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U. S. NAVAL PROVING GROUND  
DANL. GREN, VIRGINIA

REPORT NO. 1149

TEST OF OERLIKON 20MM MACHINE GUN COMPONENTS

1st Partial Report

-----  
TEST OF 20MM MOUNT MARK 10, WITH OERLIKON MODIFICATIONS

FINAL Report

Copy No. \_\_\_\_\_

Task

Assignment WPG-Rep-1-15-52

Classification RESTRICTED

SECURITY INFORMATION

1953 APR 21 PM 1 03

U. S. Naval Proving Ground  
Dahlgren, Virginia

OMG:RVC:jlr  
A9-10  
Ser 33202

RESTRICTED

From: Commander, Naval Proving Ground  
To: Chief, Bureau of Ordnance

JUL 13 1953

Subj: NPG Report No. 1119 "Test of Oerlikon 20mm  
Machine Gun Components"; correction to

Encl: (1) Corrected Pages 7 and 8 and Table I,  
Appendix (A), of Subject Report

1. The subject report dated 20 April 1953 was re-examined at the Naval Proving Ground, and some of the rate-of-fire data contained in Table I, Appendix (A), were found to be in error. Although these errors do not affect the qualitative results and conclusions, they do affect the magnitude of the comparisons made in paragraph 10b.

2. In order to facilitate corrections to the subject report, enclosure (1) consists of pages 7 and 8 and Table I, Appendix (A), which can be substituted as such into the report. Also, on page 1, paragraph 4, change "635 r.p.m." to read "640 r.p.m.".

Copy to:

J. F. BYRNE

BUORD (Ad3)  
BUORD (Re2)  
BUORD (Re5)  
BUORD (Re5c)

Chief of Ordnance

Department of the Army  
Attn: ORDTX-AR  
Commanding General,  
Aberdeen Proving Ground  
Aberdeen, Maryland

Attn: Technical Information Section  
Development and Proof Services  
Commander, Operational Development Force;  
U. S. Atlantic Fleet, U. S. Naval Base,  
Norfolk 11, Virginia  
Navy Research Section  
Library of Congress  
Washington 25, D. C.  
(Via BUORD Re5c)  
Naval Gun Factory  
Naval Ordnance Laboratory

E. A. Ruckner  
By direction

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speed motion pictures of the gun action during the firing of these bursts. Dispersion patterns were not obtained for these 16 runs because the ammunition used consisted of high explosive fuzed rounds which would have detonated on the dispersion cards.

c. Twenty-two (22) single rounds of SUL Oerlikon ammunition were fired to determine muzzle velocity, time of flight to 1000 yards, the coefficient of form and ballistic coefficient of the projectile. Measurements were made by Computation and Ballistics Department, and their report is presented in Appendix (C). Figure 1, Appendix (C), is a plot of the dispersion pattern of the 22 rounds.

d. To test the destructive effects of the Oerlikon ammunition, three (3) rounds of high explosive PD fuze (SS/K) and four (4) rounds of incendiary PD fuze (SS/K) were fired into the port wing structure of a TBF aircraft located about 100 yards from the gun. Figure 2, Appendix (C), pictures the wing before firing. Figures 3 thru 6, Appendix (C), picture the resulting damage.

#### 10. RESULTS AND DISCUSSIONS:

a. In the judgment of the personnel who fired both the standard gun and mount and the modified gun and mount, the Oerlikon modifications reduced the vibration to a considerable degree without otherwise altering the feel or ease of handling of the mount.

b. A study of the rates of fire given in Table I, Appendix (A), provides the following comparisons in which the values are weighted according to the number of rounds in a burst:

(1) With standard barrel springs and standard ammunition, the modified cradle increases the rate of fire by 82 r.p.m. over that with the standard cradle.

(2) With standard barrel springs and Oerlikon ammunition, the modified cradle increases the rate of fire by 130 r.p.m. over that with the standard cradle.

(3) With the modified cradle and standard ammunition, the Oerlikon barrel springs provide a decrease of 37 r.p.m. under that with the standard springs.

(4) With the modified cradle and Oerlikon ammunition, the Oerlikon barrel springs provide a decrease of 53 r.p.m. under that with the standard springs.

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Enclosure (1)

OMC:RVC:jlr  
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(5) With the modified cradle, the Oerlikon ammunition fired on the average about 100 r.p.m. faster than standard ammunition. With the standard cradle, the Oerlikon ammunition averaged only about 50 r.p.m. faster than standard ammunition. These comparisons were made with the gun at a five degree elevation angle.

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Mark 10, with Cerlikon Modification

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Test of 20mm

TABLE I

AMMUNITIONS USED IN HURST FILING

TEST CONDITIONS OF FIRE OBTAINED

AND

Burst No.	No. of Rounds	Elevation Angle (degree)	Grade	Signal	Barrel Springs	Ammunition	Rate of Fire (R.P.M.)
1	17	55	Modified	Mark 10	Standard	Standard	520
2	10	55	Modified	Mark 14	Standard	Cerlikon	640
3	9	55	Modified	Mark 20	Standard	Standard	515
4	10	55	Modified	Mark 20	Standard	Cerlikon	620
5	13	55	Modified	Mark 20	Cerlikon	Standard	495
6	6	55	Modified	Mark 20	Cerlikon	Cerlikon	575
7	17	55	Modified	Mark 14	Cerlikon	Standard	490
8	6	55	Modified	Mark 14	Cerlikon	Cerlikon	580
9	14	60	Modified	Mark 6	Standard	Standard	520
10	6	60	Modified	Mark 6	Standard	Cerlikon	585
11	6	60	Modified	Mark 6	Standard	Standard	450
12	6	60	Modified	Mark 6	Standard	Cerlikon	515

k 10, with Oerlikon Modifications  
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PART A

SYNOPSIS

Al Joras, Zurich, Switzerland, has designed a mount which is claimed by Oerlikon to increase or decrease the vibration of the standard 20mm gun t Mark 10 was equipped with this new Oerlikon or spring mounting of the gun. A standard addition of a recoiling-parts buffer mounted box and with modifications to the firing ed with the modified mount. Oerlikon barrel ided for use with the modified gun.

One of the tests was to determine whether the Oerlikon mount and gun provide for any decrease in rate of fire.

As requested to test the new Oerlikon ammunition velocity, time of flight to 1000 yards, coefficient of dispersion, dispersion on a plane normal to the line of fire, and the destructive effect of the high velocity ammunition.

The modified mount and gun was adjudged to have less vibration than standard mount and gun. The modifications to the gun both increase the rate of fire. However, with standard springs the rate of fire was less than with modified springs. Irrespective of what combination of standard components was used, the Oerlikon ammunition gave a higher rate of fire than did the standard ammunition. The rate of fire obtained was 635 r.p.m. and was obtained with standard mount, modified mechanism, standard barrel springs and standard ammunition.

The velocity of the blind loaded and traced ammunition was 2800 f.p.s. The time of flight to about 1000 yards ranged from 1.13 seconds. The coefficient of form of the ammunition was 1.20. The reduced ballistic coefficient was .346.

It is concluded that the Oerlikon modifications do provide for less vibration and an increase in the rate of fire.



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PART B

INTRODUCTION

1. AUTHORITY:

The tests reported herein were authorized by reference (a) and conducted under Task Assignment NPG-Re5-1-15-52, established by reference (b).

