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Ballistic Research Laboratories

TECHNICAL NOTE NO. 739

SEPTEMBER 1952

Comparative Firing of 105mm Shell T131E31 and 105mm Shell M1 From Unmodified and Counterbored M2A1 Howitzer Tubes

LEONARD C. Mac ALLISTER

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TECHNICAL NOTE NO. 739

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COMPARATIVE FIRING OF 105MM SHELL T131E31 AND 105MM SHELL M1 FROM UNMODIFIED AND COUNTERBORED M2A1 HOWITZER TUBES

Leonard C. MacAllister

Project No. TB3-0230A of the Research and Development Division, Ordnance Corps

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BALLISTIC RESEARCH LABORATORIES

TECHNICAL NOTE NO. 739

LCMacAllister/jrr
Aberdeen Proving Ground, Md.
September 1952

COMPARATIVE FIRING OF 105MM SHELL T131E31 AND 105MM SHELL M1 FROM UNMODIFIED AND COUNTERBORED M2A1 HOWITZER TUBES

ABSTRACT

The results of a program to determine the effects of a 2" long muzzle counterbore on the dispersion of the 105mm T131E31 are given. Some information is also given for the M1 shell which were used as calibration patterns. It is shown that the counterbore adversely affects the dispersion of these shell.

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INTRODUCTION

In the course of test firings of the T131E31 HEAT projectile (Fig. 1) designed for the 105mm Howitzer, it was found that the dispersion patterns fired from the counterbored[1] Howitzer tube were about double the size of the patterns given by the unmodified tube.[2] In the earlier stages of testing this shell had occasionally suffered fin damage during launching. In order to investigate whether or not the counterbored tube was damaging fins a program was planned for the Transonic Spark Range; the photographs and shadow graphs of the projectile early along its trajectory would indicate whether the shell had sustained any damage. Also, information on the yawing motion of each shell might shed some light on the causes for excessive dispersion as recorded on a thousand yard target.

TEST

Facility

The Transonic Spark Range is an enclosed firing range 760 feet long. Twenty-five photographic stations are distributed along its length in five groups of five units each. Each station has a camera unit to take shadowgraphs in both the horizontal and vertical planes. The photographs from these positions and the associated timing data determine the position and attitude of the projectile as a function of time or distance for the portion of the shell's trajectory which lies within the range building. Additional instrumentation in the form of yaw cards, microflash units, and direct full scale shadowgraphs can be provided between the station positions in the range. Exterior to the range building the projectile can fly along a cleared area up to a 1000 yard target. In this area yaw cards, microflash stations and movie camera may be employed.

Program

The test program consisted of the schedule of rounds shown in Table I below.

Table I

No.	Shell	Tube	Velocity	Instrumentation
10	M1	M2A1 - 2" counterbore	1730 fps	Velocity coils and 1000 yd. target (control pattern)
10	T131E31	M2A1 - 2" counterbore	1750 fps	Full range instrumentation and 1000 yd. target
10	M1	M2A1 Unmodified	1750 fps	Velocity coils and 1000 yd. target (control pattern)
12	T131E31	M2A1 Unmodified	1770 fps	Full range instrumentation and 1000 yd. target

1. The counterbore was two inches long, from the muzzle face, and one-thirty second of an inch deeper than the groves.

2. For further description of the shell and dispersion tests, "Engineering Progress Reports - 105mm Shell T131", Budd Co.

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A later program consisting of five rounds each of 105mm M1 fired from the counterbored and unmodified tubes at 1060 fps was carried out. These firings were carried out utilizing the range instrumentation alone since the physical height of the range building prohibited the use of gun elevations that would be required to reach a 1000 yard target at this velocity. Comparison of the average magnitudes of the yawing motion for the two groups would give an estimate of their relative dispersions.

Results and Conclusions

The measured dispersion patterns are shown in graphs 1, 2, 3, and 4. The probable errors are listed for comparison in Table II.

