Penetration

Note: Bird penetration inside the cockpit is considered a failure of the windshield.

TABLE 2. ESTIMATED MEASUREMENT UNCERTAINTIES

Parameter Designation	Estimated Measurement							Range	Type of Measuring Device	Type of Recording Device	Method of System Calibration
	Precision Index (S)			Bias (B)		Uncertainty ± (B + t95S)					
	Percent of Reading	Unit of Measurement	Degree of Freedom *	Percent of Reading	Unit of Measurement	Percent of Reading	Unit of Measurement				
Bird Velocity	± 0.23		31	0		± 0.46		300-600 knots	Calculated from *Displacement & Time* Measurements		
Axial Displacement		± 0.105 in			0		± 0.21	0-10 ft	X-ray System	X-ray Shadowgrams	Comparison with Secondary Standard
Time		$\pm 1.1 \times 10^{-6}$ sec	31		0		$\pm 2.2 \times 10^{-6}$ sec	0 to 0.056 sec	One Megacycle Counter	Computer Printer	"
Bird Weight		± 0.5 gm	31		0		± 1.0 gm	0-2000 gm	Laboratory Pan Scale	Manual	"
Bird Temperature		± 0.5 °F	31		0		± 1.0 °F	32-80 °F	Mercury Thermometer	Manual	"
Test Area Temperature		± 0.5 °F	31		0		± 1.0 °F	40-90 °F	Copper-Constantan Thermocouple	Manual	"

*A listed value of 31 indicates degrees of freedom ≥ 31

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