2. REFERENCES:

- a. BUORD Restr ltr NP9 Re5d-DFA:hsr S74-2(20mm) of 22 May 1951
- b. BUORD Restr ltr NP9 Re5d-LRS:hms of 28 June 1951
- c. BUORD ltr NP7 Re5d-JCP:hms of 24 April 1951
- d. BUORD ltr NP9 Re5c-FEY:nts S74-1(20mm) of 9 December 1952

3. BACKGROUND:

a. Oerlikon Machine Tool Works, Zurich, Switzerland, has designed a cradle for the 20mm mount which is claimed by Oerlikon to increase the rate of fire and decrease the vibration of the standard 20mm gun. A 20mm Mount Mark 10 was equipped with new Oerlikon cradle which provides for spring mounting of the gun. The gun to be tested was a standard 20mm mechanism with the addition of a recoiling parts buffer mounted forward of the trigger box and with modifications to the firing mechanism.

b. Since the characteristics of the Oerlikon barrel spring provided for the modified gun were not known, dimensional and load checks were conducted on one (1) set of the Oerlikon springs and two (2) sets of standard 20mm AA gun springs at the Naval Gun Factory as authorized in reference (c).

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4. OBJECT OF TEST:

- a. To determine performance characteristics of the Oerlikon modified mount as compared to a standard 20mm Mount Mark 10.
- b. To test the new Oerlikon 20mm ammunition as follows:
  - (1) Obtain muzzle velocity and time of flight to about 1000 yards.
  - (2) Obtain coefficient of form.
  - (3) Obtain dispersion on a normal plane at about 1000 yards.
  - (4) Determine effect of Oerlikon HE rounds when fired through aircraft wings.

5. PERIOD OF TEST:

- |                                     |                  |
|-------------------------------------|------------------|
| a. Date of Project Letter           | 22 May 1951      |
| b. Date Necessary Material Received | 16 May 1951      |
| c. Date Commenced Test              | 9 July 1951      |
| d. Test Completed                   | 29 February 1952 |

6. REPRESENTATIVE PRESENT:

F. B. Weathersbee, Rc5c-3, was present on 17 July 1951.

PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

- a. A 20mm Mount Mark 10 and 20mm Mechanism Mark 4 with Oerlikon modifications. The mount was equipped with a new Oerlikon cradle that provides for spring mounting of the gun. That is, the gun is not rigidly secured to the cradle but is spring mounted so that during firing the gun moves with respect to the cradle. The gun was a standard 20mm mechanism Mark 4 with the addition of an auxiliary recoiling-parts buffer mounted forward of the trigger box and with modifications to the firing mechanism.

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b. New-type Oerlikon Ammunition:

- (1) 45 rounds blind loaded and traced (SUL)
- (2) 25 rounds high explosive PD fuze (SS/K)
- (3) 25 rounds incendiary PD fuze (SB/K)

c. A gun sight Mark 14 Mod 6 and a gun sight Mark 20 Mod 5 together with associated adapter equipment.

d. A standard 20mm cradle and standard 20mm ammunition for comparative purposes.

8. DESCRIPTION OF TEST EQUIPMENT:

a. Three (3) 35mm Fastax high speed motion picture cameras were used to photograph the Mark 14 or Mark 20 gun sight reticule, the barrel springs, and the auxiliary buffers during burst firing.

b. The following equipment was used to obtain initial velocity and time of flight to 1000 yards:

- (1) Westinghouse Doppler Chronograph.
- (2) 2 - Potter Counter Chronographs with associated solenoids.
- (3) Potter Interval Timer and associated screens.
- (4) Drum camera and Sperry reference solenoid.

c. A Brush recorder and microphone pick-up was used to obtain rate of fire.

9. PROCEDURE:

a. A standard 20mm Mount Mark 10 with a standard gun was installed adjacent to the modified mount with modified gun. A 60 round burst of standard ammunition was fired from each for comparative purposes.

b. A series of 16 bursts were fired with various combinations of test components. The mount was secured both in train and at the indicated angle of elevation. Table I, Appendix (A), lists the 16 runs fired with the test components used and the measured rate of fire for each burst. Three (3) 35mm Fastax cameras took high

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speed motion pictures of the gun action during the firing of these bursts. Dispersion patterns were not obtained for these 16 runs because the ammunition used consisted of high explosive fuze rounds which would have detonated on the dispersion cards.

c. Twenty-two (22) single rounds of SUL Oerlikon ammunition were fired to determine muzzle velocity, time of flight to 1000 yards, the coefficient of form and ballistic coefficient of the projectile, and dispersion on a normal plane at 1000 yards. The required measurements were made by Computation and Ballistics Department, and their report is presented in Appendix (C). Figure 1, Appendix (C), is a plot of the dispersion pattern of the 22 rounds.

d. To test the destructive effects of the Oerlikon ammunition, three (3) rounds of high explosive PD fuze (SS/K) and four (4) rounds of incendiary PD fuze (SB/K) were fired into the port wing structure of a TBF aircraft located about 100 yards from the gun. Figure 2, Appendix (C), pictures the wing before firing. Figures 3 thru 6, Appendix (C), picture the resulting damage.

#### 10. RESULTS AND DISCUSSIONS:

a. In the judgement of the personnel who fired both the standard gun and mount and the modified gun and mount, the Oerlikon modifications reduced the vibration to a considerable degree without otherwise altering the feel or ease of handling of the mount.

b. A study of the rates of fire given in Table I, Appendix (A), provide the following comparisons:

(1) Using standard barrel springs and standard ammunition, the modified cradle increases the rate of fire by 53 r.p.m.

(2) Using standard barrel springs and Oerlikon ammunition, the modified cradle increases the rate of fire by 135 r.p.m.

(3) Using the modified cradle and standard ammunition the Oerlikon barrel springs provide a decrease of about 35 r.p.m. under that with standard barrel springs.

(4) Using the modified cradle and Oerlikon ammunition, the Oerlikon barrel springs provide a decrease of about 50 r.p.m. under that with standard springs.

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(5) Using the modified cradle, the Oerlikon ammunition fired on the average about 100 rounds per minute faster than standard ammunition. With the standard cradle, the Oerlikon ammunition averaged only about 30 r.p.m. faster than standard ammunition. This increase in rate of fire of the Oerlikon ammunition over standard ammunition is due in part to the greater muzzle velocity obtained with the Oerlikon ammunition.