Table II

No.	Shell	M2A1 Tube	Velocity fps	$P.E._h$ mils	$P.E._v$ mils
10	M1	Unmodified	1750	0.18	0.13
10	M1	2" counterbore	1730	0.18	0.24
9	T131E31	Unmodified	1770	0.36	0.24
				0.26	0.24*
10	T131E31	2" counterbore	1750	0.53	0.63
				0.36	0.32*

* Dispersion pattern after removal of aerodynamic jump effects.[4]

In the case of the T131E31 rounds a limited yaw reduction[3] was carried out and the yawing motion was extrapolated to the region of the muzzle to obtain the initial conditions. The yawing velocity is the predominant initial condition and, for the projectiles of this type, initial yawing velocity is a major contributor to aerodynamic jump. The jump, attributable to the initial conditions, was calculated[4] for each shell and its effect subtracted vectorially from the observed strike of the shell on a 1000 yard target. The resulting dispersion patterns are given in graphs 5 and 6. The pattern, so corrected, for the T131 shell from the unmodified tube was slightly decreased. The dispersion from the counterbored tube, however, was diminished to about one half of its original size by the jump corrections and gave a probable error comparable with the unmodified tube firings.

This would indicate that the major difference between the patterns given by the unmodified and counterbored tubes to the T131 shell is due to the aerodynamic jump resulting from more adverse initial conditions induced by the counterbore.

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3. "Reduction of Spark Range Data", BRL Report 684, R. Turetsky.

4. "On Jump Due to Muzzle Disturbance", BRL Report 703, S. Zaroodny.

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The average maximum yaw for the firings of the M1 shell at 1060 fps are given in Table III.

Table III

Tube	Average Yaw (Deg.)
Unmodified	1.78
2" counterbore	2.01

A weak trend is evident toward larger yaws, and hence possibly larger dispersions for shell from the counterbored tube. However, since only a total of five rounds were reducible the results might be considered to carry little weight despite the fact that the trend seems to be in the expected direction.

It appears as if there might be a basic dispersion level for the gun-shell system (for the systems considered it appears to be on the order of $P.E._{h,v} = 0.13$) and in addition each type of shell reacts with the blast and/or other exit phenomenon which introduce more dispersion due principally to the aerodynamic jump. The M1 shell appears little affected by the exit phenomenon while the T131 shell reacts more strongly. The use of the counterbore apparently alters the exit conditions in a way to increase the amount of disturbance given to the shell.