(6) The highest rate of fire obtained was 635 r.p.m. and was obtained with the modified mount, modified mechanism, standard barrel springs and Oerlikon ammunition. This compares with the nominal rate of fire of 450 r.p.m. for the standard mount, gun and ammunition.

c. High speed motion pictures were taken during the firing of each burst listed in Table I, Appendix (A). One (1) camera was focused on the gun sight reticule during those bursts in which the gun was fixed at 5° elevation (bursts 1-8, inclusive, and 13-16, inclusive). A second camera viewed the action of the barrel springs on all bursts. The third camera took pictures just aft of the trunnion. These pictures show the functioning of the auxiliary buffer and the movements of the recoiling gun parts and the receiver with respect to each other and the mount. Film A shows the vibration of the Mark 14-6 or Mark 20-5 gun sight during burst firing. Bursts 9 to 12, inclusive, were omitted from this film since no sight was used. Film B shows the action of compression and release of the standard and Oerlikon barrel springs. Film C shows the action of the sliding cradle (on the modified mount) and the recoiling parts of the gun. All the motion picture records contain a timing indication in the form of an intermittent darkening of the film along one (1) edge outside of the sprocket holes. This indication was formed by a light flashing 120 times a second. Therefore, the frame speed in frames per second is equal to the number of frames between timing marks on the film edge multiplied by 120. The frame speed will vary somewhat over different parts of the film. All motion picture records were sent to the Bureau of Ordnance, Re5e, under separate cover.

d. The average muzzle velocity of 22 rounds of blind loaded and traced Oerlikon ammunition (SUL) as reported in the memorandum of Appendix (B), was 2971 ft./sec. This compares to a nominal muzzle velocity of 2770 ft./sec. for standard ammunition fired in a standard gun and mount. The time of flight to about 1000 yards ranged between 1.26 and 1.33 seconds. The coefficient of form of the projectile was determined to be 1.20. The reduced ballistic



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Test of 20mm Mount Mark 10, with Cerlikon Modifications  
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coefficient was .346. The standard deviation for the first day's firing of 10 rounds was \*29 inches vertically and \*18 inches horizontally. The standard deviation for the second day's firing was \*17 vertically and \*16 horizontally.

e. Results of the test firings to determine the destructive effect of the fuze and loaded types of ammunition (SS/K and SB/K) are given in Appendix (D). Table II gives the location on the wing of the points of entry of each shot. Figures 3 and 4 show the entry holes on the wing. Figure 5 shows the damage after the three (3) SS/K rounds had been fired, and Figure 6 shows the additional damage resulting from the firing of the four (4) SB/K rounds.

f. Results of the dimensional and deflection-load tests conducted by the Naval Gun Factory as requested by reference (c) are given in Tables III-IV Inclusive, Appendix (D).

PART D

CONCLUSIONS

11. It is concluded that:

a. The Cerlikon modifications to the 20mm Mount Mark 10 and the 20mm Mechanism Mark 4 appreciably decrease the vibration which is characteristic of the standard mount and gun.

b. Use of the modified mount with the sliding cradle does increase the rate of fire of the gun. However, a greater rate of fire was obtained with standard barrel springs and the modified mount than with the Cerlikon barrel springs and the modified mount. Irrespective of what combination of modified and standard components was used, the Cerlikon ammunition fired at a greater rate of fire than did the standard ammunition.



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Test of 20mm Mount Mark 10, with Oerlikon Modifications  
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PART E

DISPOSITION OF MATERIAL

12. The modified cradle was removed from the 20mm Mount Mark 10, and with the modified 20mm mechanism was shipped to Canadian Oerlikon Agencies, 69 Sparks Street, Ottawa, Canada, by authority of reference (d). The gun sights, Mark 14, Mod 6 and Mark 20, Mod 5, are being retained at the Naval Proving Ground pending disposition instructions from the Bureau of Ordnance.

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Test of 20mm Mount Mark 10, with Overlike Modifications

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The tests upon which this report is based were conducted by:

C. D. BERRY, Lieutenant, USN  
Machine Gun Division Firing and Project Officer  
Armament Department

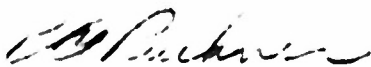
This report was prepared by:

C. D. BERRY, Lieutenant, USN  
Machine Gun Division Firing and Project Officer  
Armament Department  
R. V. COLLINS, Lieutenant (jg), USNR  
Machine Gun Division Firing and Project Officer  
Armament Department

This report was reviewed by:

J. J. TURNER, Head, Research Branch  
Machine Gun Division  
Armament Department  
R. C. PATTON, Lieutenant, USN  
Machine Gun Battery Officer  
Armament Department  
L. C. KLINGAMAN, Commander, USN  
Armament Officer  
Armament Department  
C. C. BRAMELE, Director of Research  
Ordnance Group

APPROVED: J. F. EYRNE  
Captain, USN  
Commander, Naval Proving Ground



E. A. RUCKNER  
Captain, USN  
Ordnance Officer  
By direction

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NPG REPORT NO. 1119

U. S. NAVAL PROVING GROUND  
DAHLGREN, VIRGINIA

First Partial Report

on

Test of Oerlikon 20mm Machine Gun Components

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Final Report

on

Test of 20mm Mount Mark 10, with Oerlikon Modifications

Proj. No. NPG-Re5-1-15-52  
No. of Pages: 11

Date: APR 20 1953

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Test of 20mm Mount Mark 1C, with Oerlikon Modifications

NPC REPORT NO. 1119

TABLE I

TEST COMPONENTS USED IN BURST FLYING  
AND RATE OF FIRE OBTAINED

Burst No.	No. of Rounds	Elevation Angle (degree)	Mount	Sight	Barrel Spring	Ammunition	Rate of Fire (R.P.M.)
1	17	5	Modified	Mark 14	Standard	Standard	500
2	10	5	Modified	Mark 14	Standard	Oerlikon	640
3	9	5	Modified	Mark 20	Standard	Standard	550
4	10	5	Modified	Mark 20	Standard	Oerlikon	630
5	18	5	Modified	Mark 20	Oerlikon	Standard	490
6	6	5	Modified	Mark 20	Oerlikon	Oerlikon	575
7	17	5	Modified	Mark 14	Oerlikon	Standard	490
8	6	5	Modified	Mark 14	Oerlikon	Oerlikon	590
9	14	60	Modified	None	Standard	Standard	490
10	6	60	Modified	None	Standard	Oerlikon	590
11	17	60	Standard	None	Standard	Standard	495
12	6	60	Standard	None	Standard	Oerlikon	535
13	14	5	Standard	Mark 14	Standard	Standard	445
14	6	5	Standard	Mark 14	Standard	Oerlikon	500
15	20	5	Standard	Mark 20	Standard	Standard	500
16	6	5	Standard	Mark 20	Standard	Oerlikon	500

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APPENDIX A

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Test of 20mm Mount Mark 10, with Oerlikon Modifications  
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NPG MOVIES UNDER

SEPARATE COVER TO PUORD Re5

Film A - Gun sight reticule

Film B - Barrel Springs

Film C- Action of sliding cradle  
and recoiling parts of gun.

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APPENDIX B

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NPG REPORT NO. 1119

Test of 20mm Mount Mark 10, with Oerlikon Modifications

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Y

1 December 1951

MEMORANDUM

From: OKB  
To: OMC  
Via: OK

Subj: 20mm Mount Mark 10, with Oerlikon Modification;  
ballistic firing of

Ref: (a) BUORD restr ltr Re5d-DFA:hsr S74-2(20mm)  
of 22 May 1951 to NAVPROV  
(b) TeleCon NPG(LCDR Dickson) to BUORD(LCDR Simerville)  
of 4 June 1951

Encl: (1) Initial Velocity and Time of Flight to 1000 yds.  
(2) Ballistic Coefficient and Coefficient of Form  
(3) Impact and Dispersion on a Normal Plane at 1000 yds.  
(4) Setup for 20mm Velocities at Pumpkin Neck

1. In compliance with the portion of reference (a) assigned to OKB, coefficients of form of the subject ammunition were calculated from measurements of time of flight and initial velocities taken on firings of 10 and 11 July 1951. Reference (b) recommended a change in the position of the target from 2000 yards from the trunnion of the gun to 1000 yards from the trunnion of the gun.

2. On 10 July 1951 eleven (11) rounds of OERLIKON fixed ammunition, weight 1752 grains with tracers were fired from a Mk 4/0 barrel, Mk 4/0 mechanism, Mk 10/4 mount, Mk 7/1 stand and Mk 7/0 carriage. The gun barrel number was 84128. On 11 July 1951 eleven (11) more rounds were fired from the same combination firing system. In addition three (3) warming rounds of Mk 7/23E service projectiles were fired on 10 July and two (2) rounds on 11 July.

3. The second round fired on 10 July 1951 was reported to have thrown its band. It missed the target. All other rounds hit target.

4. Enclosure (1) gives the initial velocity 75 feet from the muzzle as determined by two (2) sets of solenoids and by Westinghouse doppler equipment, and the time of flight from a lumiline screen 83.04 feet in front of the trunnion to the target.

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Test of 20mm Mount Mark 10, with Gerlikon Modifications

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5. Enclosure (2) gives the measured ballistic coefficient for each round and the average coefficient of form relative to the Gg drag function. The average value is 1.20 for each days firing.
6. Enclosure (3) gives the observed pattern of impact on the target and the dispersion laterally and vertically.
7. Enclosure (4) shows the physical setup for the test firing on the two (2) days.

Prepared by: /s/ William E. Moyer

Submitted by: /s/ William A. Kemper

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NPG REPORT NO. 1119

## Test of 20mm Mount Mark 10, with Oerlikon Modifications

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Enclosure (1)

TABLE I

INITIAL VELOCITY AND TIME OF FLIGHT TO 1000 YARDS  
20MM GUN 84128 ON OERLIKON-MODIFIED 20MM MOUNT MARK 10

Date 1951	Rd.	Velocity 83.04 Feet from Trunnion				Time of Flight (sec.) 83.04 ft. from trunnion to 3002 ft. from trunnion
		By Solenoids 1 and 3	By Solenoids 2 and 4	Westinghouse Doppler Chronograph	Average	
7-10	1	2960	2956	--	2958	1.29739
	2	2969	2970	--	2970	--
	3	3008	3007	3013	3009	1.27268
	4	2988	2989	2993	2990	1.28482
	5	2990	2988	--	2989	1.28116
	6	2997	2998	--	2998	1.26025
	7	2988	2988	2996	2991	1.27700
	8	2953	2953	2975	2960	1.30554
	9	2960	2959	2971	2963	1.30262
	10	2958	2956	--	2957	1.30539
	11	2973	2995	--	2994	1.28650
7-11	1	2974	2973	--	2974	1.27737
	2	2951	2949	2958	2953	1.30285
	3	2958	2958	2972	2963	1.31647
	4	2925	2923	--	2924	1.32582
	5	2963	2963	2965	2964	1.29228
	6	2948	2947	2955	2950	1.32058
	7	2965	2965	2973	2968	1.29889
	8	2963	2963	2972	2966	1.29908
	9	2988	2988	3000	2992	1.28756
	10	2953	2953	--	2953	1.29020
	11	2984	2982	--	2983	1.28844
Average					2971	1.29404

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## Test of 20mm Mount Mark 10, with Cerlikon Modifications

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Enclosure (2)

TABLE II

BALLISTIC COEFFICIENT AND COEFFICIENT OF FORM

<u>Date</u> <u>1951</u>	<u>Rd.</u>	<u>Weight</u> <u>(grains)</u>	<u>Diameter</u> <u>(inches)</u>	<u>Relative</u> <u>Air</u> <u>Density (%)</u>	<u>Ballistic Coefficient/</u> <u>Relative Density</u>	<u>Coef.</u> <u>of</u> <u>Form</u>
7-10	1	1752	C.787	96.6	0.349	1.20
	2	"	"	"	--	
	3	"	"	"	.348	1.20
	4	"	"	"	.345	1.21
	5	"	"	"	.351	1.19
	6	"	"	"	.364	1.15
	7	"	"	"	.353	1.19
	8	"	"	"	.343	1.22
	9	"	"	"	.344	1.22
	10	"	"	"	.344	1.22
	11	"	"	"	.342	1.23
				Average	.348	1.20
7-11	1	1752	.787	97.8	0.359	1.15
	2	"	"	"	.348	1.19
	3	"	"	"	.334	1.24
	4	"	"	"	.342	1.21
	5	"	"	"	.351	1.18
	6	"	"	"	.334	1.24
	7	"	"	"	.346	1.19
	8	"	"	"	.345	1.20
	9	"	"	"	.344	1.20
	10	"	"	"	.357	1.16
	11	"	"	"	.346	1.19
				Average	.346	1.20

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NPG REPORT NO. 1119

Test of 20mm Mount Mark 10, with Oerlikon Modifications

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Enclosure (3)

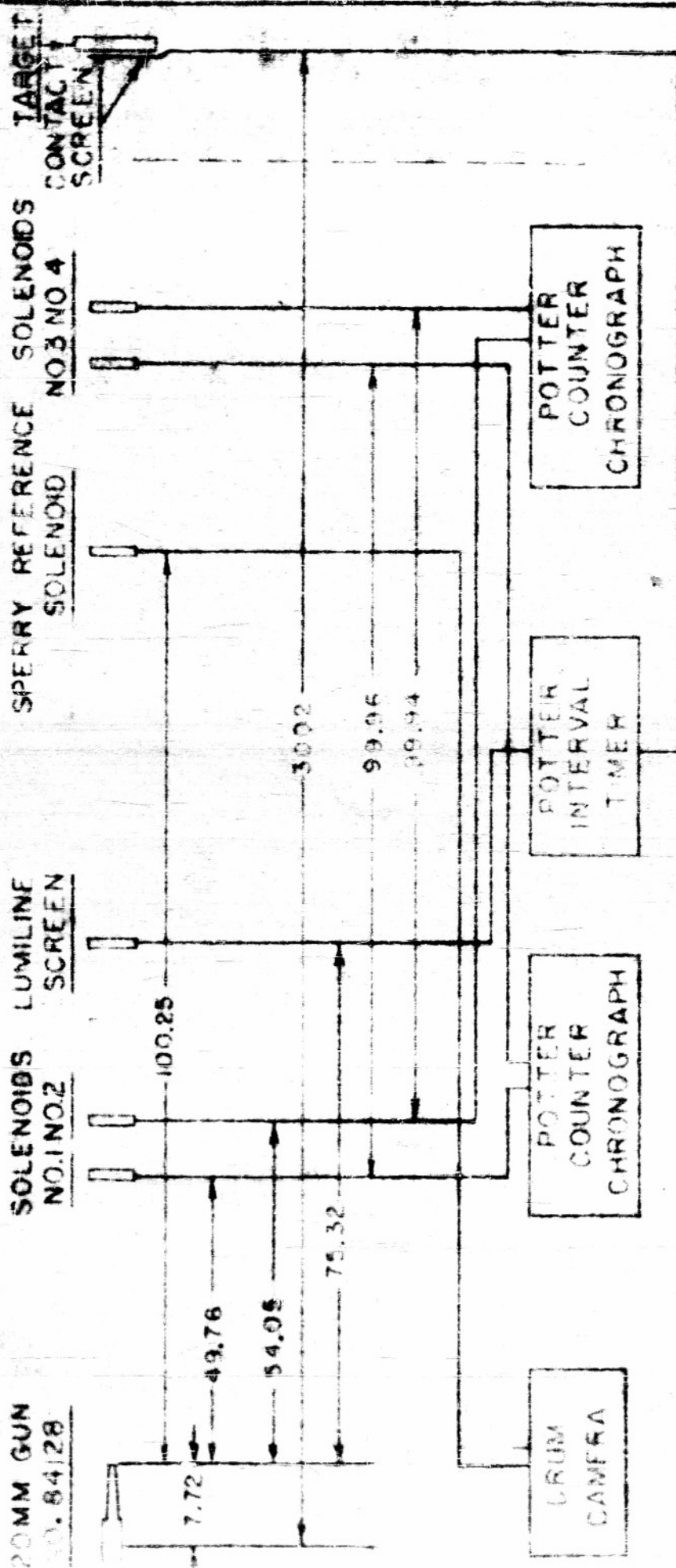
TABLE IIIDISPERSION ON A NORMAL PLANE AT 1000 YARDS  
(WITH RESPECT TO SIGHT ANGLE OF  
9.5 MINUTES AND POSITION ANGLE OF -5 MIN.)