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105 MM SHELL T131 E31

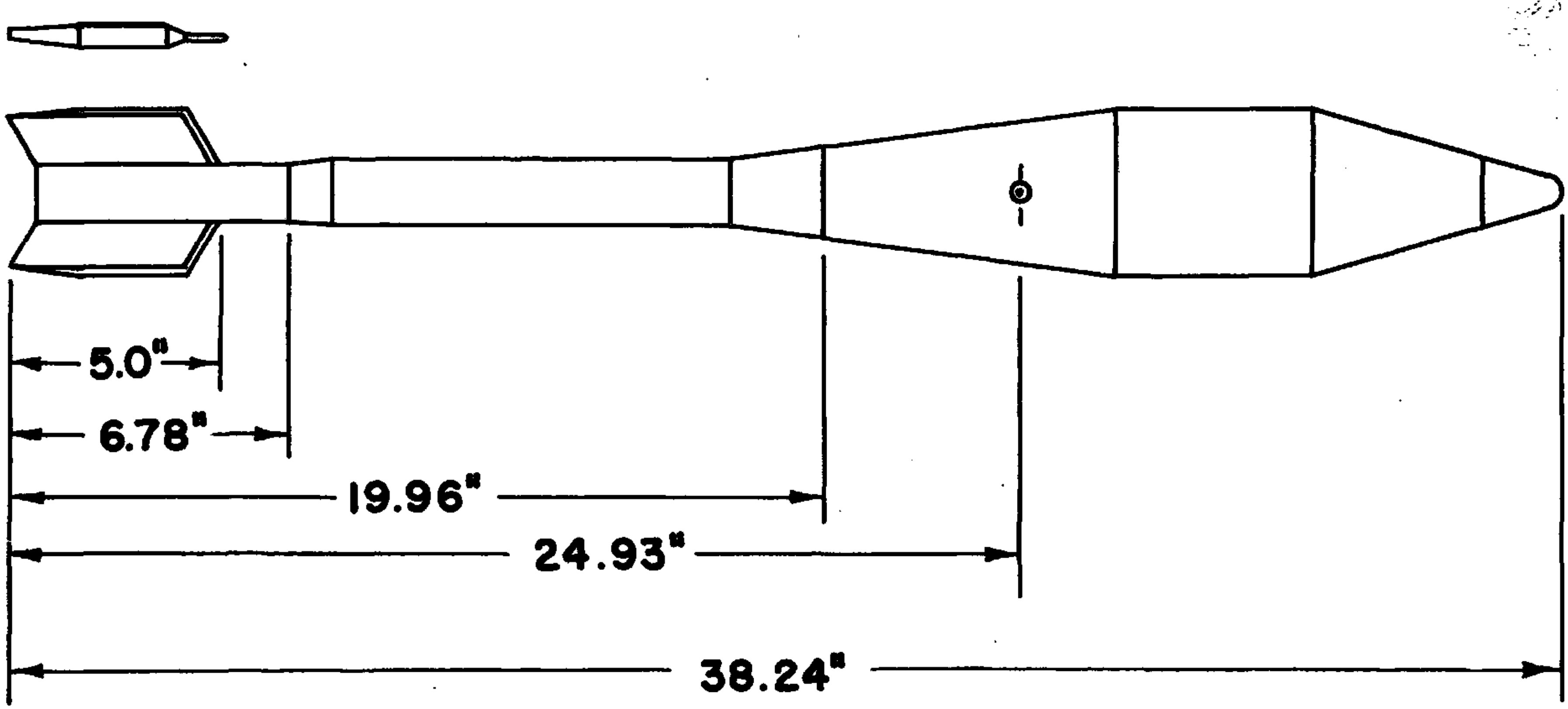

FIG. 1

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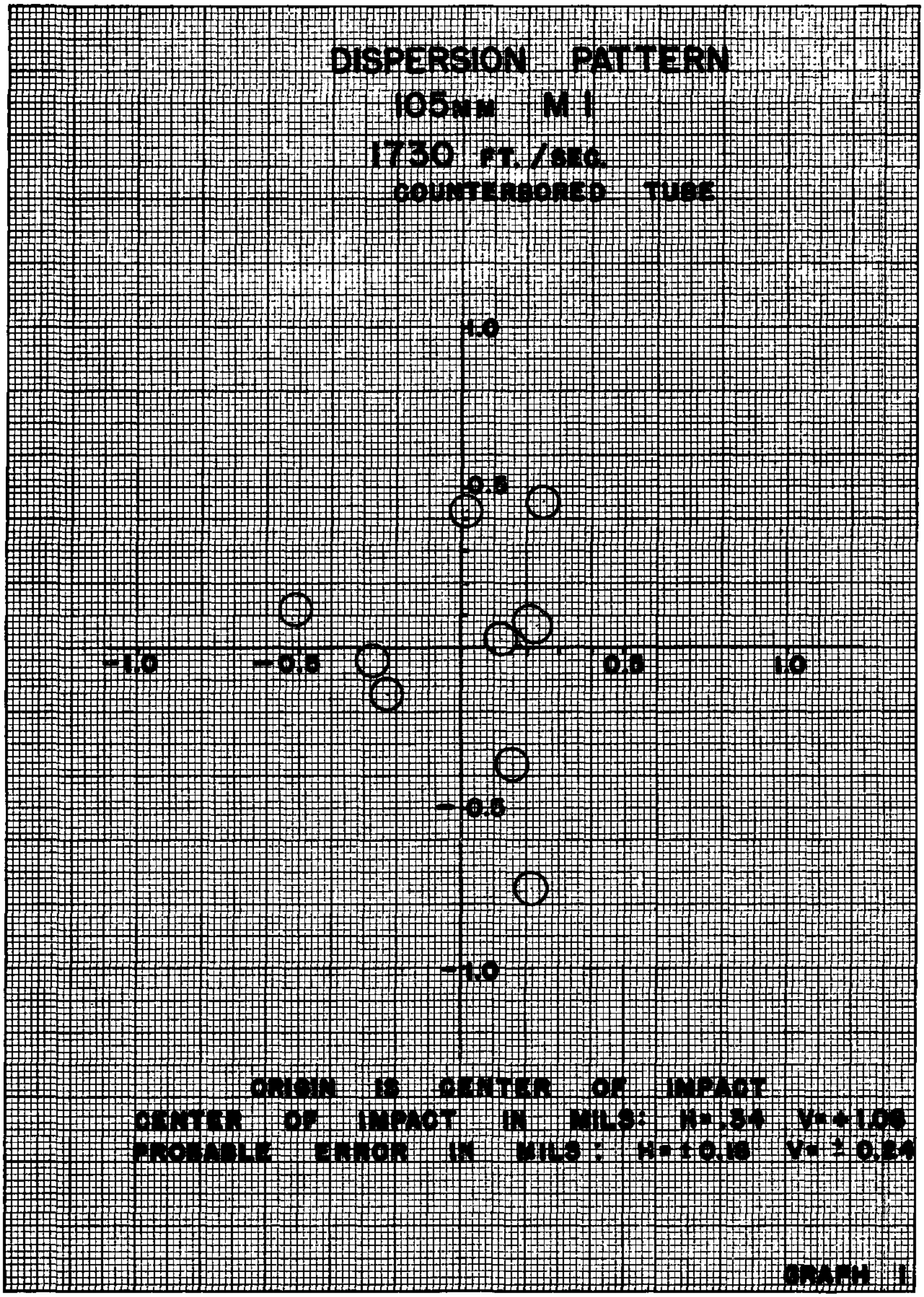