Date <u>1951</u>	<u>Rd.</u>	<u>Vertical</u> <u>(inches)</u>	<u>Lateral</u> <u>(inches)</u>	
7-10	1	+14	+17	
	2	--	--	rotating band thrown
	3	+28	-9	
	4	+45	-2	
	5	+36	-9	
	6	+39	+12	
	7	+54	+20	
	8	+13	+37	
	9	+2	+20	
	10	-46	+39	
	11	+31	-3	
	Average	+22	+12	Excluding Round No. 2
	Std. Dev.	+29	+18	" " " "
7-11	1	+16	-6	
	2	+15	+30	
	3	-18	+15	
	4	-27	+27	
	5	+28	0	
	6	+6	+10	
	7	+8	+16	
	8	-12	+6	
	9	+6	+48	
	10	+8	+3	
	Average	+3	+15	
	Std. Dev.	+17	+16	

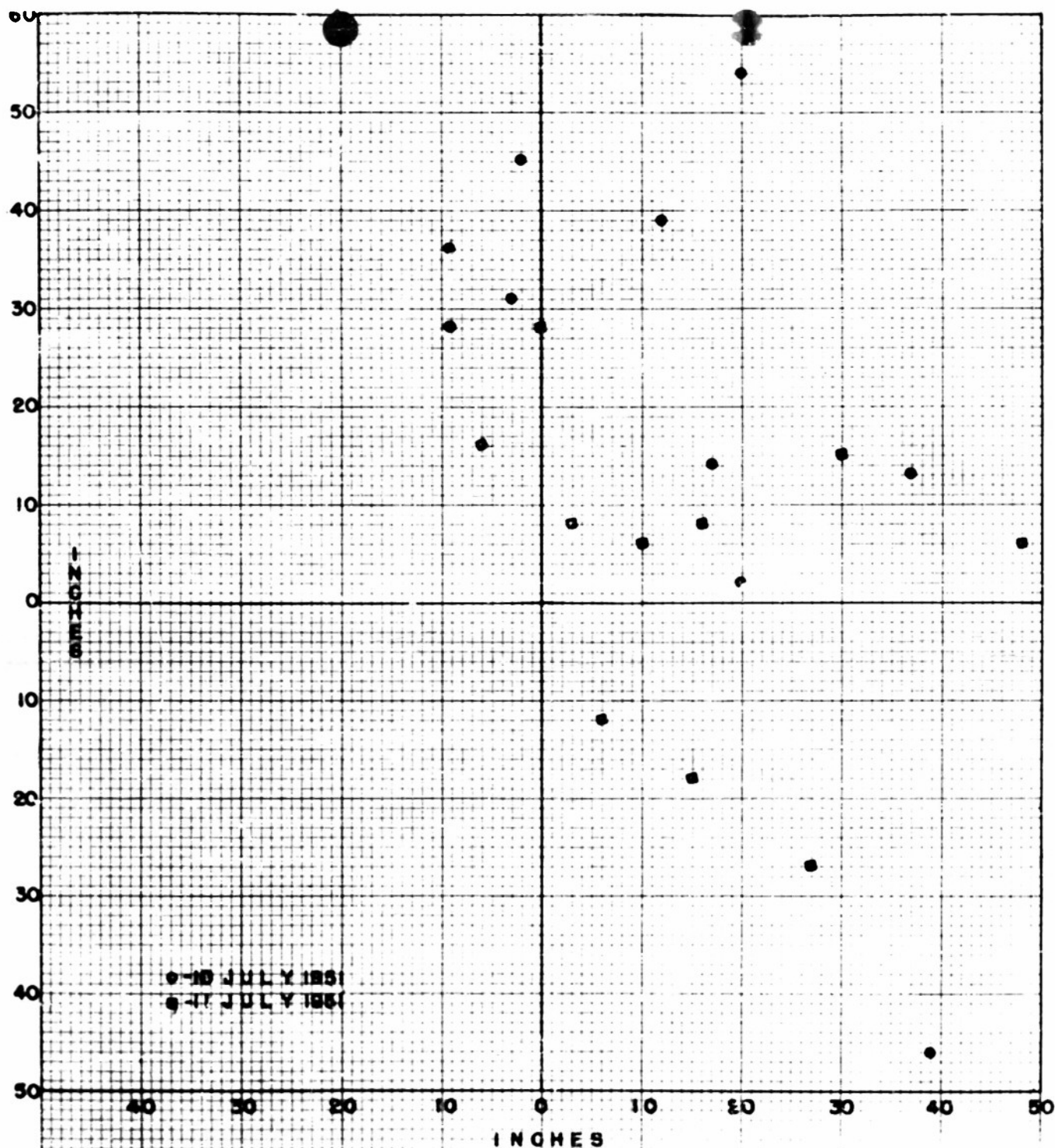
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11 JUL 51

NOTE: DISTANCES OUT TO SOLENOID NO. 4 ARE MEASURED ALONG THE LINE OF FIRE. DISTANCE TO TARGET IS MEASURED ALONG A HORIZONTAL LINE. WESTINGHOUSE DOPPLER VELOCITY MEASURED APP. 7 FT. FROM MUZZLE.



APP'G			SETUP FOR 20 MM VELOCITIES			NAVAL PROVING		
4-15-51			AT PUMPKIN NECK			GROUND		
JCS			JULY 10 8 11, 1951			DAHLGREN, VA.		
CHECKED 8-15-51			NOT TO SCALE			NPG DRAWING NO.		
DRAWN 8-15-51			DIMENSIONS ARE IN FEET			E-A425		



NPO-62539

Figure 1

Dispersion pattern on normal plane at 1000 yards of Gerlikon 20mm projectiles. Zero point on the graph was on the line of sight.

Appendix (C)

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Test of 20mm Mount Mark 10, with Oerlikon Modifications

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TABLE II

POINTS OF ENTRY OF 20MM  
PROJECTILES ON PORT WING OF TRF AIRCRAFT

<u>Shot No.</u>	<u>Type</u>	<u>Entry Hole Diameter (inches)</u>	<u>Distance From Previous Shot (inches)</u>
1	SS/K	13/16	
2	SS/K	15/16	27-1/2
3	SS/K	1	14-1/2
4	SB/K	7/8	15
5	SB/K	3/4	16
6	SB/K	1-1/32	26
7	SB/K	1-1/32 X 1-1/4	38-1/4

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APPENDIX B



NP9-62540

17 July 1951

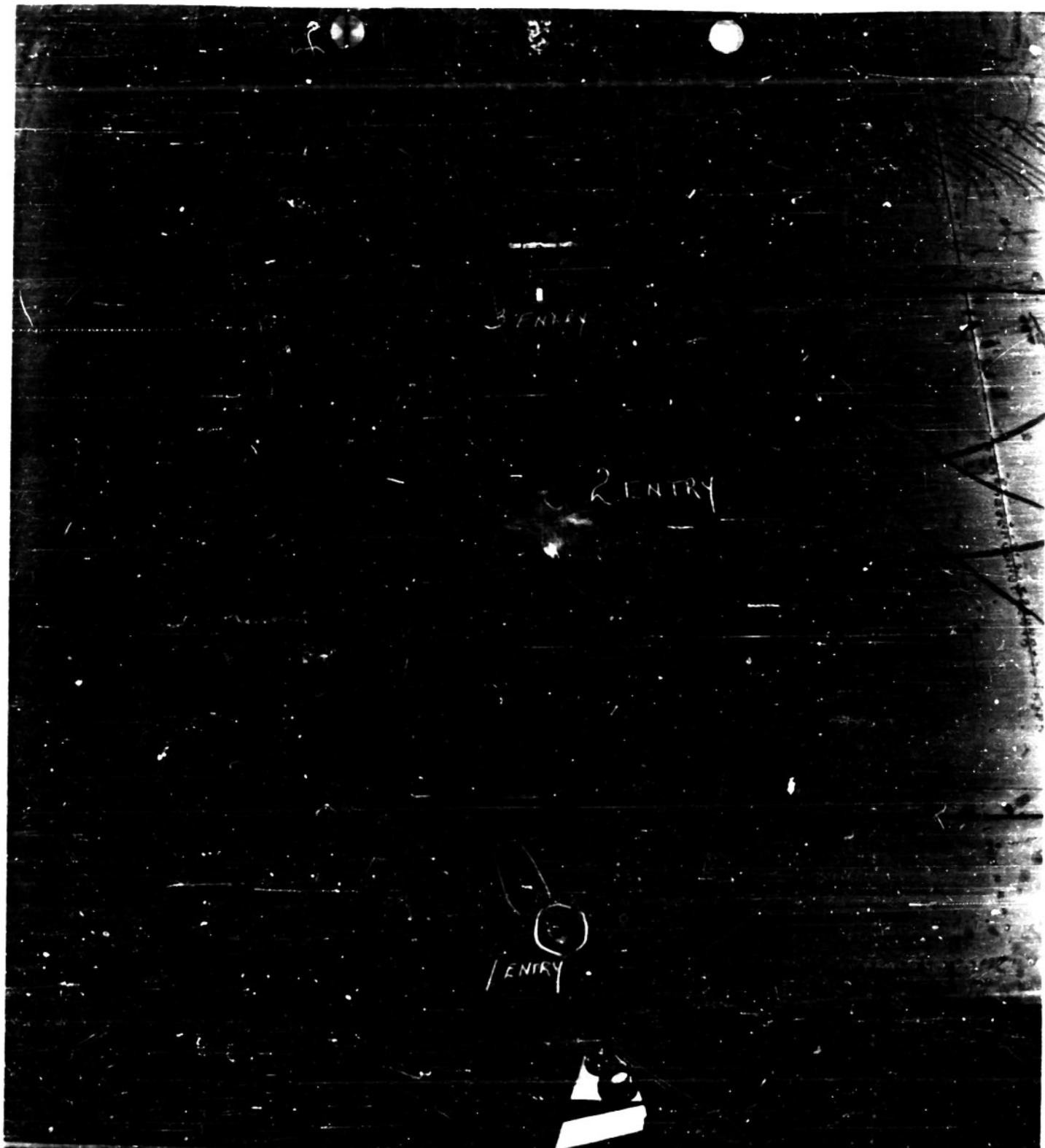
Port wing of a TBF aircraft in position for test firing of Oerlikon  
20mm-fuzed and loaded ammunition.

Figure 2

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Appendix D



NP9-62541

17 July 1951

Part of wing showing points of entry of first three Oerlikon  
20mm projectiles, type SS/K.

Figure 3

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Appendix D



NP9-62542

17 July 1951

Part of wing showing points of entry of Oerlikon 20mm projectiles.

Figure 4

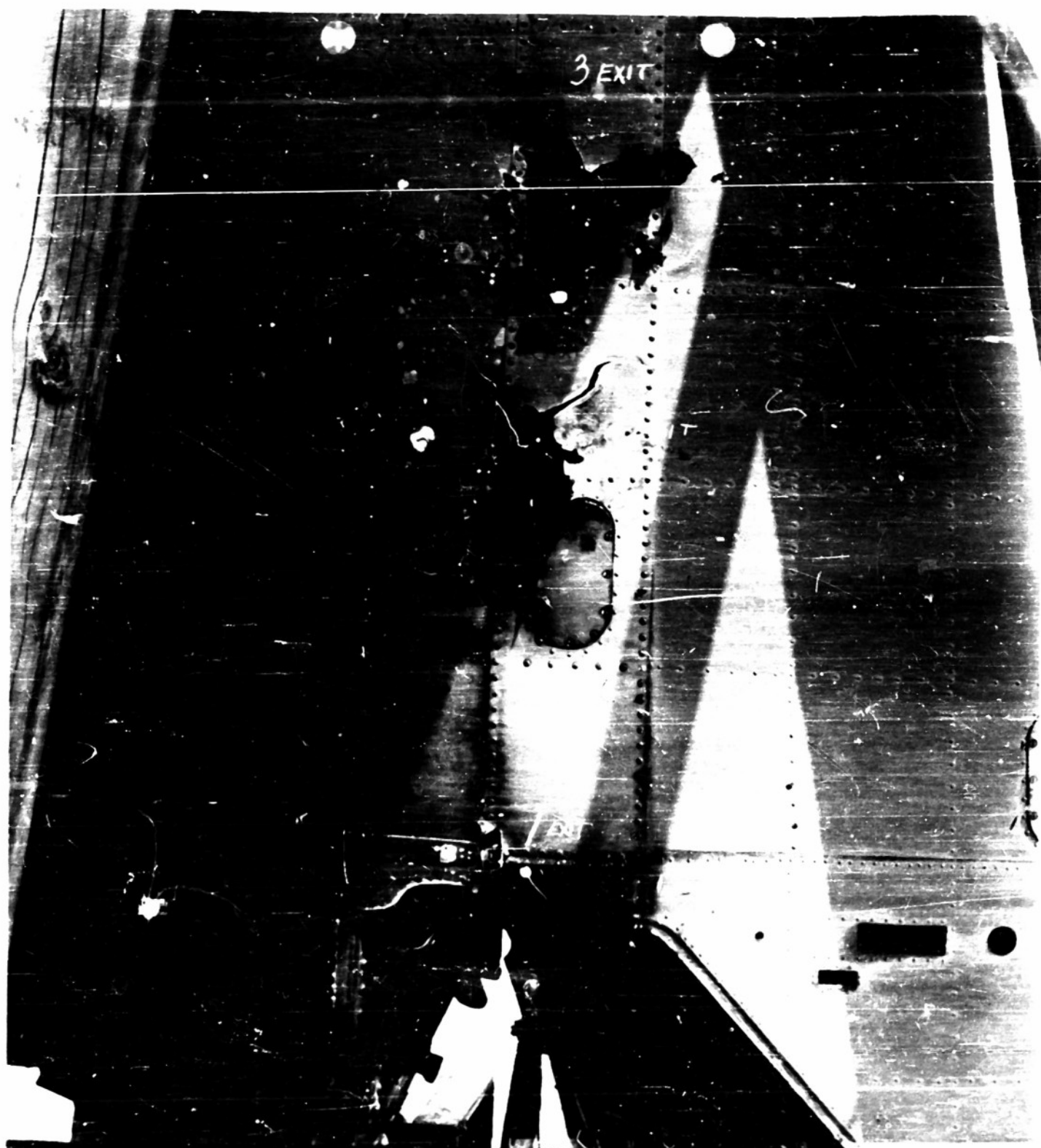
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Appendix D