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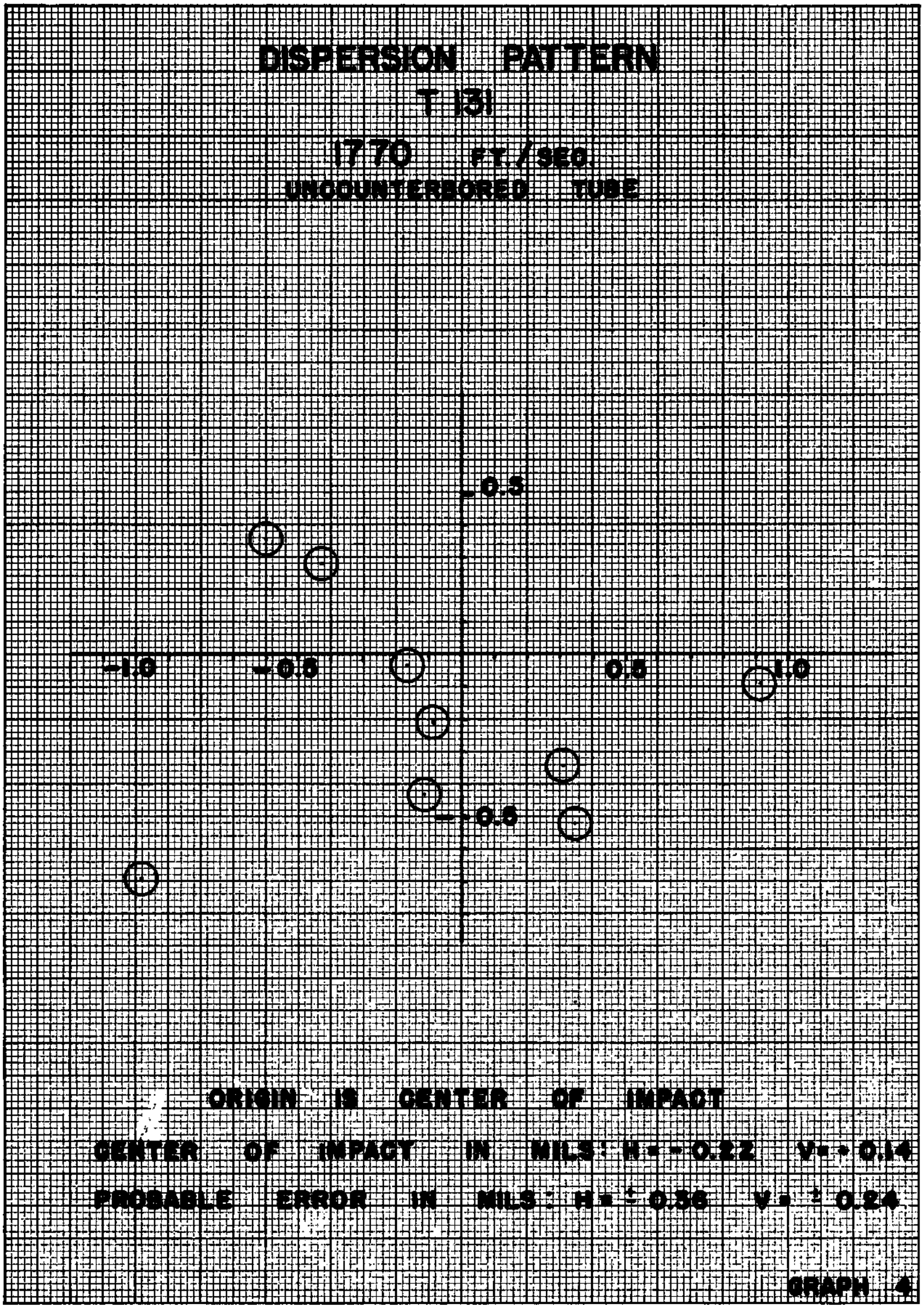