NP9-62543

17 July 1951

View of wing showing damage resulting from first three rounds  
of Oerlikon 20mm projectiles, type SS/K.

Figure 5

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Appendix D

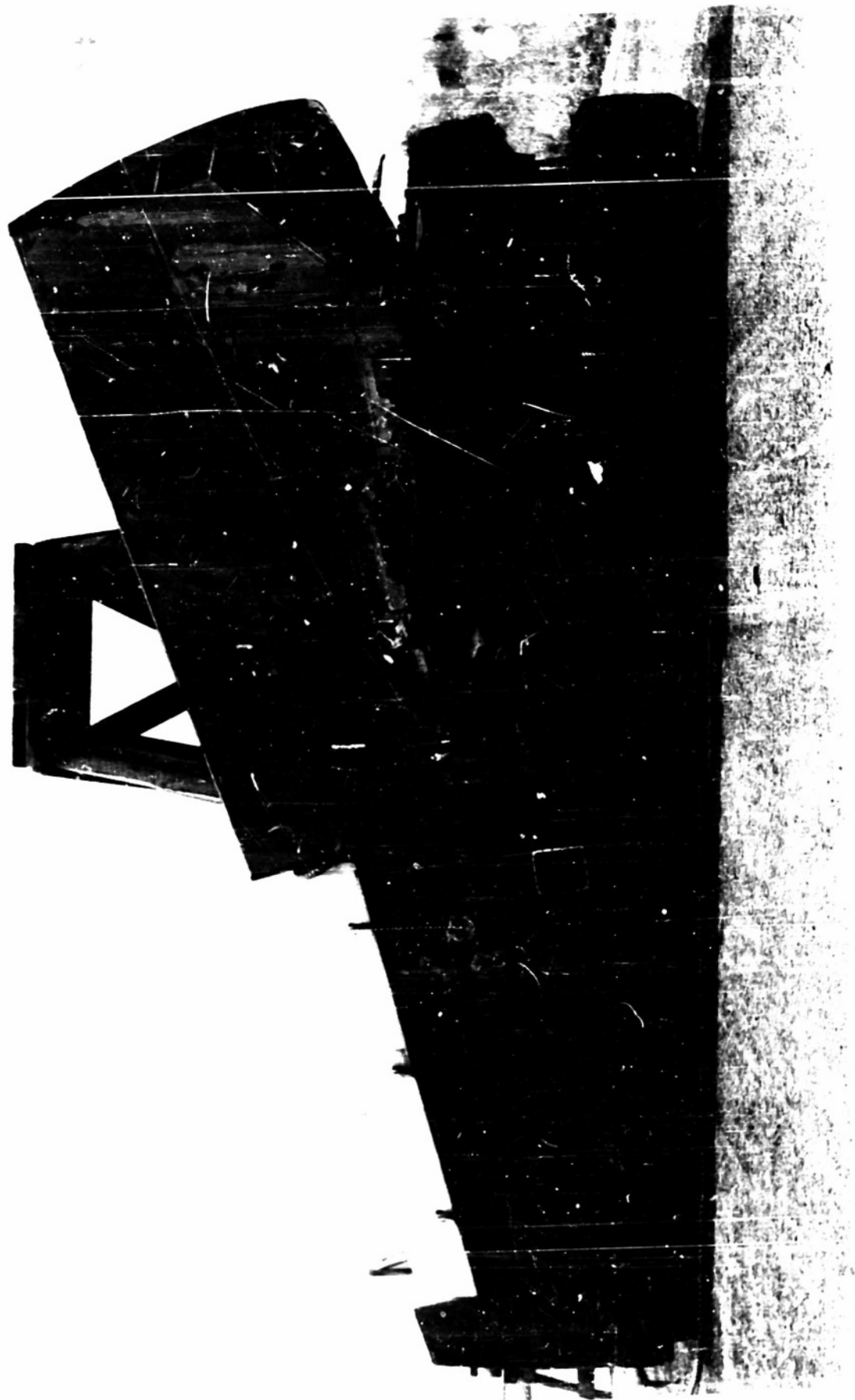
NP9-62544

View of wing showing damage  
types SS/K and SB/K.

17 July 1951

resulting from seven rounds of  
Figure 6

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Oerlikon 20mm ammunition,  
Appendix D



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Test of 20mm Mount Mark 10, with Oerlikon Modifications

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TABLE III

DIMENSIONS OF SPRINGSDimensional and Deflection-Load Data

<u>Spring No.</u>	<u>Outside Diameter</u>	<u>Inside Diameter</u>	<u>Wire Diameter</u>	<u>Free Length</u>	<u>Number of Actual Coils</u>	<u>Direction of Winding</u>	<u>Offset from Perpendicular</u>
Z-37243	3 3/30	2 7/62	0 7/30	20 7/80	22 7/8	Right Hand	0 7/50
Z-37244	3 3/31	2 7/62	0 7/31	20 7/72	21 7/7	Right Hand	0 7/50
Z-37245	3 7/28	2 7/57	0 7/30 x 0 7/345	17 7/50	19 7/5	Left Hand	< 0 7/09
Z-37246	3 7/30	2 7/62	0 7/30	10 7/90	13 7/9	Left Hand	0 7/40
Z-37247	3 7/31	2 7/63	0 7/30	10 7/81	13 7/8	Left Hand	0 7/30
Z-37248	3 7/07 and 3 7/27 *	2 7/35 2 7/55 *	0 7/30 x 0 7/345	9 7/84	12 7/5	Right Hand	< 0 7/09

\* Dimensions given are for unpainted end and painted end respectively.

Note: (1) Springs No. Z-37245 and Z-37248 are springs from a special 20mm recoil assembly received from the Bureau of Ordnance.

(2) The remaining four (4) springs were drawn from stock at the Naval Gun Factory. These springs are parts for a 20mm standard recoil assembly.