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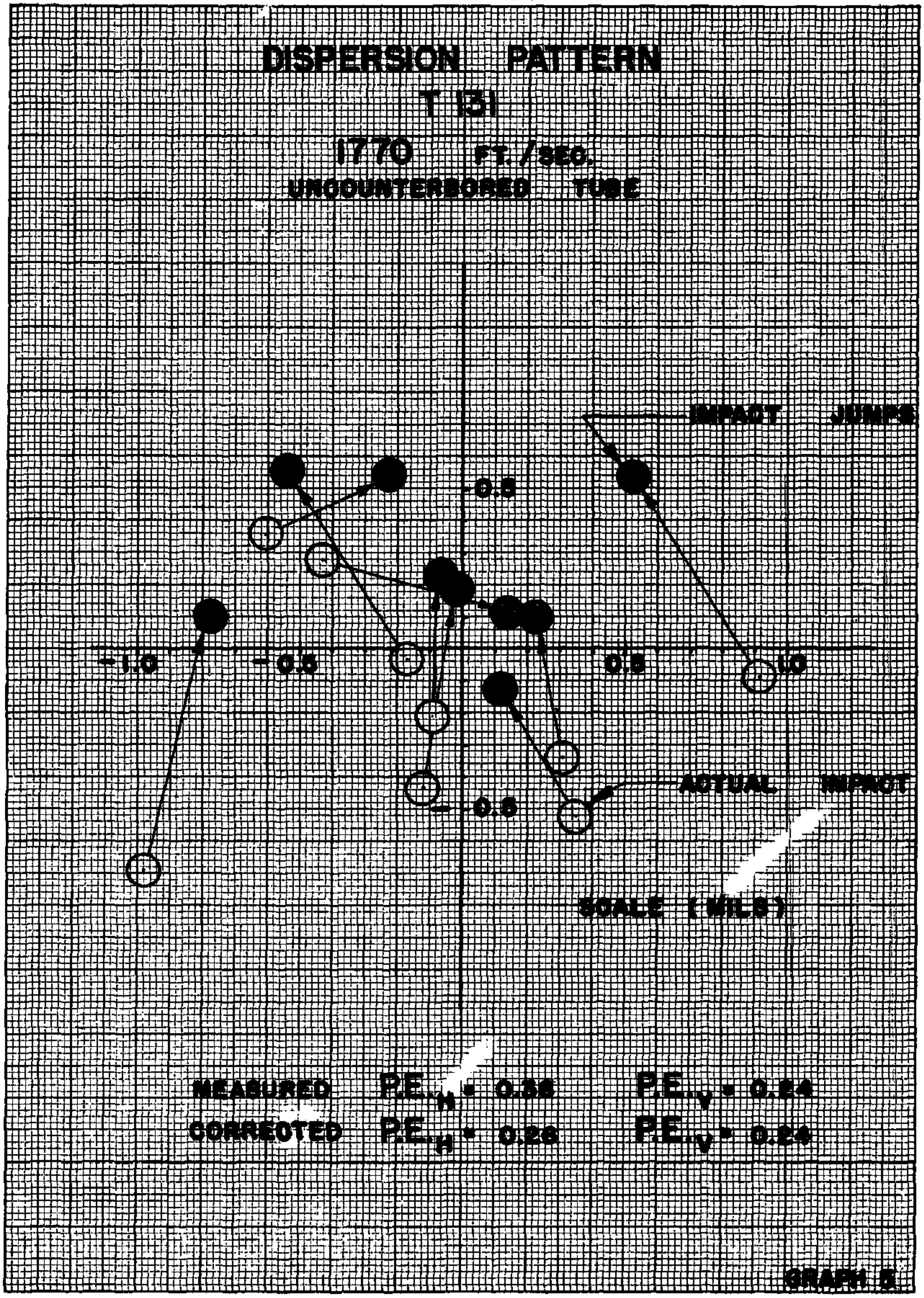