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APPENDIX E

## Test of 20mm Mount Mark 10, with Oerlikon Modifications

TABLE IV

DEFLECTION - LOAD TEST DATA

(a) Spring No. Z-37243

<u>1st Cycle</u>		<u>Compressed Height for * Cycles 2-5 Incl.</u>	<u>Load in Pounds</u>			
<u>Compressed Height</u>	<u>Load in Pounds</u>		<u>2nd Cycle</u>	<u>3rd Cycle</u>	<u>4th Cycle</u>	<u>5th Cycle</u>
20"30	16	20"16	16	16	16	16
19"30	33	19"66	33	32	32	32
19"30	49	19"16	49	49	49	49
18"80	65	18"66	65	65	65	65
18"30	81	18"16	81	81	81	81
17"80	97	17"66	97	97	97	97
17"30	115	17"16	115	115	115	116
16"80	131	16"66	131	131	131	131
16"30	148	16"16	148	148	147	147
15"80	164	15"66	164	164	164	164
15"30	180	15"16	180	180	180	180
14"80	197	14"66	197	197	197	197
14"30	213	14"16	213	213	213	213
13"80	230	13"66	230	230	230	230
13"30	246	13"16	247	247	247	247
12"80	258	12"66	252	262	262	262
12"30	279	12"16	280	280	280	280
11"80	293	11"66	295	295	295	295
11"30	311	11"16	312	312	312	312
10"80	327	10"66	330	330	330	330
10"30	346	10"16	346	347	347	347
9"80	362	9"66	363	363	363	363
9"30	377	9"16	378	378	378	378
8"80	398	8"66	398	398	398	398
8"30	413	8"16	413	414	414	413
7"80	450	7"66	451	451	451	451
7"62	Solid	7"62	Solid	Solid	Solid	Solid

\* Spring showed 0"14 permanent set after 1st compression.

## Test of 20mm Mount Mark 10, with Oerlikon Modifications

TABLE IV (Continued)

DEFLECTION - LOAD TEST DATA

(b) Spring No. Z-37244

<u>1st Cycle</u>		<u>Compressed Height for * Cycles 2-5 Incl.</u>	<u>Load in Pounds</u>			
<u>Compressed Height</u>	<u>Load in Pounds</u>		<u>2nd Cycle</u>	<u>3rd Cycle</u>	<u>4th Cycle</u>	<u>5th Cycle</u>
20:22	19	20:06	19	18	19	18
19:72	35	19:56	36	36	37	37
19:22	53	19:06	53	53	53	53
18:72	69	18:56	68	68	68	68
18:22	86	18:06	85	85	85	85
17:72	104	17:56	103	103	103	103
17:22	120	17:06	121	121	122	121
16:72	135	16:56	137	137	137	137
16:22	152	16:06	153	153	153	153
15:72	170	15:56	170	171	171	171
15:22	187	15:06	188	188	188	188
14:72	202	14:56	204	204	204	204
14:22	219	14:06	220	220	220	220
13:72	235	13:56	238	238	238	238
13:22	252	13:06	254	254	254	254
12:72	270	12:56	273	273	273	273
12:22	286	12:06	289	289	289	289
11:72	303	11:56	306	306	306	306
11:22	319	11:06	321	321	321	321
10:72	334	10:56	340	340	340	340
10:22	353	10:06	356	356	356	357
9:72	369	9:56	374	374	374	374
9:22	387	9:06	389	389	389	390
8:72	405	8:56	408	408	408	408
8:22	423	8:06	428	428	428	428
7:72	451	7:56	469	470	470	470
7:40	Solid	7:40	Solid	Solid	Solid	Solid

\* Spring took 0.16 permanent set on 1st compression

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Test of 20mm Mount Mark 1C, with Oerlikon Modifications

TABLE IV (Continued)

DEFLECTION - LOAD TEST DATA

(c) Spring No. Z-37245

Compressed Height for Cycles 1-5, Incl.	Load in pounds				
	1st Cycle	2nd Cycle	3rd Cycle	4th Cycle	5th Cycle
17:00	28	28	28	28	28
16:50	55	55	55	55	55
16:00	82	83	83	83	83
15:50	107	108	108	109	109
15:00	137	137	137	137	137
14:50	165	164	164	164	164
14:00	192	192	192	192	192
13:50	219	219	219	219	219
13:00	247	247	247	247	247
12:50	275	274	274	275	275
12:00	303	302	302	302	302
11:50	331	330	330	330	330
11:00	360	359	359	359	359
10:50	389	386	386	387	387
10:00	415	416	416	416	416
9:50	439	443	443	443	443
9:00	466	466	466	466	466
8:50	500	500	500	500	500
8:00	530	531	531	531	531
7:50	555	557	557	557	557
7:00	588	589	589	589	589
6:50	623	624	624	624	624
6:20	Solid	Solid	Solid	Solid	Solid

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Test of 20mm Mount Mark 10, with Oerlikon Modifications

TABLE IV (Continued)

DEFLECTION - LOAD TEST DATA

(d) Spring No. Z-37246

Compressed Height for Cycles 1-5, Incl.	Load in Pounds				
	1st Cycle	2nd Cycle	3rd Cycle	4th Cycle	5th Cycle
10"40	26	26	26	26	26
9"90	52	52	52	52	52
9"40	79	79	79	79	79
8"90	103	102	103	103	103
8"40	135	134	134	134	134
7"90	162	161	161	161	161
7"40	190	188	189	189	188
6"90	212	213	213	213	213
6"40	244	243	243	243	243
5"90	273	272	272	272	272
5"40	303	302	302	302	302
4"90	337	337	337	337	337
4"70	Solid	Solid	Solid	Solid	Solid

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Test of 20mm Mount Mark 1C, with Gerlik n Modifications

TABLE IV (Continued)DEFLECTION - LOAD TEST DATA

(e) Spring No. Z-37247

Compressed Height for Cycles 1-5, Incl.	Load in Pounds				
	1st Cycle	2nd Cycle	3rd Cycle	4th Cycle	5th Cycle
10 <sup>7</sup> 31	28	26	26	26	26
9 <sup>7</sup> 81	54	52	53	52	52
9 <sup>7</sup> 31	81	80	80	80	80
8 <sup>7</sup> 81	109	105	106	106	105
8 <sup>7</sup> 31	133	130	130	130	130
7 <sup>7</sup> 81	160	157	156	156	156
7 <sup>7</sup> 31	186	184	185	184	184
6 <sup>7</sup> 81	210	209	210	210	210
6 <sup>7</sup> 31	238	236	236	236	236
5 <sup>7</sup> 81	268	265	264	264	264
5 <sup>7</sup> 31	300	295	295	295	295
4 <sup>7</sup> 81	336	336	335	336	336
4 <sup>7</sup> 72	Solid	Solid	Solid	Solid	Solid



## Test of 20mm Mount Mark 10, with Oerlikon Modifications

TABLE IV (Continued)  
DEFLECTION - LOAD TEST DATA

(f) Spring No. Z-37248

Compressed Height for Cycles 1-5, Incl.	Load in Pounds				
	1st Cycle	2nd Cycle	3rd Cycle	4th Cycle	5th Cycle
9"34	49	49	49	49	49
8"84	100	100	99	100	99
8"34	151	151	150	151	151
7"84	204	204	204	204	204
7"34	257	258	258	258	257
6"84	306	307	307	306	307
6"34	360	360	360	360	361
5"84	418	418	418	418	418
5"34	465	465	465	465	465
4"84	525	526	526	526	526
4"34	600	600	600	600	600
4"05	Solid	Solid	Solid	Solid	Solid

Note: Spring No. Z-37248 O.D. is 3"27 on painted end and 3"07 on unpainted end.

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Test of 20mm Mount Mark 10, with Oerliken Modifications

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APPENDIX F