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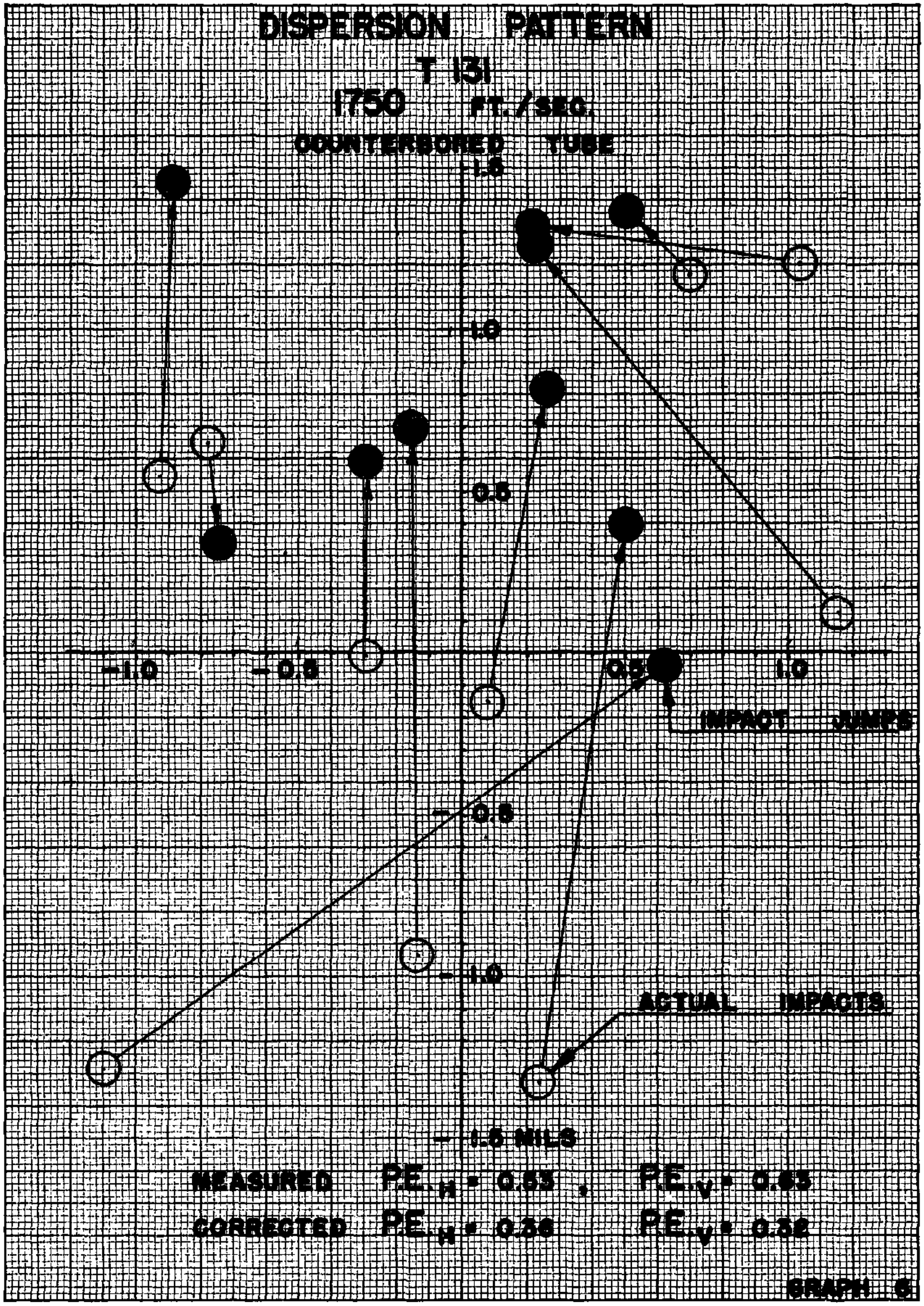

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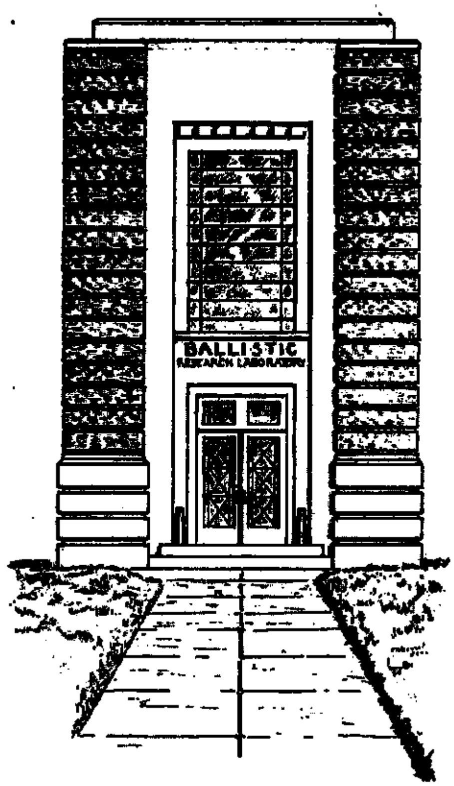

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